GE Healthcare
Radiology
Forum 2019

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Madrid, Spain

RADIATION PROTECTION IN MEDICINE
ALARA PROCESS

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CSN CONSEJO DE SEGURIDAD NUCLEAR

EUROPEAN ALARA NETWORK

INTRODUCTION

ELEMENTS

ALARA

IN MEDICINE

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INTRODUCTION: RADIATION PROTECTION

- PROTECTION AGAINST RADIATION
- EFFECTS OF RADIATION
    - TISSUE REACTIONS (DETERMINISTIC EFFECTS)
    - STOCHASTIC (LNT MODEL)

introduction

INTRODUCTION: PROTECTION AGAINST RADIATION

time

distance

shielding

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INTRODUCTION: EFFECTS OF RADIATION

tissue reactions

stochastic

INTRODUCTION: EFFECTS OF RADIATION

tissue reactions

Fig. 8. Necrosis of skin and underlying tissue from overexposure during a cardiac catheterization procedure.

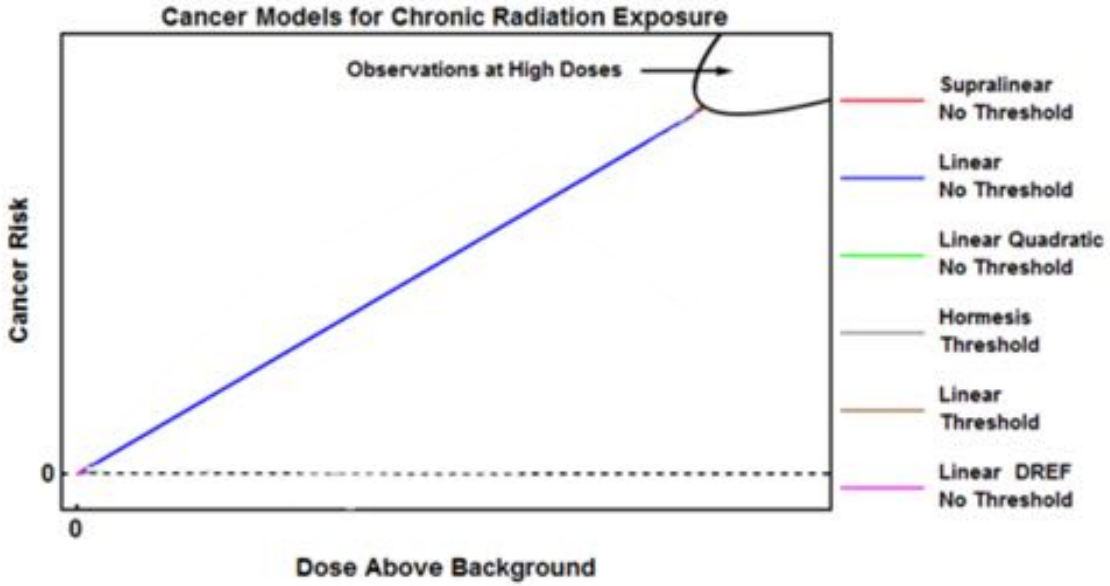
O. Holmberg et al. / European Journal of Radiology 76 (2010) 6–10

INTRODUCTION: EFFECTS OF RADIATION

tissue reactions

stochastic

INTRODUCTION: EFFECTS OF RADIATION



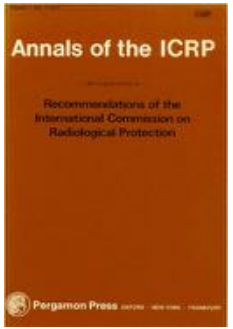
stochastic

RADIATION PROTECTION ELEMENTS

- JUSTIFICATION
- OPTIMIZATION
- DOSE LIMITS

International Commission of Radiation Protection (ICRP)

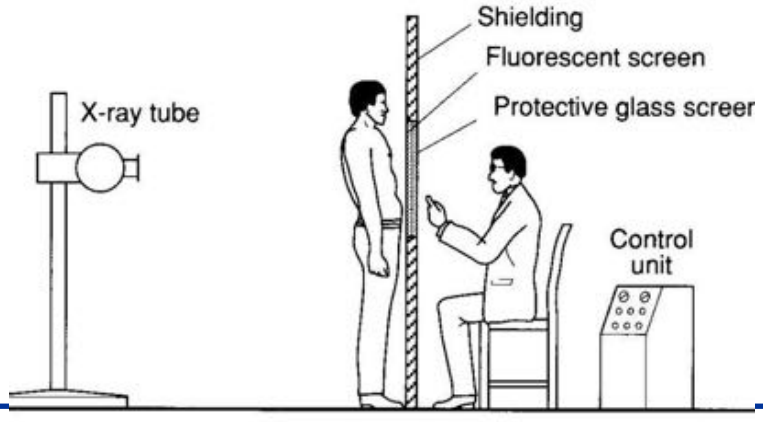
Publication n°26 of 1977

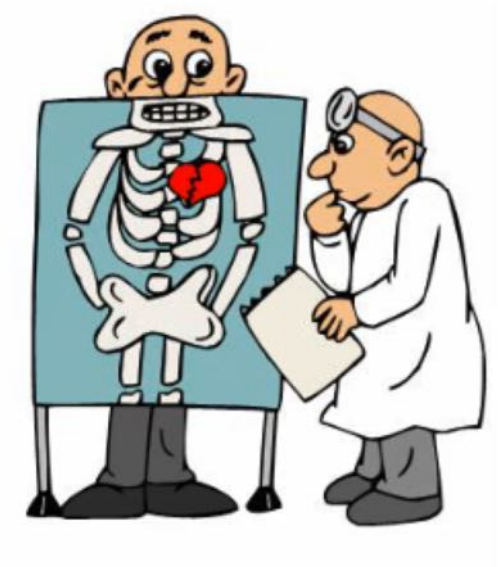


elements

ELEMENTS: JUSTIFICATION

- JUSTIFICATION
  - PRACTICES
    - NOT SET IN STONE
    - EXAMPLE: DIRECT FLUROSCOPY





justification

ELEMENTS: JUSTIFICATION

- JUSTIFICATION
  - PRACTICES
    - NOT SET IN STONE
    - EXAMPLE: DIRECT FLUROSCOPY
  - MEDICINE: PATIENT / PROCEDURE
    - Justification means that the procedure must be medically indicated and useful

justification

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ELEMENTS: DOSE LIMITS

- DOSE LIMITS for WORKERS AND PUBLIC
  - AVOID TISSUE REACTIONS (DETERMINISTIC)
  - NOT SET IN STONE
    - EXAMPLE: LENS OF THE EYE

dose limits

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ELEMENTS: DOSE LIMITS

- DOSE LIMITS for WORKERS AND PUBLIC
  - AVOID TISSUE REACTIONS (DETERMINISTIC)
  - NOT SET IN STONE
    - EXAMPLE: LENS OF THE EYE
- IN MEDICAL EXPOSURES: NOT APPLICABLE (ICRP)
  - DIAGNOSIS REFERENCE LEVELS

dose limits

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ELEMENTS: OPTIMIZATION (ALARA)

HISTORY

- In 1954, the National Committee on Radiation Protection, Report 17, "radiation exposure should be kept at the lowest practical level"

- In 1959 the International Commission on Radiological Protection (ICRP), Publication 1 "all doses be kept as low as practicable, and that any unnecessary exposure be avoided."

optimization

ELEMENTS: OPTIMIZATION (ALARA)

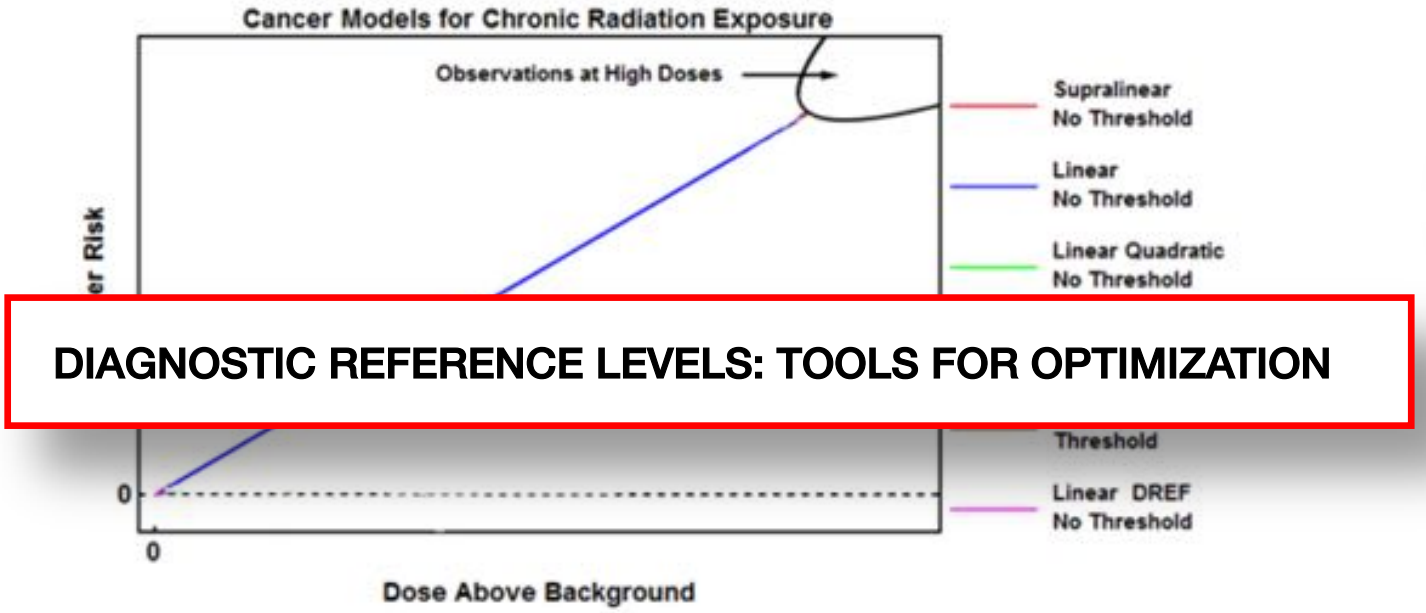
HISTORY

- “the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses should all be kept AS LOW AS REASONABLY ACHIEVABLE, taking into account economic and societal factors” (ICRP 103, 2007)

