Accreditation of Dosimetry Services

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AV-Controlatom

Content

- History
- Regulatory requirements
- Discussion of reference documents/standards
- Practical implementation
- Conclusion

History

- Before 2001
  - Responsibility of Ministery of Labour to 'approve' dosemeters
  - Only dosemeters were approved, not the laboratories or dosimetry services
  - Dosemeters approved as 'basic dosemeter' to be used as official dosemeter (basis dosismeter/ dosimètre de base)

History

Approval of filmdosemeter in 1966

MINISTERIE VAN TEWERKSTELLING EN ARBEID

Ministerieel besluit waarbij een type dosimeter erkend wordt. (1).

De Minister van Tewerkstelling en Arbeid,

Gelet op het koninklijk besluit van 28 februari 1963 houdende algemeen reglement op de bescherming van de bevolking en van de werknemers tegen het gevaar van de ioniserende stralingen, inzonderheid op artikel 30.6 gewijzigd bij het koninklijk besluit van 17 mei 1966;

Gelet op de aanvragen, gedagtekend 11 februari 1966 en 7 maart 1966, waarbij de Rijksuniversiteit te Gent, St.Pieters-nieuwstraat 25, Gent en het Radiologisch instituut van de Rijksuniversiteit te Luik, 66, boulevard de la Constitution, Luik, de erkenning aanvragen van een type dosimeter, gefabriceerd door het Atomic Energy Research Establishment - (A.E.R.E.) in samenwerking met de Radiological Protection Service (R. P. S.), afhangend van de United Kingdom Authority van Engeland, type ERP 30;

Gelet op het advies van de Administratie van de arbeidsveiligheid;

MINISTERE DE L'EMPLOI ET DU TRAVAIL

Arrêté ministériel agréant un type de dosimètre.(1)

Le Ministre de l'Emploi et du Travail,

Vu l'arrêté royal du 28 février 1963 portant règlement général de la protection de la population et des travailleurs contre le danger des radiations ionisantes, notamment l'article 30.6 modifié par l'arrêté royal du 17 mai 1966;

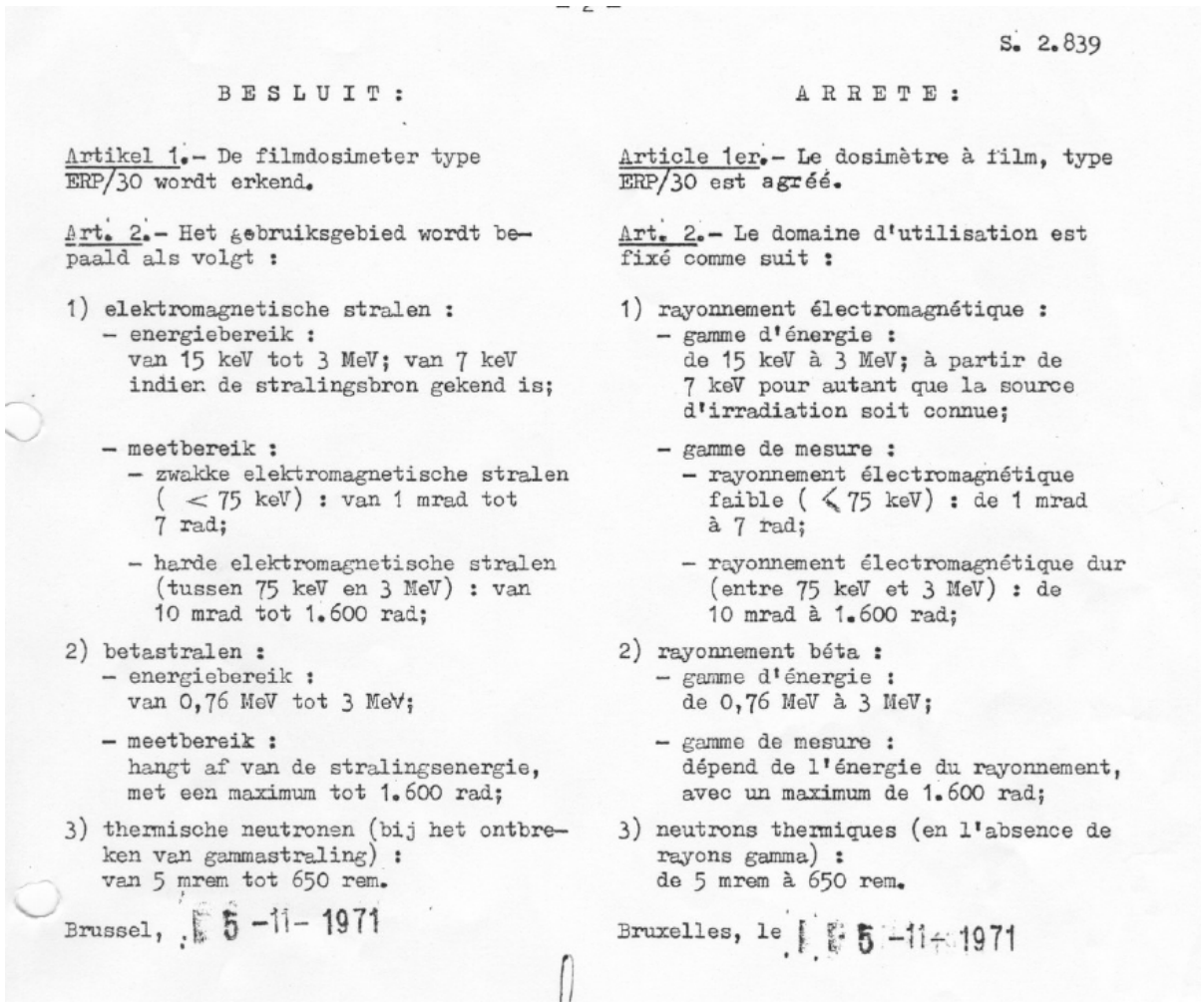
Vu les demandes, datées des 11 février 1966 et 7 mars 1966, par lesquelles l'Université de l'Etat à Gand, St-Pieters-nieuwstraat 25, Gand et l'Institut de radiologie de l'Université de l'Etat à Liège, 66, boulevard de la Constitution, Liège, sollicitent l'agréation d'un type dosimètre fabriqué par le Atomic Energy Research Establishment - (A.E.R.E.) en collaboration avec le Radiological Protection Service (R.P.S.), dépandant de l'United Kingdom Atomic Energy Authority d'Angleterre, type ERP 30;

Vu l'avis de l'Administration de la sécurité du travail;

History

Prolongation of approval of filmdosemeter

Specification of domain (doserange/ energy range/ radiation type)



S. 2.839

B E S L U I T :

Artikel 1.- De filmdosimeter type ERP/30 wordt erkend.