- “The optimisation of radiological protection means keeping the doses AS LOW AS REASONABLY ACHIEVABLE, economic and societal factors being taken into account, and is best described as management of the radiation dose to the patient to be commensurate with the medical purpose.” (ICRP 105)

optimization

ELEMENTS: OPTIMIZATION (ALARA)



DIAGNOSTIC REFERENCE LEVELS: TOOLS FOR OPTIMIZATION

optimization

ALARA PROCESS AND TOOLS

ALARA PROCESS

“methodology for identifying, evaluating and selecting protection actions, in order to reduce

- the magnitude of individual doses,
- the number of people exposed and the
- likelihood of potential exposure of workers, public and patients

to a level that is as low as reasonably achievable (ALARA)”

ALARA PROCESS AND TOOLS

ALARA PROCESS

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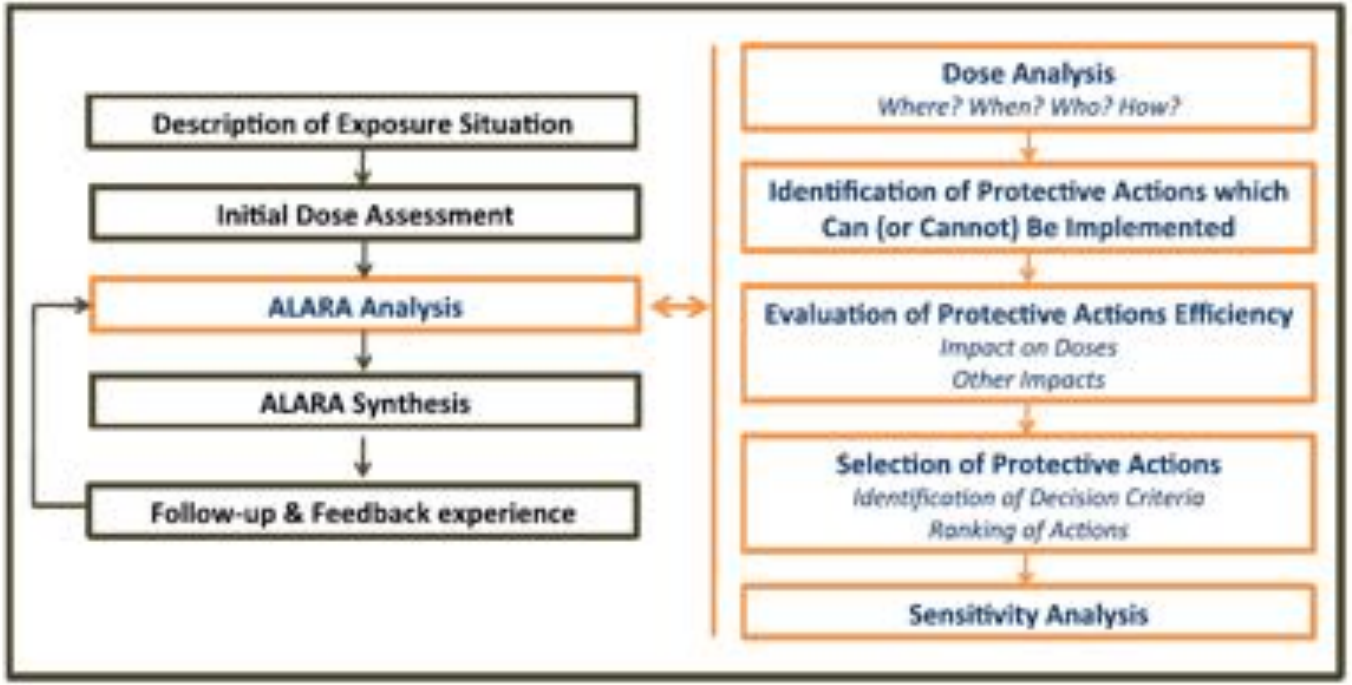
ALARA PROCESS AND TOOLS



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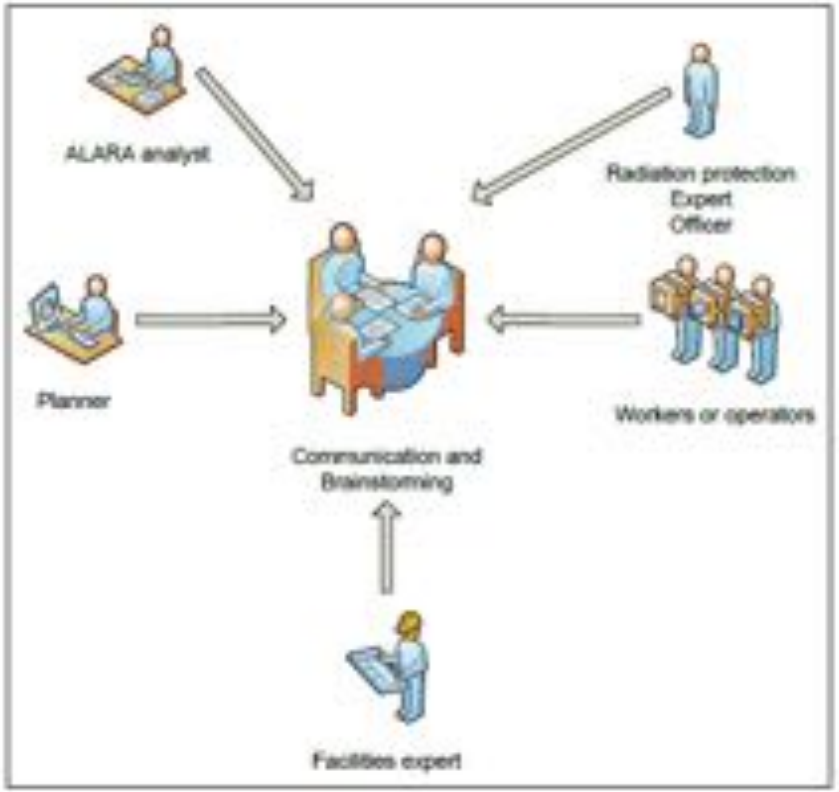

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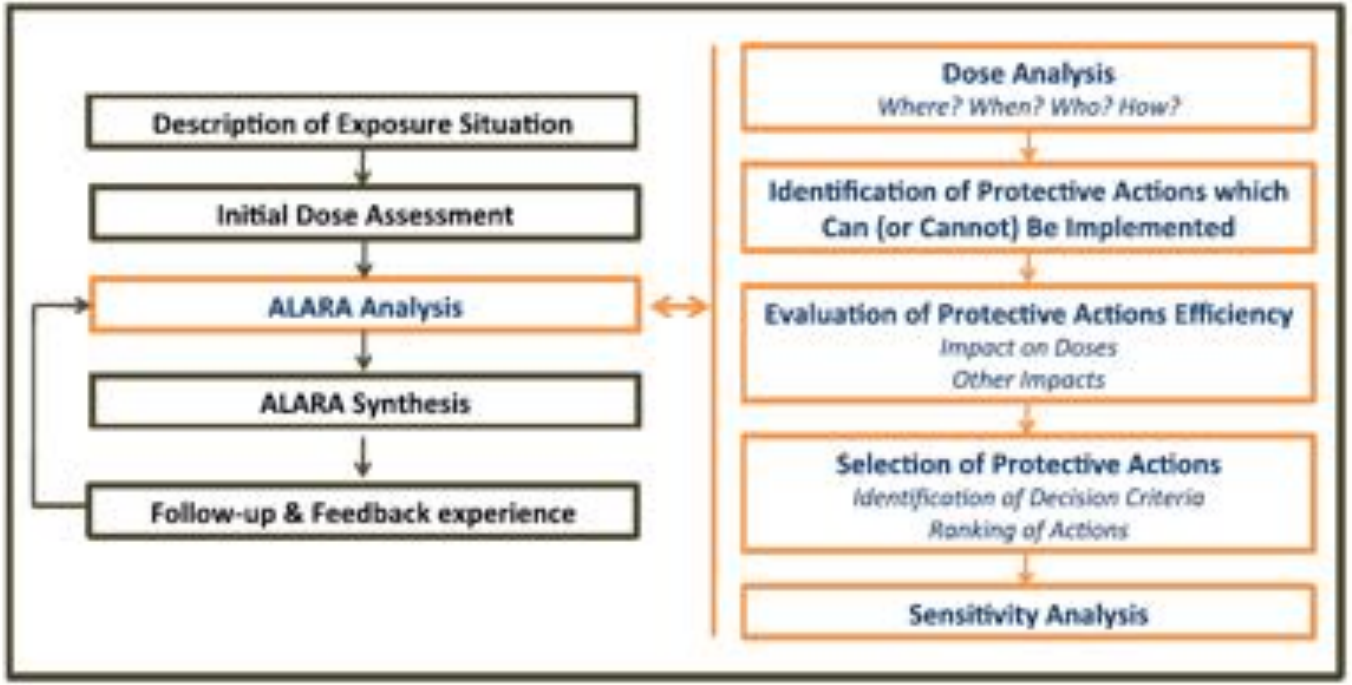

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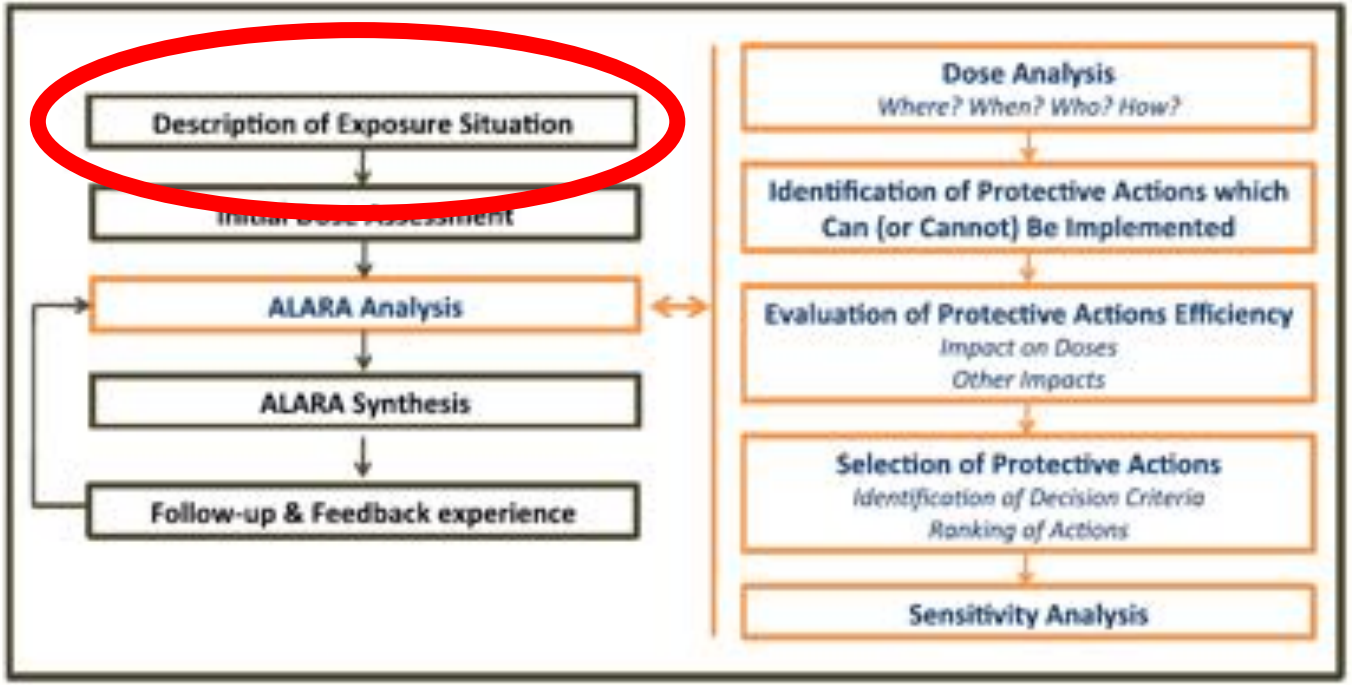

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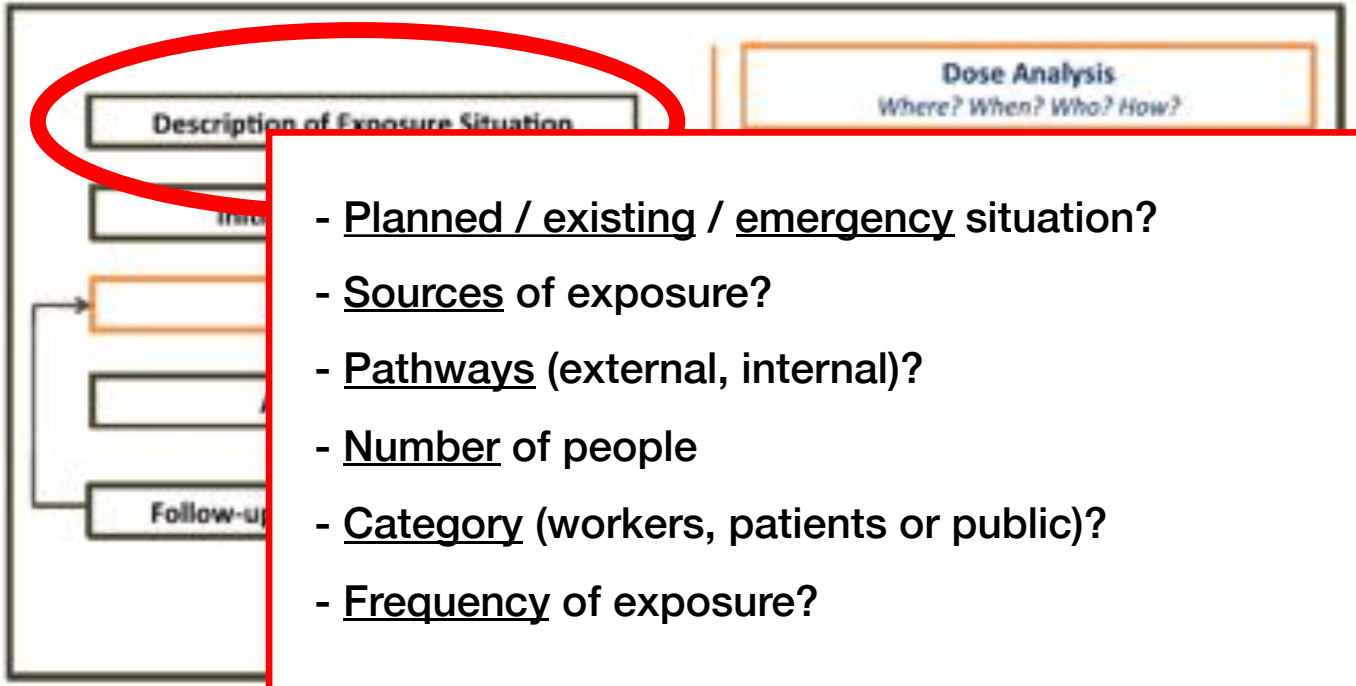
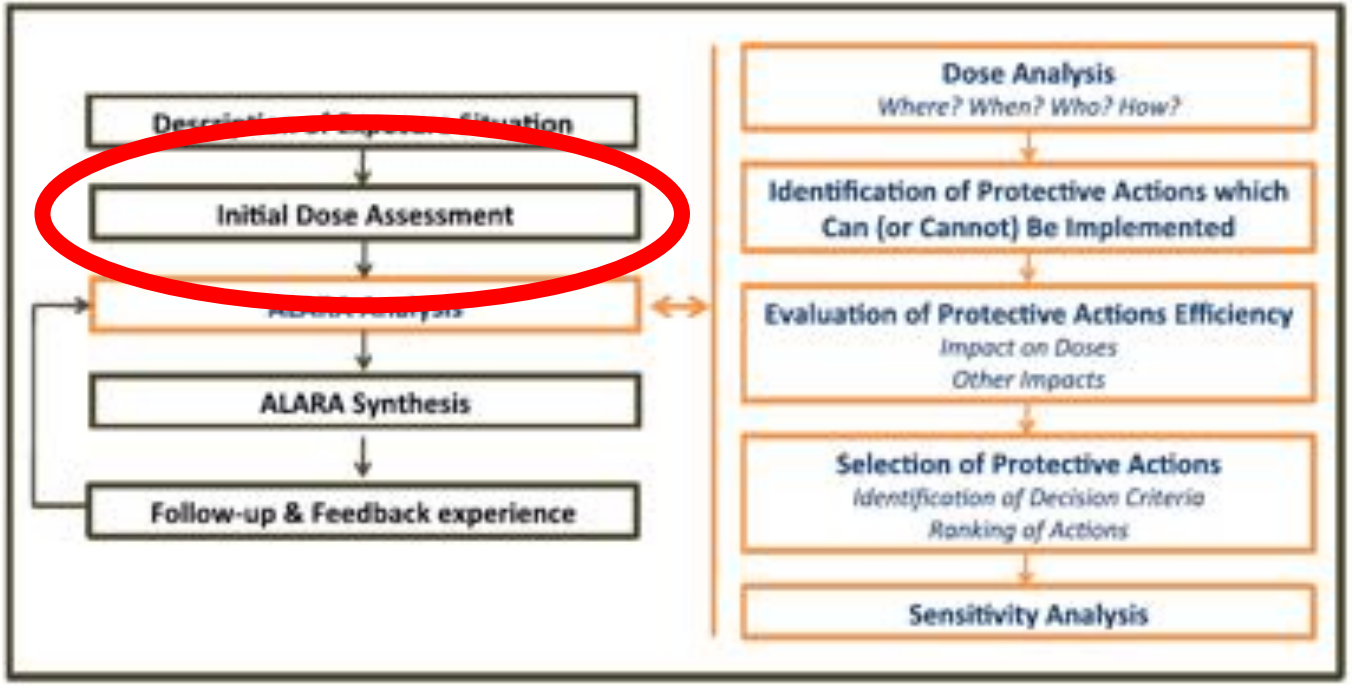


- Planned / existing / emergency situation?
- Sources of exposure?
- Pathways (external, internal)?
- Number of people
- Category (workers, patients or public)?
- Frequency of exposure?