Art. 2.- Het gebruiksgebied wordt bepaald als volgt :

1) elektromagnetische stralen :
   - energiebereik :
     van 15 keV tot 3 MeV; van 7 keV indien de stralingsbron gekend is;
   - meetbereik :
     - zwakke elektromagnetische stralen (< 75 keV) : van 1 mrad tot 7 rad;
     - harde elektromagnetische stralen (tussen 75 keV en 3 MeV) : van 10 mrad tot 1.600 rad;
2) betastralen :
   - energiebereik :
     van 0,76 MeV tot 3 MeV;
   - meetbereik :
     hangt af van de stralingsenergie, met een maximum tot 1.600 rad;
3) thermische neutronen (bij het ontbreken van gammastraling) :
   van 5 mrem tot 650 rem.

Brussel, 5 -11- 1971

A R R E T E :

Article 1er.- Le dosimètre à film, type ERP/30 est agréé.

Art. 2.- Le domaine d'utilisation est fixé comme suit :

1) rayonnement électromagnétique :
   - gamme d'énergie :
     de 15 keV à 3 MeV; à partir de 7 keV pour autant que la source d'irradiation soit connue;
   - gamme de mesure :
     - rayonnement électromagnétique faible (< 75 keV) : de 1 mrad à 7 rad;
     - rayonnement électromagnétique dur (entre 75 keV et 3 MeV) : de 10 mrad à 1.600 rad;
2) rayonnement béta :
   - gamme d'énergie :
     de 0,76 MeV à 3 MeV;
   - gamme de mesure :
     dépend de l'énergie du rayonnement, avec un maximum de 1.600 rad;
3) neutrons thermiques (en l'absence de rayons gamma) :
   de 5 mrem à 650 rem.

Bruxelles, le 5 -11- 1971

History

- New Royal Decree 2001
  - Responsibility of FANC to approve dosimetry services (art. 30.6)
    - » Only dosimetry by approved services
  - Criteria defined by FANC
    - » For service, including dosemeter
    - » For dosemeter
  - Transition period of 2 years after publication of FANC criteria

Requirements

- Fanc decree of 01.07.2008 stipulates the criteria for approval :
  - Accreditation conform ISO 17025
    (General requirements for the competence of testing and calibration laboratories)
    - Only from 2013
  - Apply the recommendations of RP73 (1994)
    (Technical recommendations for monitoring individuals occupationally exposed to external radiation)
    - » Later updated to RP160 (2009)
  - Participate in intercomparison exercises
    - » For X/γ radiation ISO 14146 applies
      (Criteria and performance limits for the periodic evaluation of processors of personal dosemeters for X and gamma radiation)

Requirements

- Supplementary standards were mentioned for the dosemeters :
  - IEC 62387 (Passive integrating dosimetry systems for personal and environmental monitoring of photon and beta radiation)
  - In 2008 also
    - ISO 1757 : Filmdosemeters
    - ISO 61066 : TLD dosemeters
    - ISO 12794 : TLD extremities, eye
    - ISO 21909 : Neutron dosemeters
  - Recent version of IEC 62387 includes the requirements that previously were published in separate standards (eg. ISO 12794)

FIRST STEP: DO WE HAVE A COMPLIANT DOSEMETER?

Performance requirements for dosemeters

- IEC 62387 remains main standard used for type testing dosemeters. Describes :
  - Test procedures
  - Performance requirements
    - Hp(10), Hp(0.07), H*(10)…
  - Requirements concerning manual
  - Requirements concerning software
  - Environmental performance requirements
    - Temperature, humidity

Performance requirements for dosemeters
(IEC 62387)

Table 3 – Performance requirements for $H_p(10)$ dosemeters

Line	Characteristic under test	Main characteristics or mandatory measuring range or mandatory range of influence quantity	Performance requirement for the rated range	Sub-clause
1	Capability of the dosimetry system	Measuring range; influence quantities; r_{max}; model function	To be documented by the manufacturer for the type test	7
2	Requirements to the design of the dosimetry system	Dose i… on rea… evalua…		
3	Effects of radiation not intended to be measured	… (O-moderated)		
4	Instruction manual	Information for correct use; information about the performance of the system	To be documented by the manufacturer for the type test and checked during type test	9
5	Softwar… and interfaces	Authenticity of the software; correctne… data	To be documented by the	10
6	Relative response due to non-linearity	0,1 mSv		
7	Coefficient of variation, v	H < 0,1 m… 0,1 mSv … $H \geq 1,1$ m…		
8	Overload, after-effects, and reusability	10 times the meas… $10 \cdot H_{up}$, however at maximum 10 Sv. Reused dosemeters shall fulfil the requirements	measuring range, after-effects may not cause fault measurements and $v(H_{low})$ shall be according to line 7	
9	Relative response due to mean photon radiation energy and angle of incidence	80 keV to 1,25 MeV and 0° to ± 60° from reference direction	For 12 keV ≤ E_{ph} < 33 keV: r_{min} = 0,67 to r_{max} = 2,00 and for 33 keV ≤ E_{ph} < 65 keV: r_{min} = 0,69 to r_{max} = 1,82 and	11.5.1
10	Relative response … to mean beta radiation energy	0,8 MeV		
11	As in line 9 and 10 but new reference direction opposite to that one used	… line … statement … manufact…		
12	Radiation incidence from the side of the dosemeter	Radiation … 60° to 12…		
13	Response to mixed irradiations	Irradiatio… radiation		
14	Total effect due to environmental performance requirements	Temperature, light, time; for details, see Table 6	See Table 6	13
15	Deviation due to electromagnetic performance requirements	See Table 7	See Table 7	14
16	Deviation due to mechanical performance requirements	Drop; for details, see Table 8	± 0,7·H_{low} at a dose of H = 7 H_{low}	15

The non-symmetrical borders of relative responses r are derived from symmetrical borders of correction factors $(1/r)$, for example: ± 40 % for $1/r \in [0,6 \ldots 1,4] \rightarrow r \in [1/1,4 \ldots 1/0,6] = [0,71 \ldots 1,67]$.