ALARA PROCESS AND TOOLS



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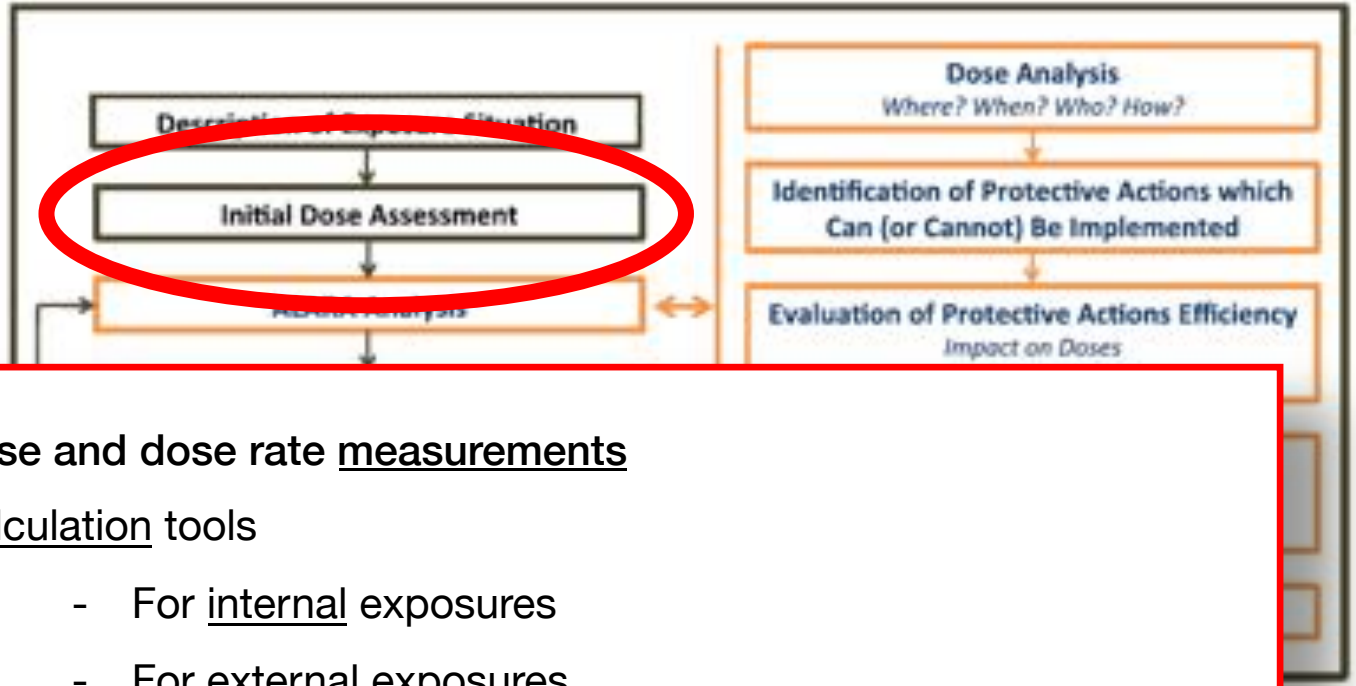

- **Dose and dose rate measurements**
- Calculation tools
  - For internal exposures
  - For external exposures

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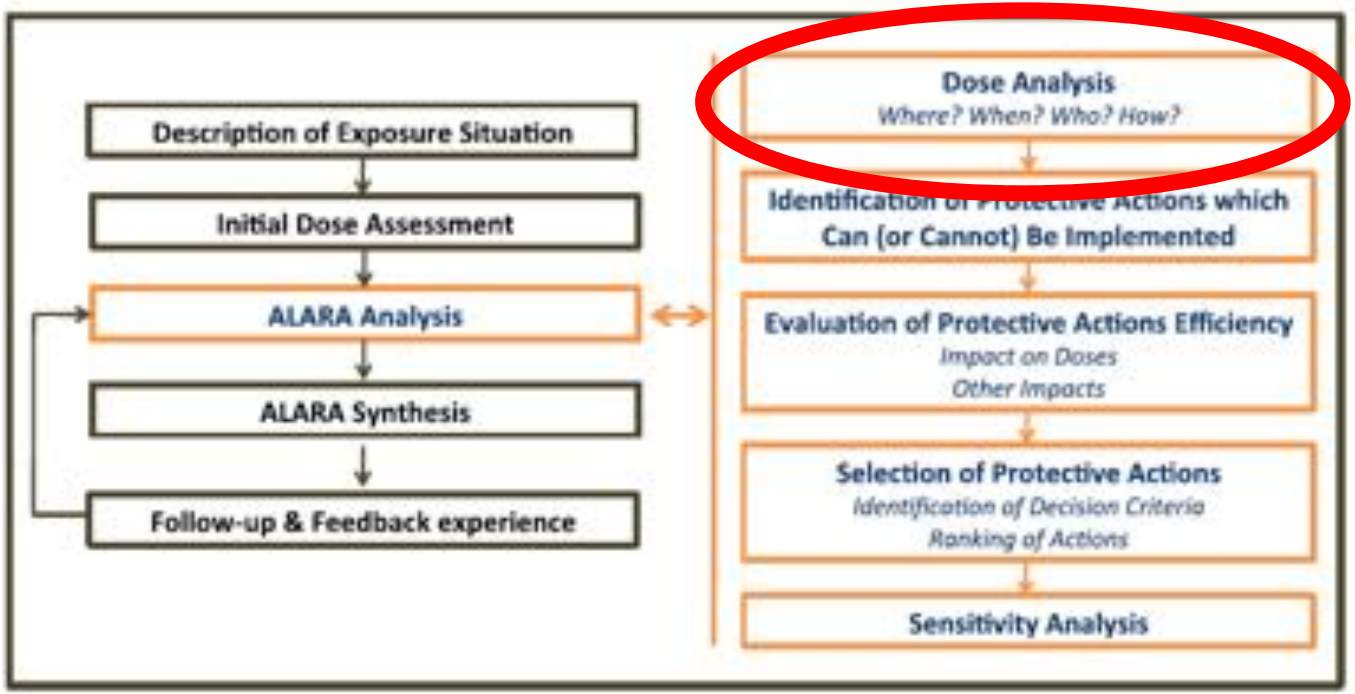
ALARA PROCESS AND TOOLS



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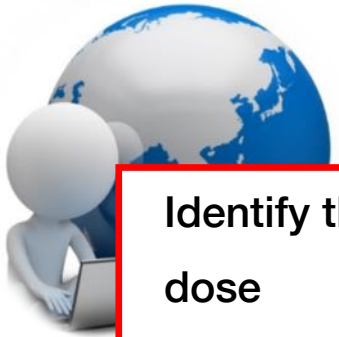
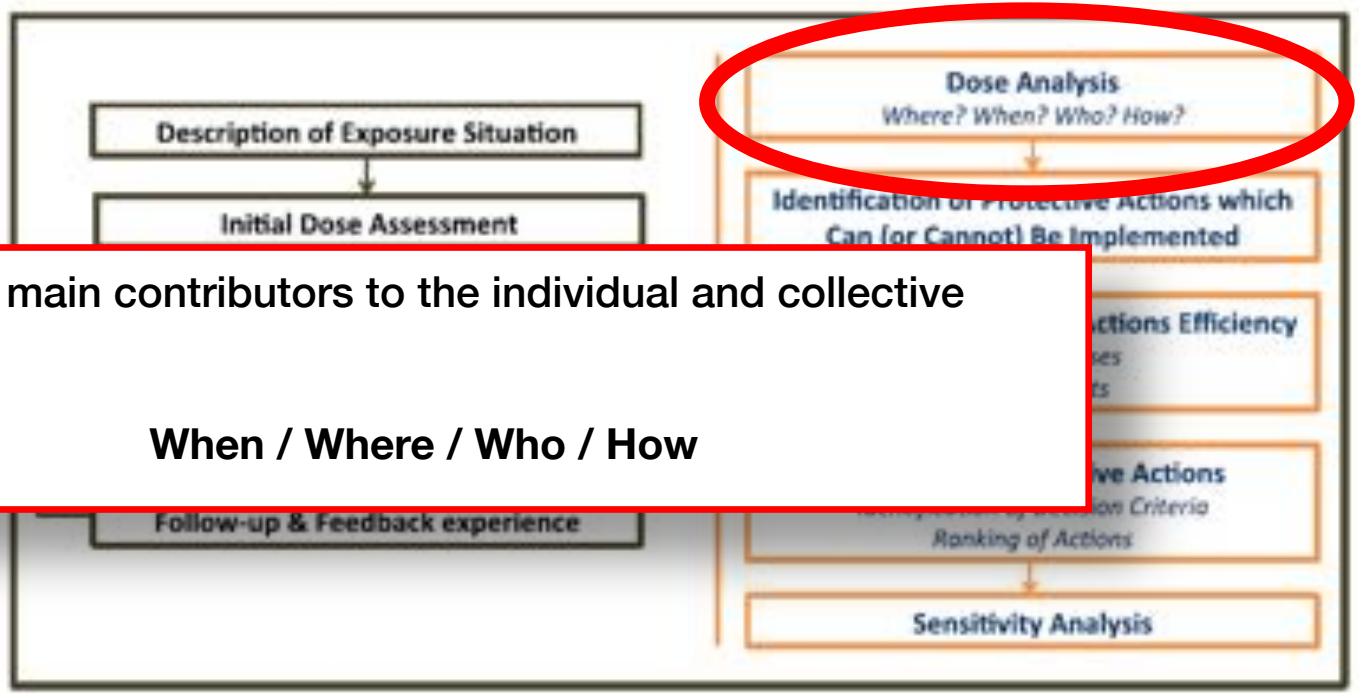
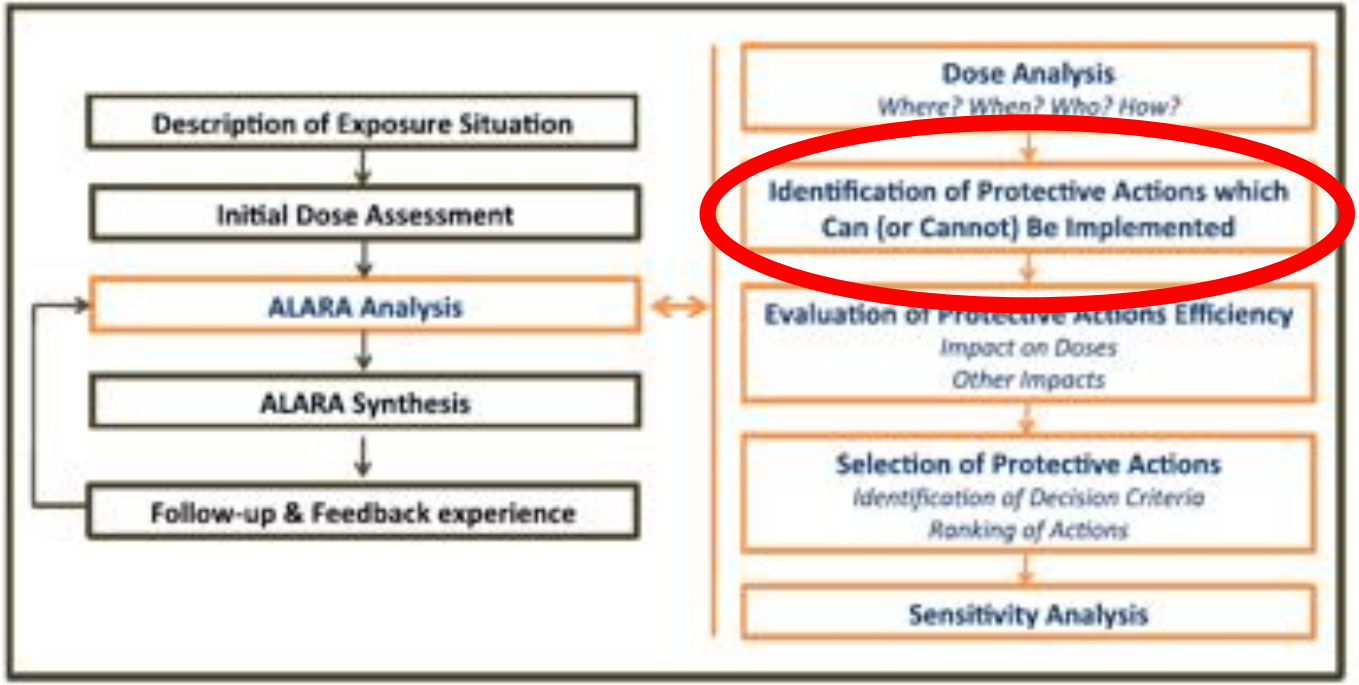




Identify the main contributors to the individual and collective dose

When / Where / Who / How

ALARA PROCESS AND TOOLS



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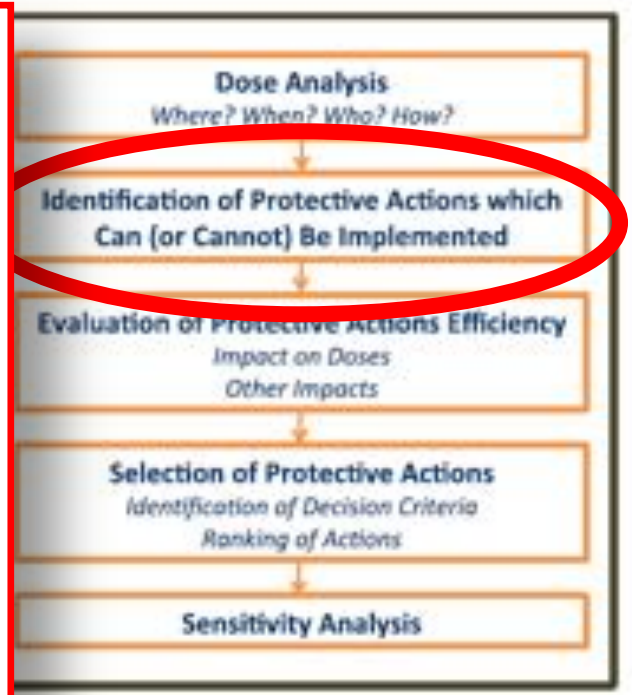
ALARA PROCESS AND TOOLS

Use as a guide…

- Reduction of the source
- Increased distance to the source
- Use of shielding
- Use of personal protective equipment
- Reduction of the exposure time
- Reduction of number of persons exposed



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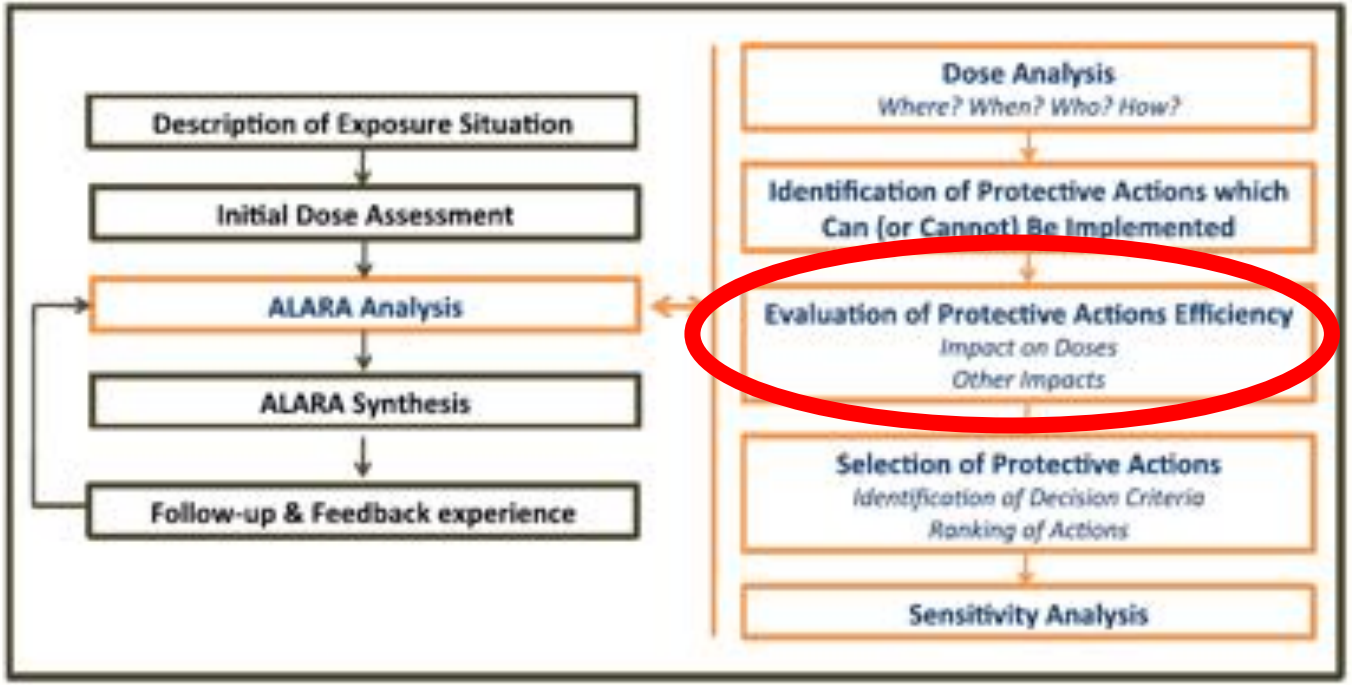

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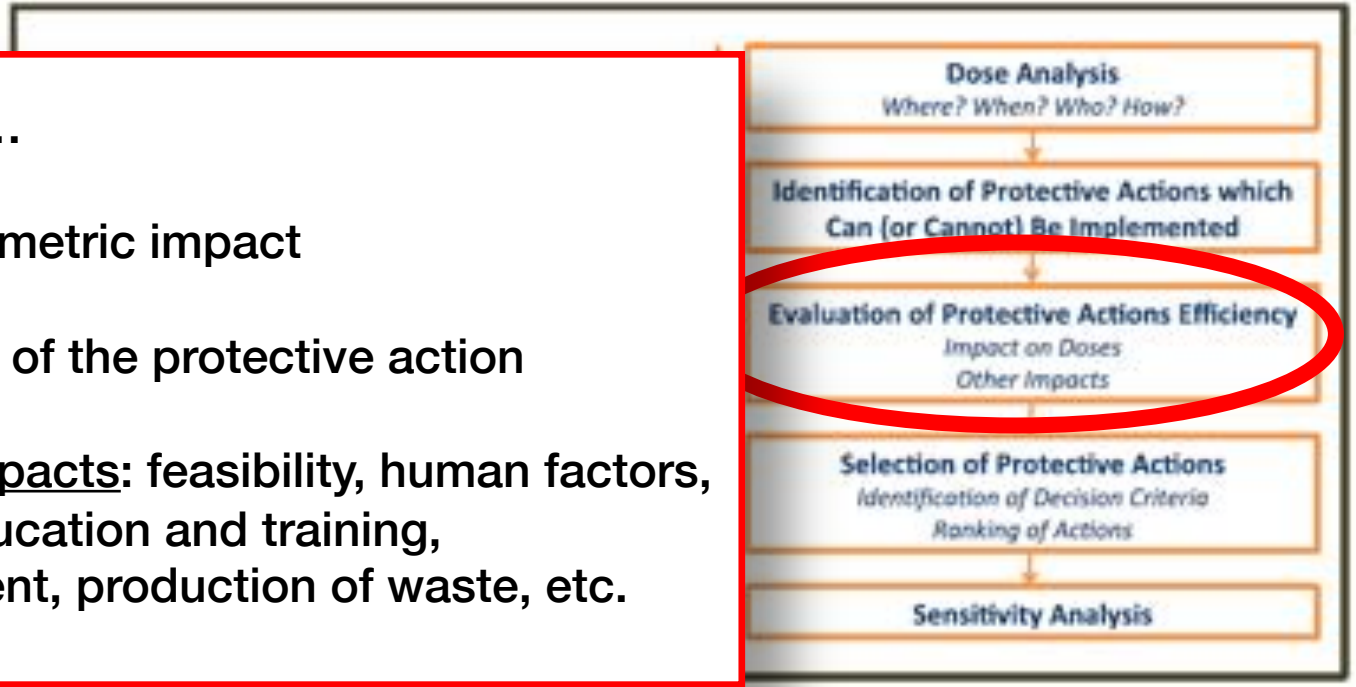
ALARA PROCESS AND TOOLS

Consider…

- The dosimetric impact

- The cost of the protective action

- Other impacts: feasibility, human factors, safety, education and training, environment, production of waste, etc.