Linearity

6	Relative response due to non-linearity	0,1 mSv ≤ H ≤ 1 Sv	–9 % to +11 %	11.3

Reproducibility

7	Coefficient of variation, v	H < 0,1 mSv 0,1 mSv ≤ H < 1,1 mSv H ≥ 1,1 mSv	15 % $\left(16 - \frac{H}{0{,}1\ \text{mSv}}\right)$ % 5 %	11.2

Energy/Angle

9	Relative response due to mean photon radiation energy and angle of incidence	80 keV to 1,25 MeV and 0° to ± 60° from reference direction	For 12 keV ≤ E_{ph} < 33 keV: r_{min} = 0,67 to r_{max} = 2,00 and for 33 keV ≤ E_{ph} < 65 keV: r_{min} = 0,69 to r_{max} = 1,82 and for E_{ph} ≥ 65 keV: r_{min} = 0,71 to r_{max} = 1,67	11.5.1

Test procedure
(Energy / Angle)

11.5.1.2 Method of test

The following radiation qualities specified in ISO 4037 shall be used:

N-15, N-20, N-30, N-40, N-60, N-80, N-100, N-150, N-200, N-300, S-Cs (^{137}Cs), S-Co (^{60}Co), R-C (4,4 MeV), R-F (6,7 MeV).

Irradiations shall be performed for the following energies and angles of incidence α:

α	$H_p(10)$ dosemeters (irradiations on phantom, 5.1.5)	$H^*(10)$ dosemeters (irradiations free in air)
0°	For all radiation qualities whose mean energy fall within the rated range of energy	For all radiation qualities whose mean energy fall within the rated range of energy
±60°	Three lowest energies in rated range of energy	Three lowest energies in rated range of energy
$\pm\alpha_{max}$	Three lowest energies in rated range of energy	Three lowest energies in rated range of energy
90°	This test is given in 11.7	Three lowest energies in rated range of energy
$\pm(180°-\alpha_{max})$	As for α_{max}, not necessary if badge is symmetrical or backwards usage is prevented (see 8.4 f)	As for α_{max}, not necessary if badge is symmetrical
±120°	As for 60°, not necessary if badge is symmetrical or backwards usage is prevented (see 8.4 f)	As for 60°, not necessary if badge is symmetrical
180°	As for 0° angle of incidence, not necessary if badge is symmetrical or backwards usage is prevented (see 8.4 f)	As for 0° angle of incidence, not necessary if badge is symmetrical
NOTE The badge is symmetrical, if all parts including filters are symmetrical with respect to a plane through the centre of the detector and perpendicular to the reference direction.		

For $\alpha = \pm 60°$, $\alpha = \pm\alpha_{max}$, $\alpha = \pm(180°-\alpha_{max})$ and $\alpha = \pm 120°$ the tests shall be performed in two perpendicular planes parallel to the reference direction and going through the reference point of the dosemeter. Different directions for one angle of incidence (for example +60° and –60°) shall only be irradiated if the construction of the dosemeter is not symmetrical with respect to a change of that direction.

Implementation by dosimetry service

- Data from type testing of supplier
  - Some tests need to be repeated for own system (eg. Linearity)
- Problems
  - Sometimes design of dosemeter < IEC 62387
  - Type testing of supplier with ANSI N13.11 standard
  - Solution
    - Dosimetry service performs (partially) type testing

Examples
(OSL BeO)

Conformity Certificate

Manufacturer: **IBA Dosimetry GmbH**
Address: **Bahnhofstraße 5**
D - 90592 Schwarzenbruck
In cooperation with
HMGU Munich

Product: Optical Stimulated Luminescence
Dosimeter System
BeO*max*

Model **BeO*max*** Reader
BeO*max* Erasure
BeO*max* Dosimeter (4element)

The products listed above comply with:

IEC 62387-1 **Radiation protection instrumentation:**

Passive integrating dosimetry systems for environmental and personal monitoring

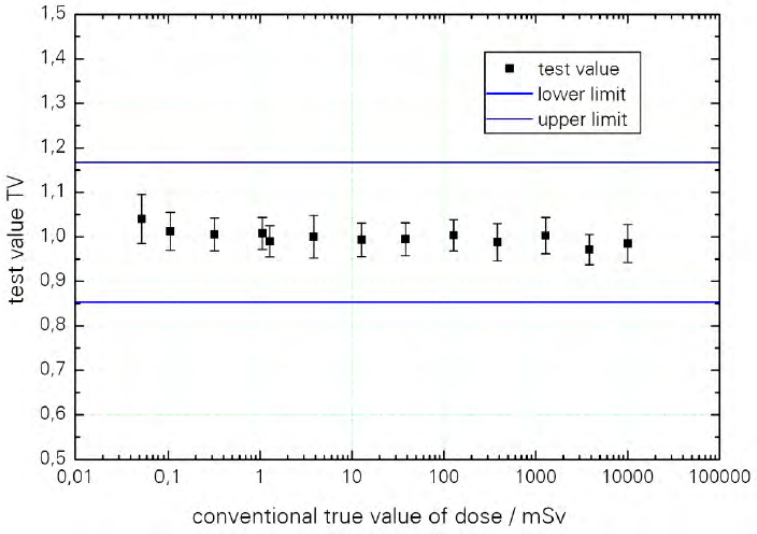
Part 1: General characteristics and performance requirements