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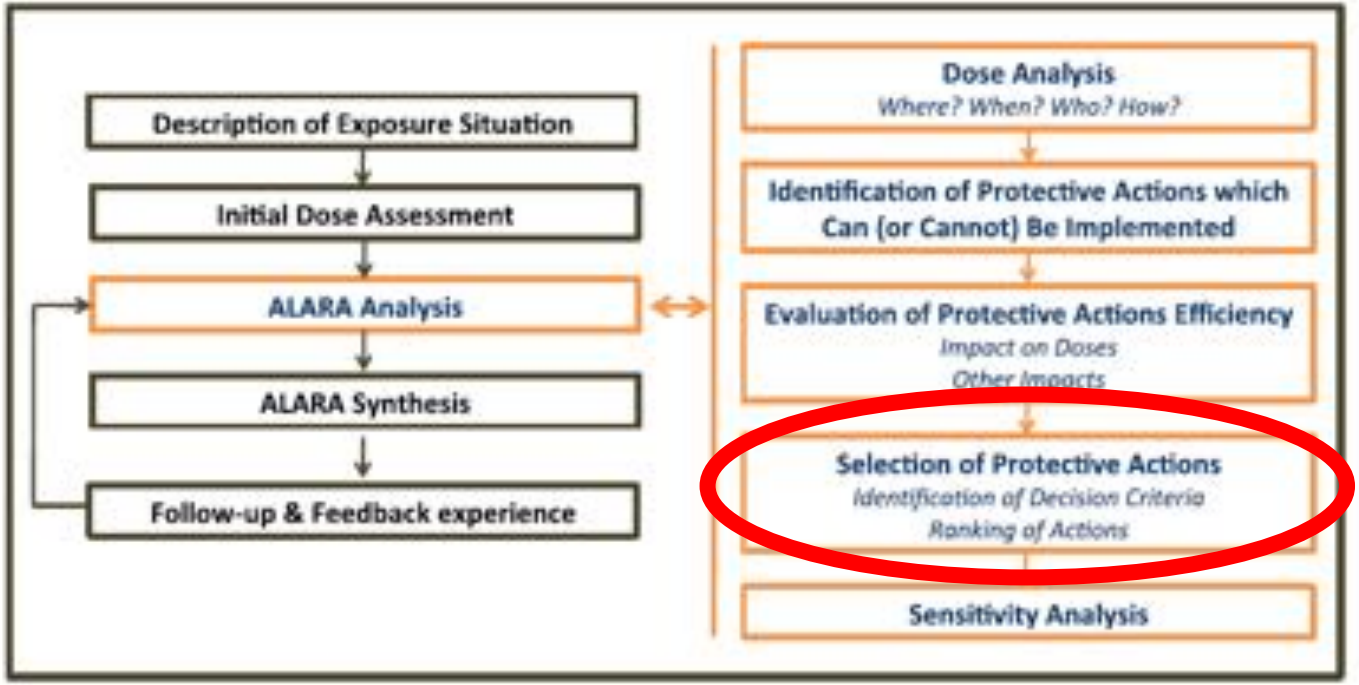

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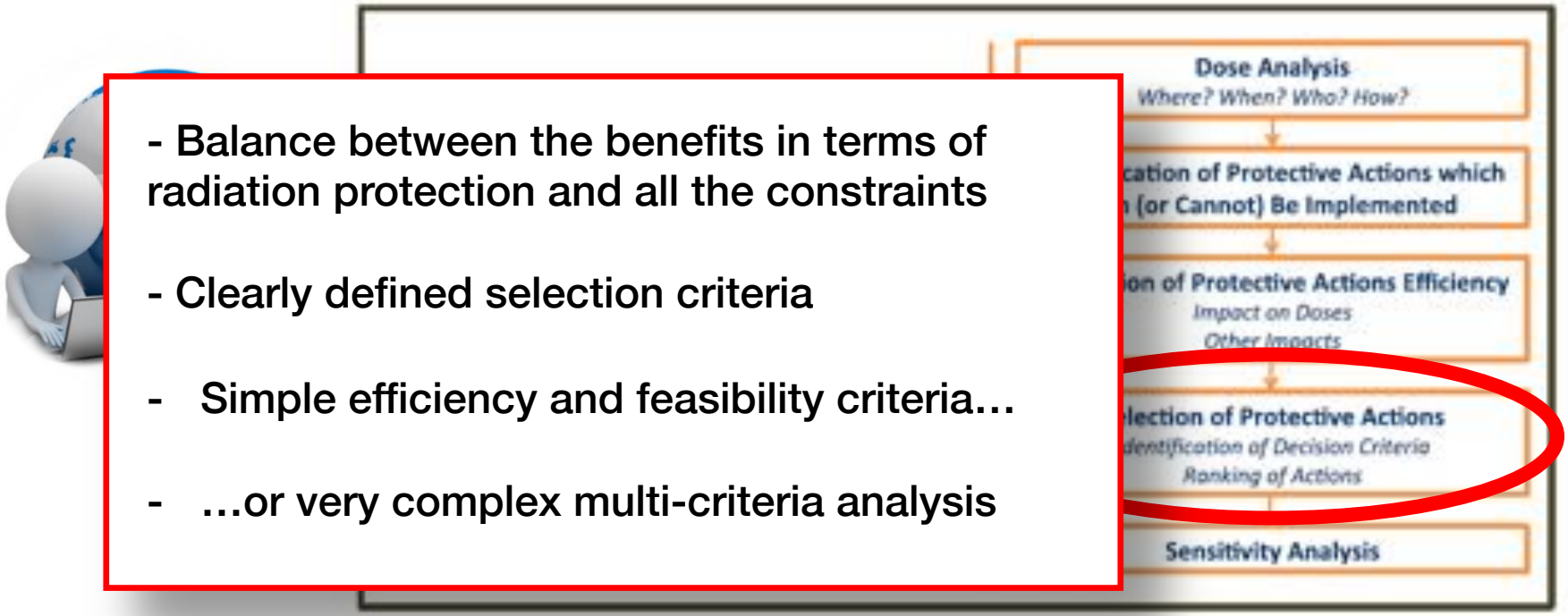

- Balance between the benefits in terms of radiation protection and all the constraints

- Clearly defined selection criteria

- Simple efficiency and feasibility criteria…

- …or very complex multi-criteria analysis

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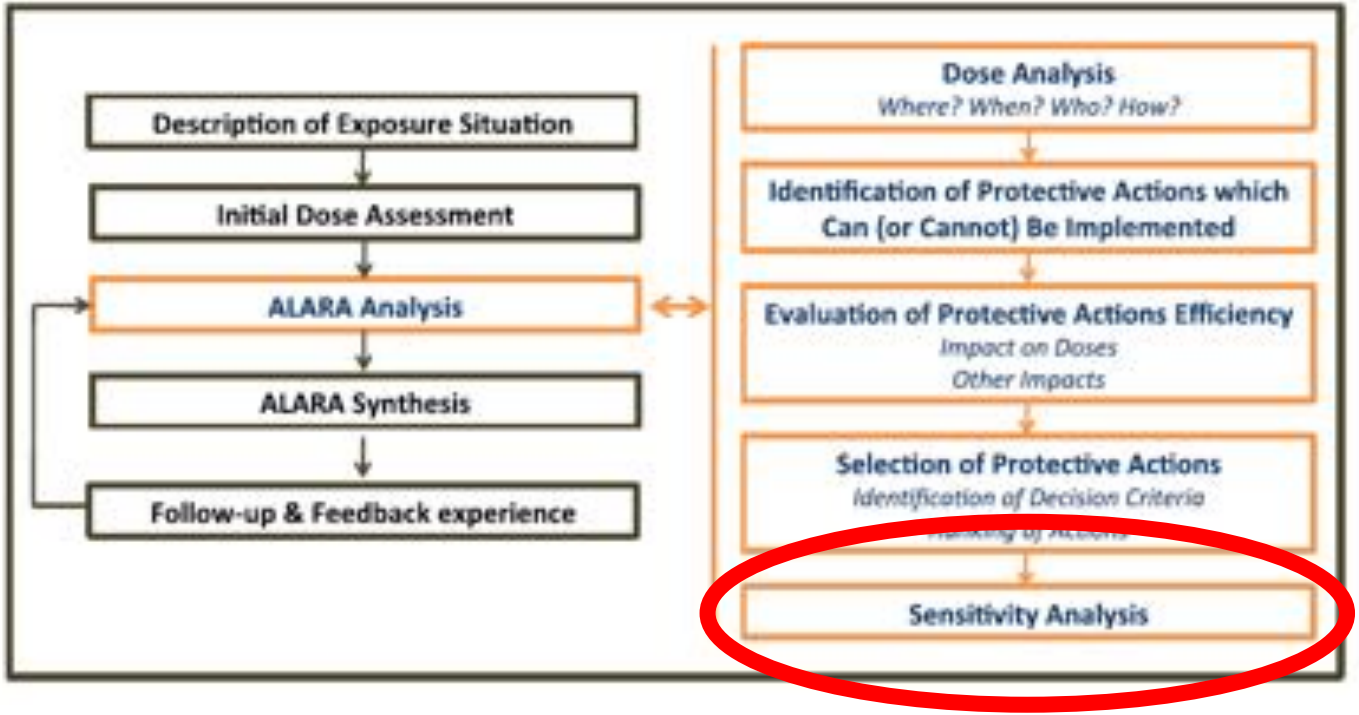
ALARA PROCESS AND TOOLS



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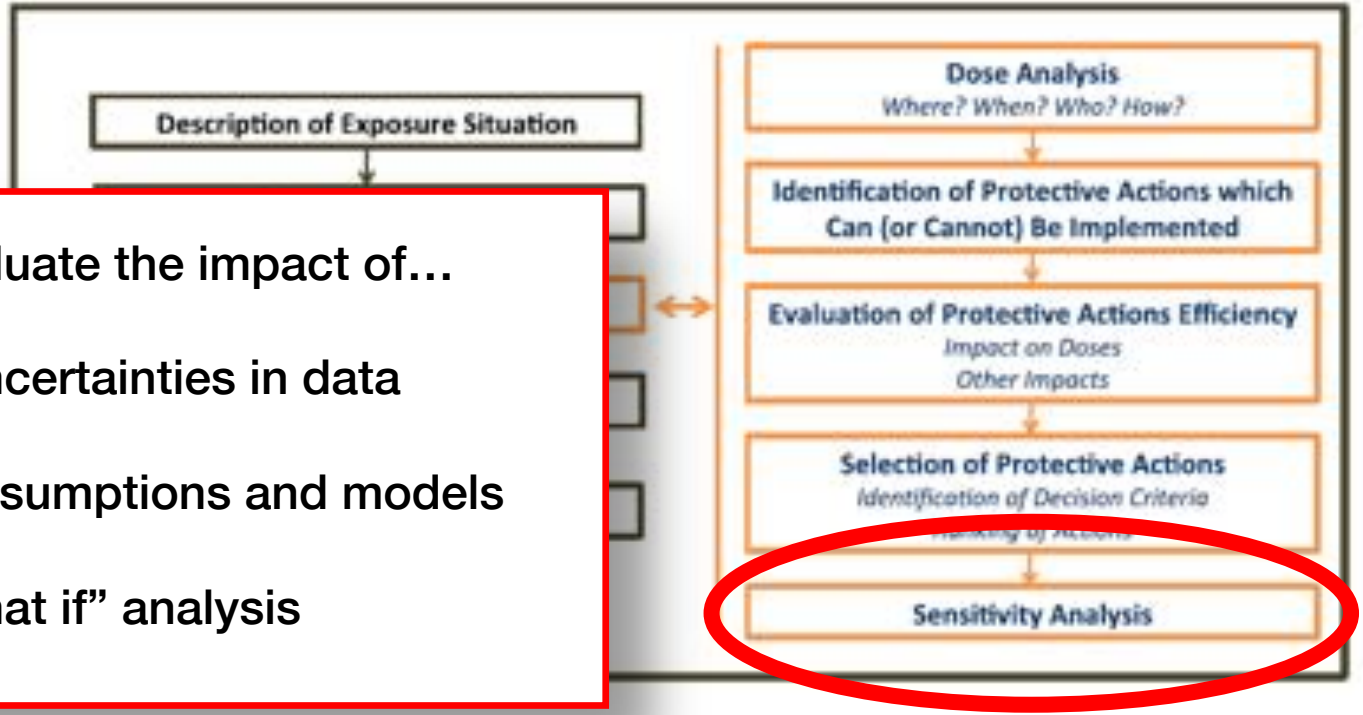
ALARA PROCESS AND TOOLS

Evaluate the impact of…

- Uncertainties in data

- Assumptions and models

“What if” analysis



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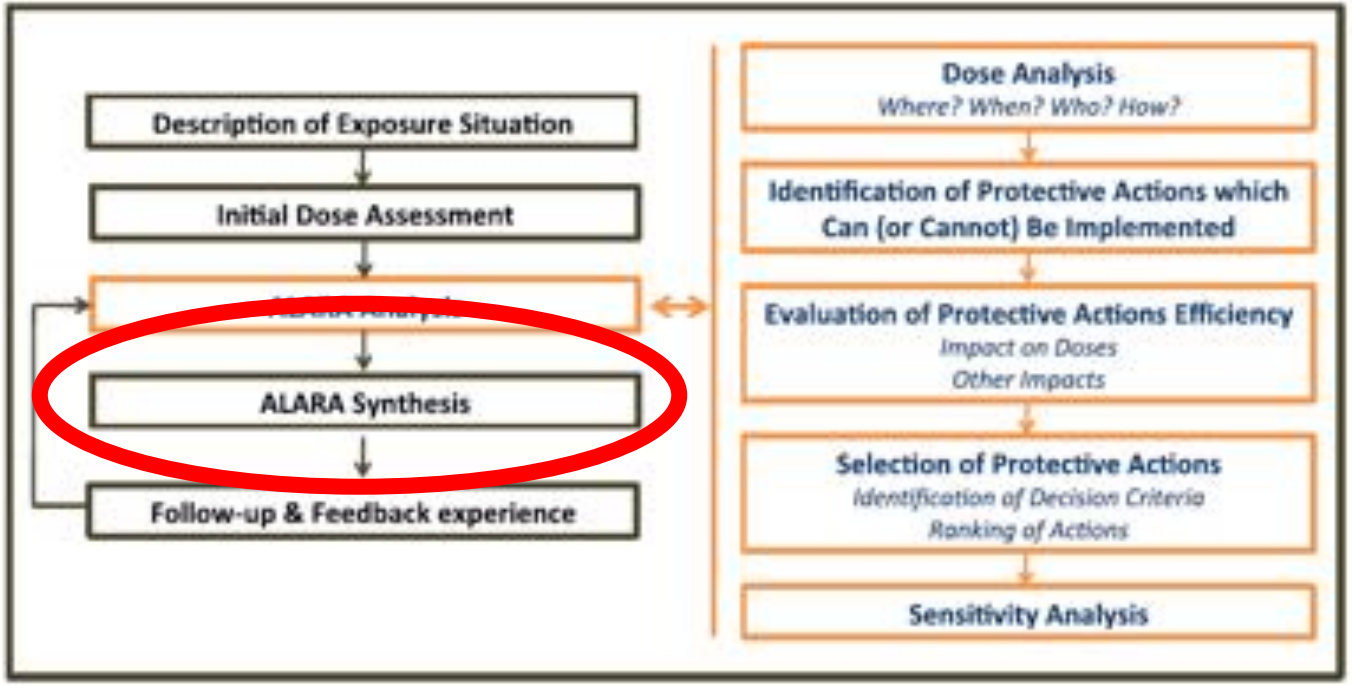

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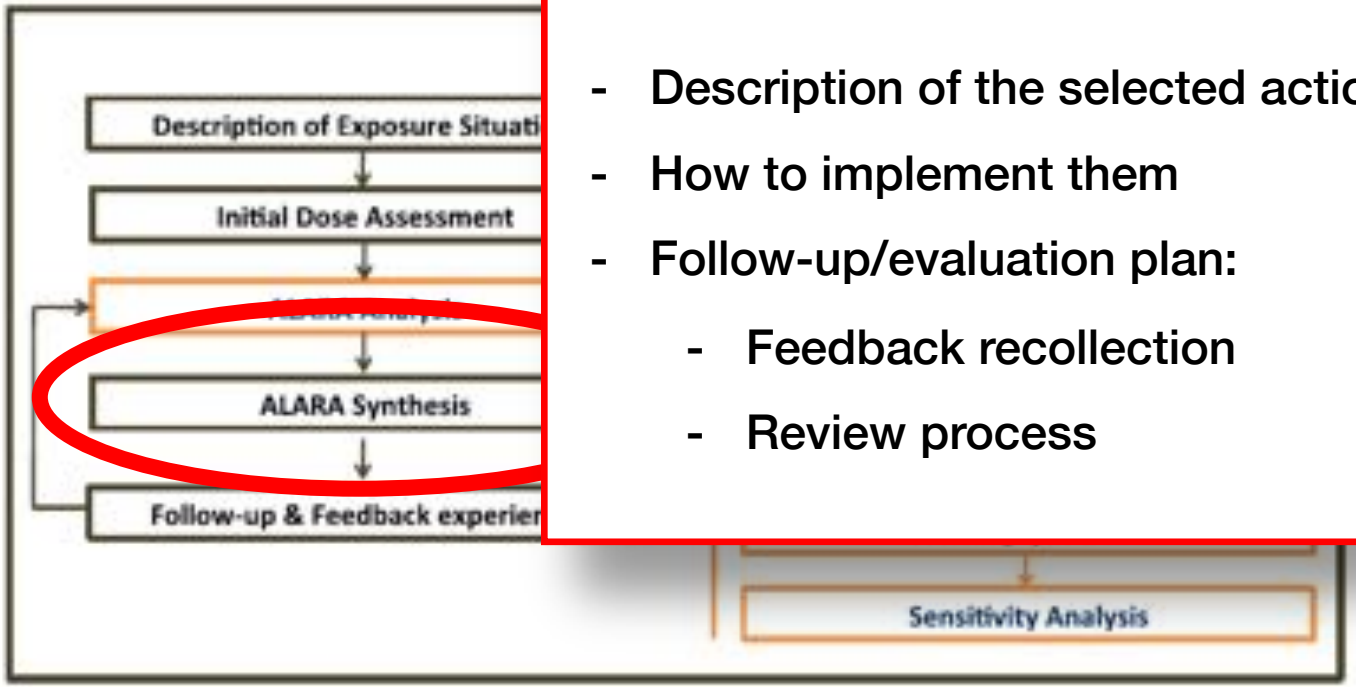
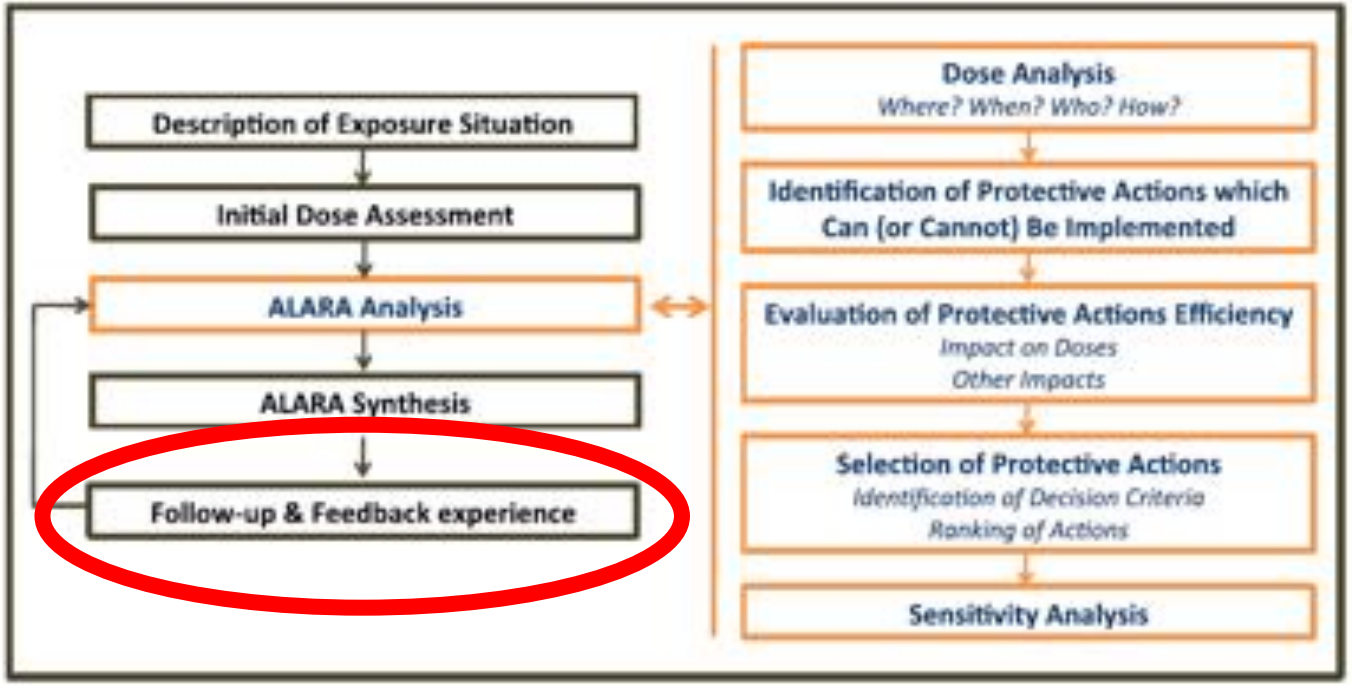