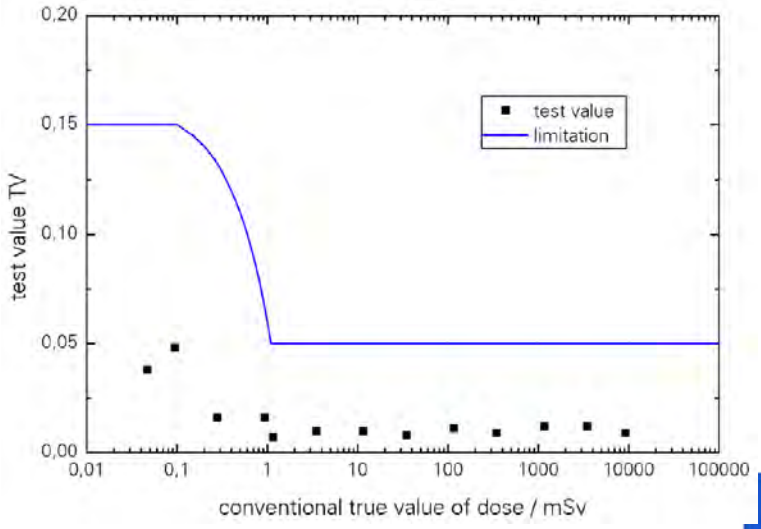
Schwarzenbruck, 24.03.2010

Vice President PLM
IBA Dosimetry GmbH
ppa. Uwe Mollenhauer

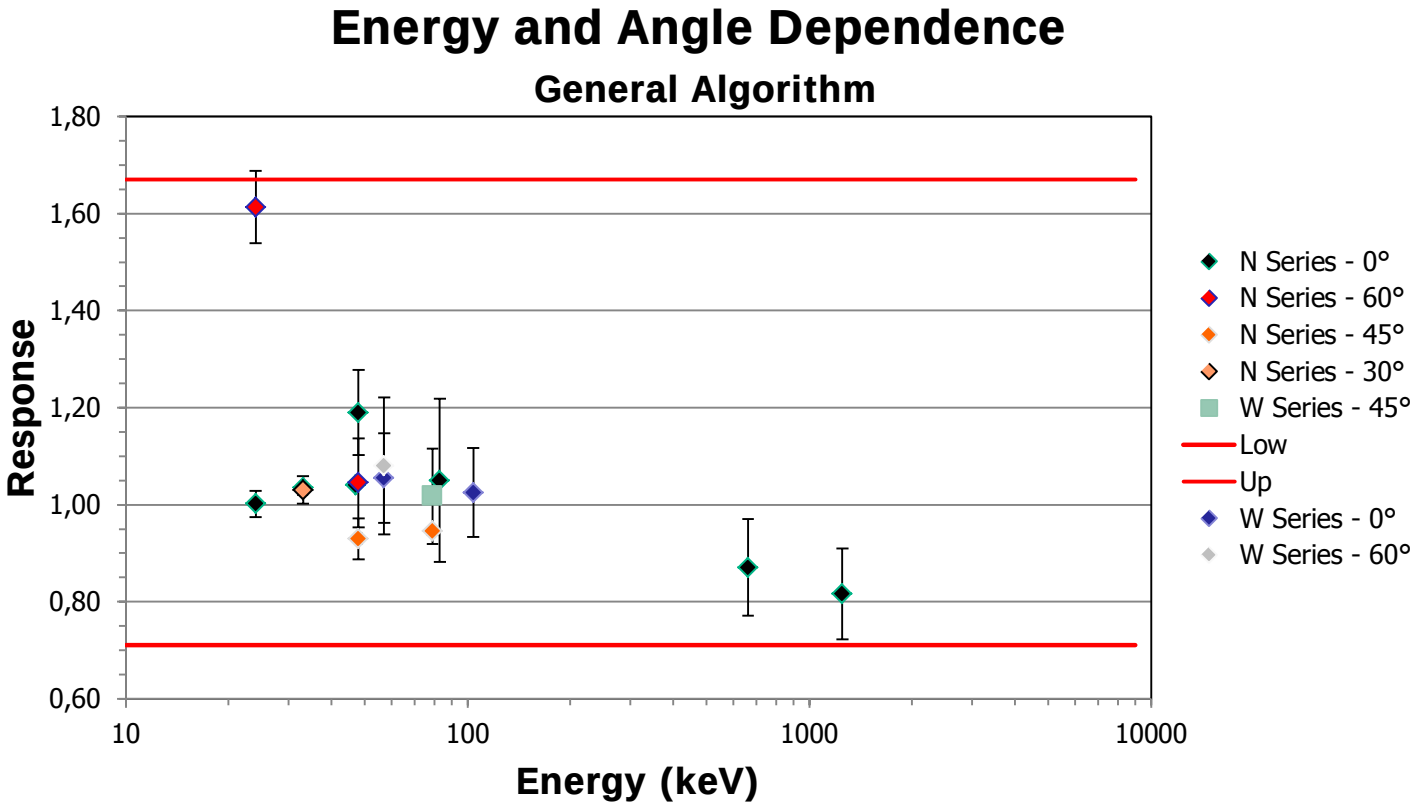
Head of AWST
HMGU Munich
Dr. Wolfgang Wahl

FO VIGL 010-1/1/12-05



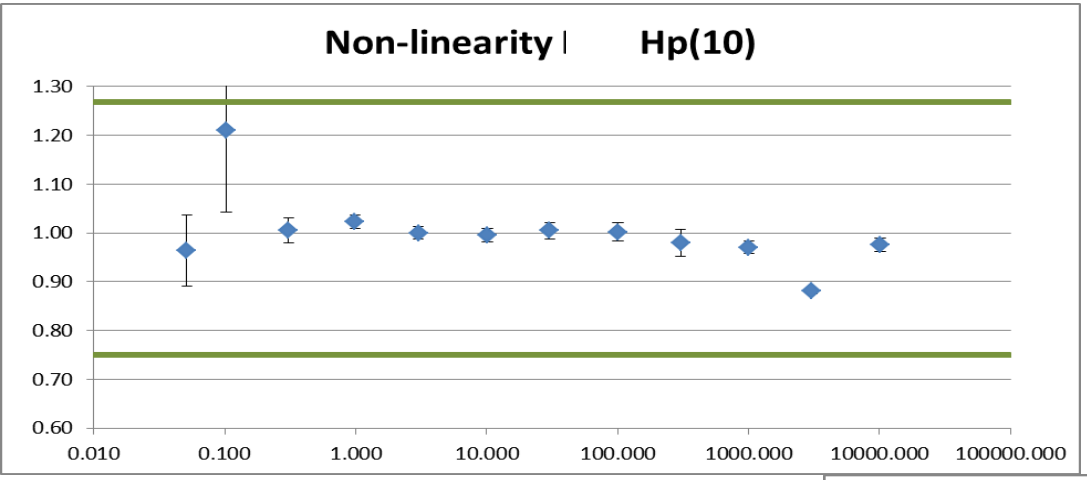


Examples
(TLD LiF)

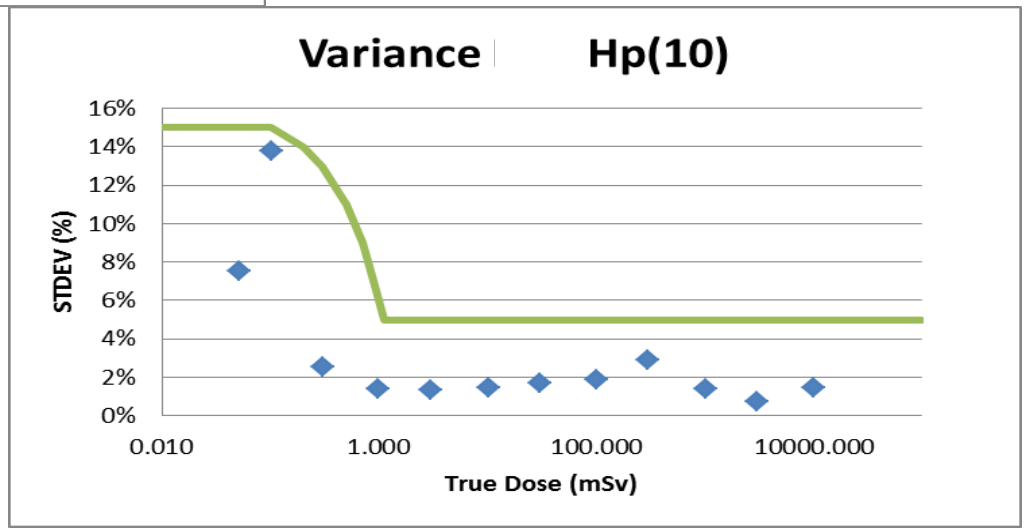


Additional exposures by Controlatom in ISO 17025 laboratories (eg. Seibersdorf) or data from intercomparison exercises (also ISO 17025 conditions)

Examples
(TLD LiF)



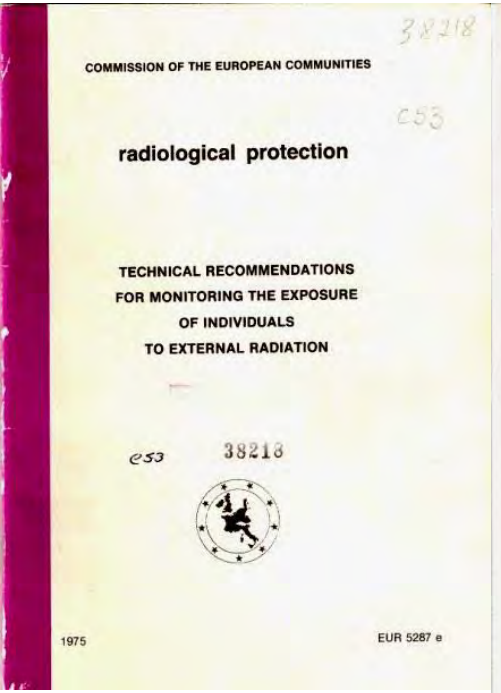
Exposures performed by Controlatom with ISO 17025 accredited Cs-137 beam

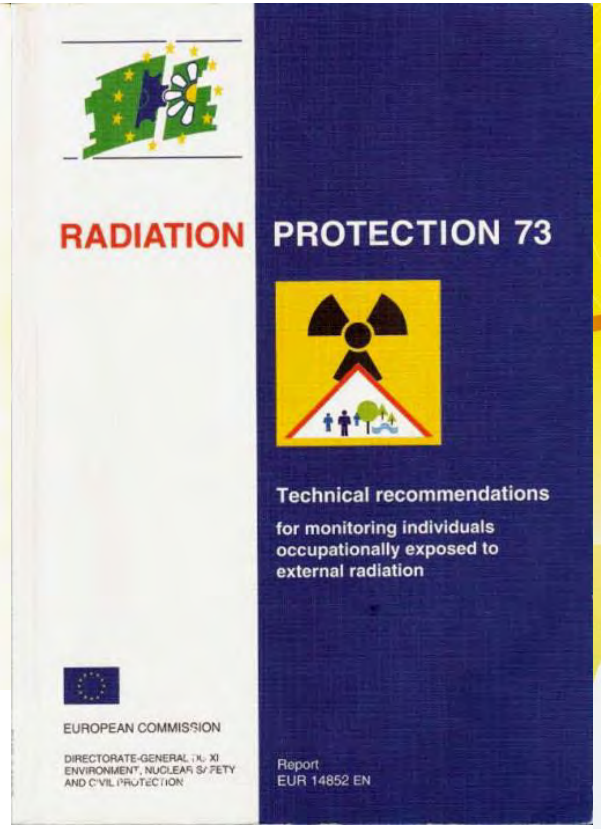


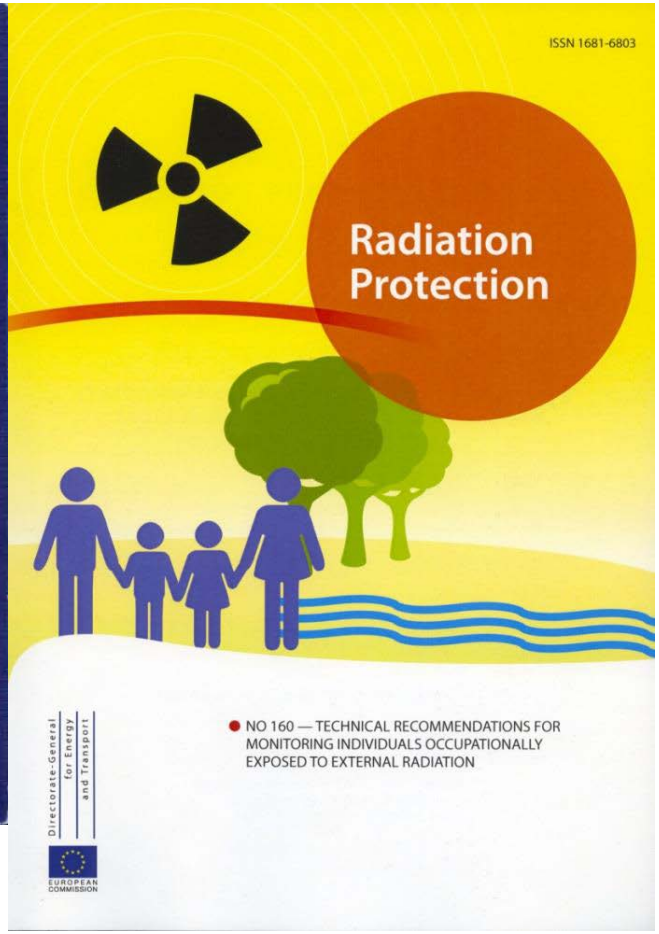
Since 1965

EUROPEAN GUIDELINES – DO WE COMPLY?

RP160 Recommendations







EUR 5286 (1975) RP 73 (1994) RP160 (2009)

RP160 Recommendations

- Revision of European documents due to :
  - RP73 :
    - Introduction of operational quantities (Hp(10),..)
    - Development of BSS
  - RP160 :
    - New BSS
    - Development of technical standards, QC standards
    - Expression of uncertainties (GUM)
    - Include film, neutron, electronic dosemeters

RP160 Recommendations

The aim of the recommendations is to achieve a harmonized system for individual monitoring in the European Union that complies with international criteria for quality assurance

RP160 Recommendations

- **The document combines requirements and guidance given in:**
- **EU Council Directives**
- **ICRP publications and ICRU reports**
- **IAEA reports, technical documents and safety guides**
- **Various international standards and guides on metrology and quality assurance, notably IEC, ISO and JCGM**

- **So one harmonised document to guide ;**
  - **Authorities**
  - **Services**
  - **Suppliers**

The scope of RP160

EURADOS

Technical recommendations for Individual Monitoring

Fundamentals	Metrology	Reporting, recording, QA accreditation, approval
1. Purpose and scope 2. Framework for IM 3. Dosimetry concepts 4. IM procedures	5. Uncertainties 6. Accuracy requirements 7. Calibration, type testing	8. General req. ADS 9. Reporting, recording 10. QA, QC 11. Approval in EU
1. Introduction 2. Recommendations 3. Terms …main text	1. Introduction 2. Recommendations 3. Terms …main text	1. Introduction 2. Recommendations 3. Terms …main text

From J. Van Dyck, RP160 training Lisbon (2015)

ACCREDITATION 17025

First thoughts… paperwork!

ISO 17025

- Implementation of formal Quality Management System
  - Tool : Sharepoint environment (2015)

Since 1965

ISO 17025

- Smaller impact on 'technical' procedures
  - Readout of dosemeters
  - Calibration of equipment
  - Since already in place (perhaps not the correct 'format' or complete)
- Installation of new irradiation device equiped with ISO 4037 collimator.
  - Cs-137 beam quality.
- All external calibrations now comply with ISO 17025
  - Ionisation chamber, Length, Air pressure, Temperature..

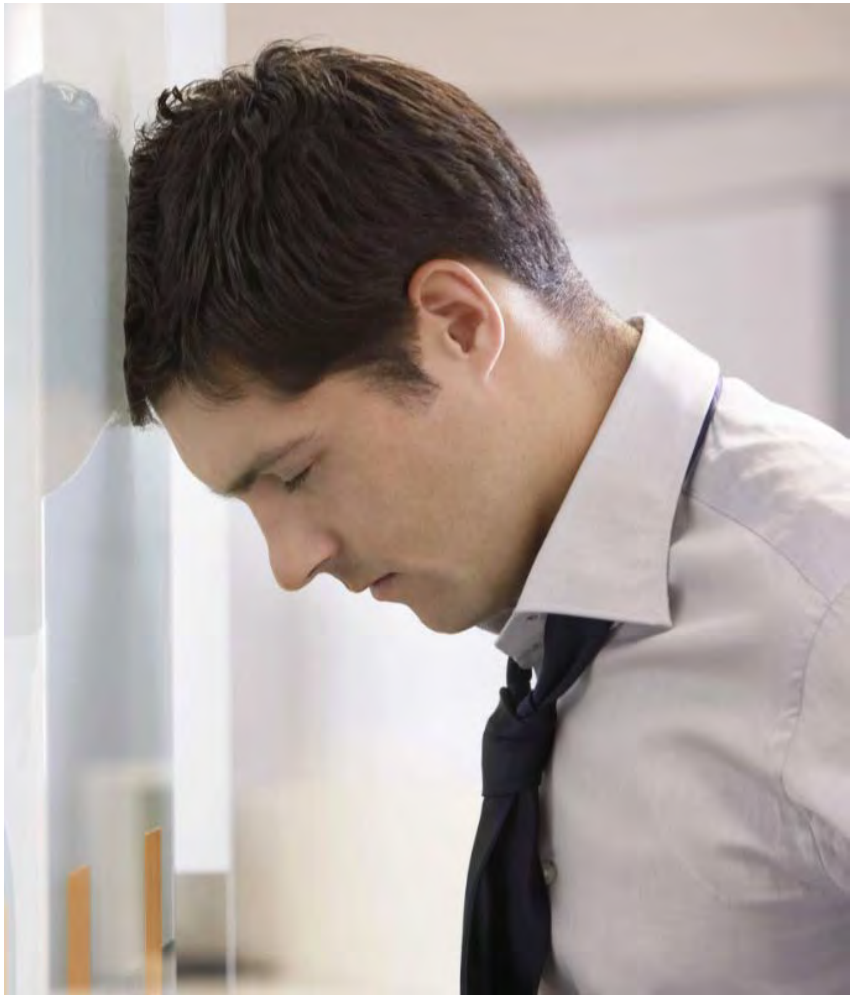
ISO 17025

- Bigger impact on 'non technical' procedures :
  - Some were inexisting or insufficient
    - Personnel
      - » Qualifications
      - » Competence management
    - Internal audits
    - Supplier evaluation
    - Formal customer feedback
    - Non conformity treatment
    - Management review

ISO 17025

- Formal BELAC accreditation audits
  - Initial audit (2012) (4 days)
    - QM system
    - Technical auditor
  - Surveillance audit (2 days)
    - Yearly (first 3 years)
    - ~18 months
  - Prolongation audit (4 days)
    - After 3 years
    - Valid 5 years

First audit… some worries



You get used to everything…

ISO 17025

- Continuous improvement
  - Different audits
    - Non conformities
    - Suggestions for improvement
  - Different auditors
    - Focus on particular aspects
    - Specialised in own domain

ISO 17025

- Results in accreditation certificates :
  - For AV-Controlatom
    - BELAC 484-CAL (calibration)
    - BELAC 484-TEST (dosimetry)
  - General
    - On website of Belac under "Testing Laboratories" or "Calibration Laboratories"
      - http://economie.fgov.be/en/entreprises/life_enterprise/quality_policy/Accreditation/accredited_Bodies/TEST/

ISO 17025

- Effort should be made by accreditation body (BELAC) and Competent Authority (FANC) to harmonise the scope definitions for dosimetry services
  - Specification of angles of incidence for which performance is respected
  - Specification of energies of radiation qualities for which performance is respected (particularly beta radiation)
    - » Mean or max. β energy

ISO 17025

Examples of scope definitions of two dosimetry services

Interne testcode	Monsters	Gemeten eigenschap
AVC - PRC - L14x	Dosimeters met OSL detectoren (BeO)	Persoonlijk dosisequivalent Hp(10) Fotonen - energie: 12 keV-7 MeV - meetbereik: 50 µSv tot 10 Sv Persoonlijk dosisequivalent Hp(0.07) Fotonen - energie: 12 keV-300 keV - meetbereik: 50 µSv tot 10 Sv Beta - energie : vanaf 926 keV (E_{mean}) (45°) - meetbereik : 50 µSv - 10Sv
KB-0250	Dosismeters met TLD detectoren	Persoonlijk dosisequivalent Hp(10) - meetbereik: 50 µSv tot 1 Sv - fotonenergie: 33 keV tot 1250keV
KB-0250	Dosismeters met TLD detectoren	Persoonlijk dosisequivalent Hp(0.07) - meetbereik : 100 µSv ≤ Hp(0.07) ≤ 1 Sv - fotonenergie : 33 keV tot 1250 keV - bèta-energie : 2.3 MeV

INTERCOMPARISONS

Intercomparisons

- Dosimetry services should participate in intercomparison exercises
- For the different irradiation qualities and dosemeter types

Intercomparisons

- Controlatom participated in
  - 11th intercomparison of environmental dosemeters (1997)
  - Eurados international intercomparisons :
    - Photons : 2008, 2010, 2012, 2014 and foreseen 2016
    - Neutrons : 2012
    - Eyelens : 2014
    - Extremity : 2009, 2015
  - National intercomparisons :
    - Photons : Belgian Army (2013)
    - Neutrons : German yearly intercomparison (2010)

Intercomparisons

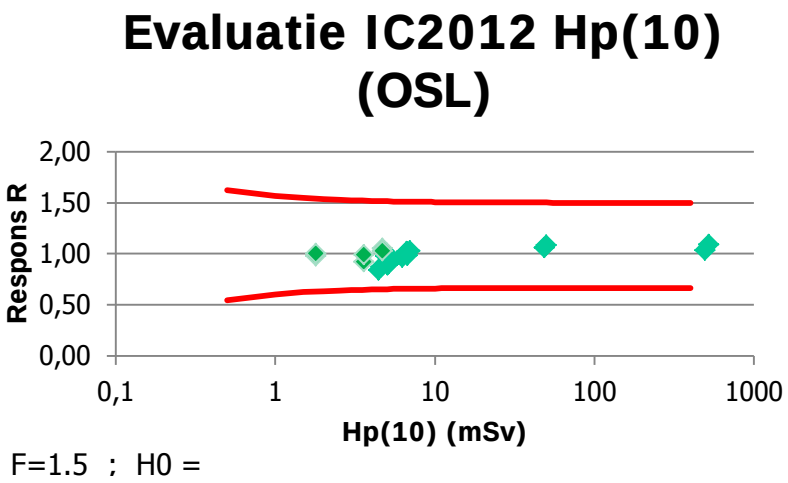
- Very valuable tool !!
- Independent performance check
  - Energy
  - Angle
  - Radiation type (γ,β,x,n)
- Calibration check
  - Traceable results

Intercomparisons

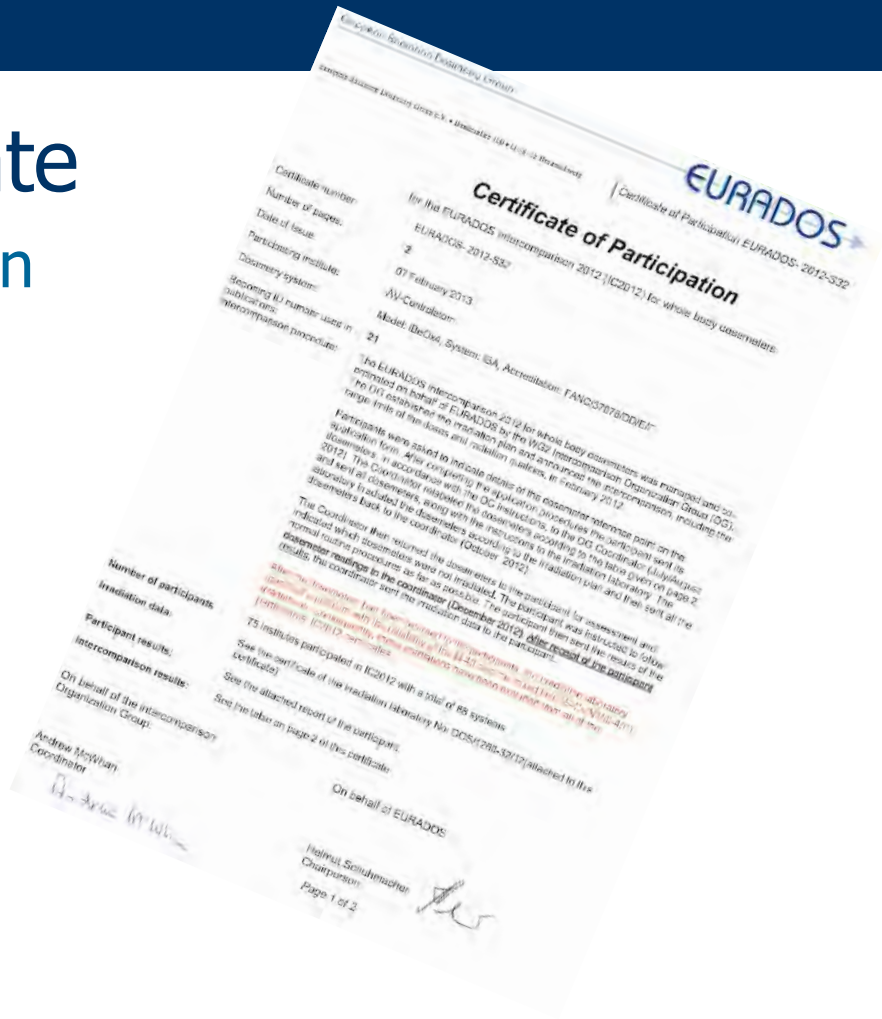
- In Europe, selfsustaining intercomparisons are organised on a periodical basis by Eurados
- Comprehensive reports are published by Eurados (http://www.eurados.org/en/Documents_Publications/Reports_documents)

Intercomparisons

- Participant gets certificate
  - Necessary for accreditation
- And evaluates his performance



F=1.5 ; H0 =



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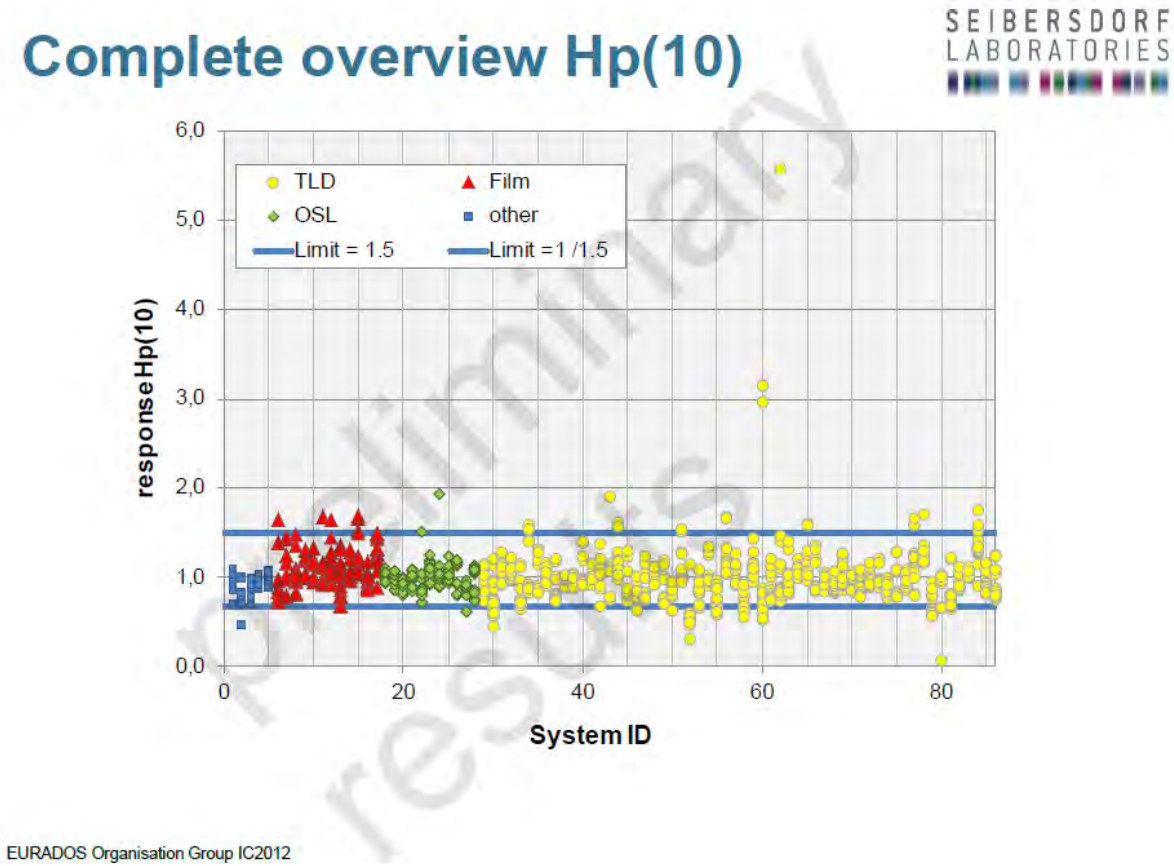
Intercomparisons

- Participant can judge his performance with respect to other participants/detector types/…



CONCLUSIONS

Conclusion

- Accreditation of dosimetry services
  - Good harmonisation within Belgium and even within Europe
  - Steadily increases the level of accuracy of dosimetry
- Data as uploaded into National Dose Registeries will be equivalent within Europe

Conclusion

A quality system NEVER ends

It becomes a way of life

- Permanent monitoring
- Every 6 months evaluation of complaints
- Every 6 months evaluation of all quality parameters
- Dummy user
- …

Conclusion

- It starts difficult and with lots of "resistance"
- After the first steps:
  - It helps to improve
  - You see "new" things because you monitor more
  - Closer to the users of the dosimeters (surveys / meetings /…)
- In the end… help for radiological protection!

Thank you for your attention !