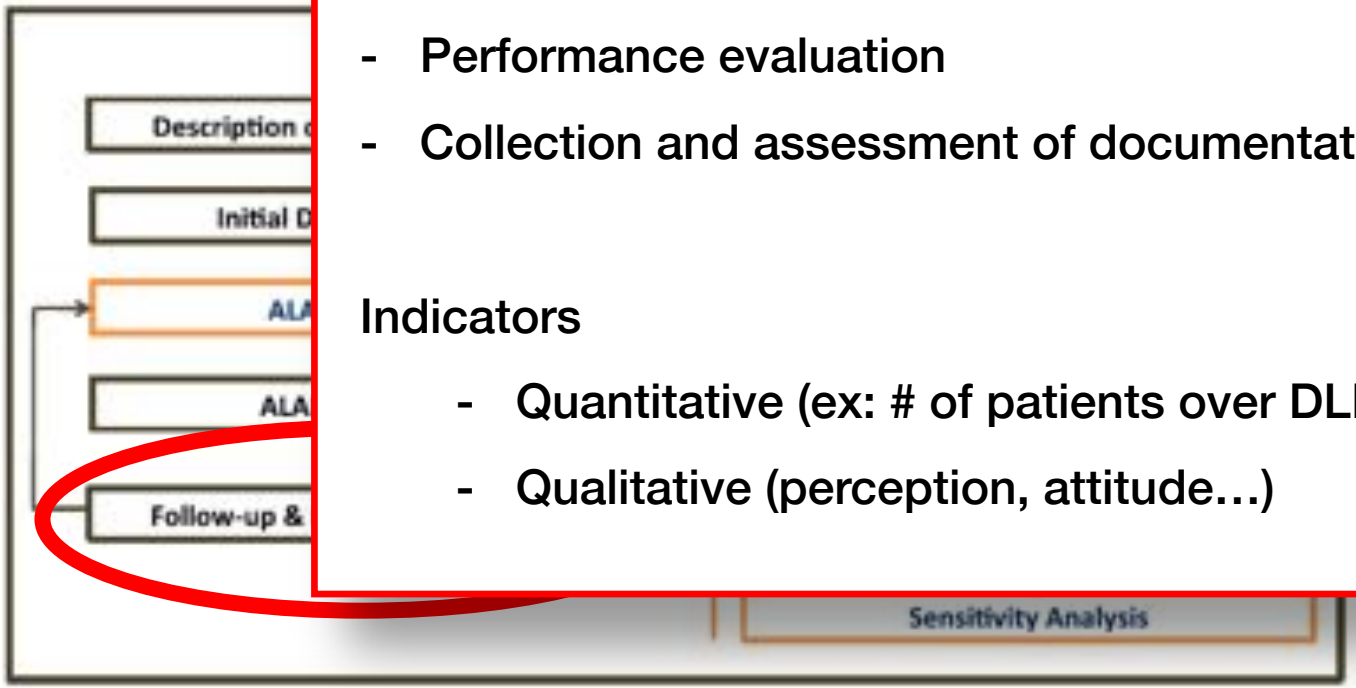
Document, including:

- Description of the selected actions
- How to implement them
- Follow-up/evaluation plan:
  - Feedback recollection
  - Review process

ALARA PROCESS AND TOOLS



ALARA PROCESS AND TO



Follow-up – evaluation of actual effetiveness

- Dose monitoring
- Performance evaluation
- Collection and assessment of documentation

Indicators

- Quantitative (ex: # of patients over DLR)
- Qualitative (perception, attitude…)

ALARA PROCESS AND TOOLS

ALARA CULTURE

COMMON CULTURE SHARED BY THE DIFFERENT STAKEHOLDERS

- Based on risk awareness and on attitudes…
    - questioning,
    - openness and transparency
    - commitment to dose reduction

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ALARA IN MEDICINE

STAKEHOLDERS IN MEDICINE

- Medical doctors (training)
- Medical physicists (supervision and evaluation)
- Radiographers (training, questioning attitude)
- Hospital/Facility directors (awareness and resources)
- Manufacturers (design and protocols)
- Well aware patients (social pressure)
- Legislators and regulators (provisions and supervision)

ALARA IN MEDICINE

STAKEHOLDERS IN MEDICINE

- Medical doctors (training)
- Medical physicists (supervision and evaluation)

IAEA's Radiation Protection of Patients (RPOP) website:

https://www.iaea.org/resources/rpop

- **Information for patients and public**
- **Training for health professionals**

ALARA IN MEDICINE - PROFESSIONALS

RADIOLOGY

- DESIGN of facilities and imaging equipment
- DESIGNATION of controlled and supervised areas,
- Individual radiation MONITORING,
- APPROPRIATE of personal protective devices (+screens)
- Optimized PROCEDURES during medical examinations

ALARA IN MEDICINE - PROFESSIONALS

INTERVENTIONAL RADIOLOGY / CARDIOLOGY (1/2)

- MINIMIZATION of FLUOROSCOPY time
- HANDS out of beam
- Individual radiation MONITORING
- APPROPRIATE of personal protective devices AND SHIELDING

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ALARA IN MEDICINE - PROFESSIONALS

INTERVENTIONAL RADIOLOGY / CARDIOLOGY (2/2)

- Use of COLLIMATION
- Awareness of body POSITION relative to beam
- TUBE FAR from patient, detector close
- Staying in LOW SCATTER AREA (far from equipment)
    - Horizontal beam: staff by the detector
    - Vertical beam: detector above the table

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ALARA IN MEDICINE - PATIENTS

CT EXAMINATIONS

Techniques for dose reduction during CT scans (ICRP 105, EMAN, ICRP 121) include:

- Improved detector technology
- Adaptive collimation to reduce over-ranging
- Dose modulation and automated exposure control
- Adaptive filtering of raw data
- Iterative reconstruction of raw data, etc.

Optimization of scan PROTOCOLS with parameters and settings to compensate for patient body variations

ALARA IN MEDICINE - PATIENTS

INTERVENTIONAL RADIOLOGY / CARDIOLOGY (1/2)

- Appropriate imaging EQUIPMENT
- PLAN the procedure using all INFORMATION
- MINIMIZATION of fluoroscopy time
- Maximization of the DISTANCE between X-ray tube and the patient

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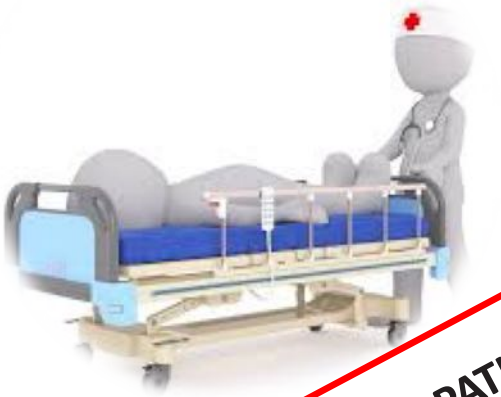
ALARA IN MEDICINE - PATIENTS



INTERVENTIONAL RADIOL… …LOGY (2/2)

- Continu… …ING of patient doses
- … … to the area of interest
- … STEEP oblique and lateral positions
- Keep unnecessary body parts out of the X-ray beam.

LOW DOSES FOR PATIENTS PROVIDE LOW DOSES FOR PROFESSIONALS

ALARA IN MEDICINE - PATIENTS

FOLLOW-UP OF PATIENT EXPOSURES

- Patient doses from the diagnostic or therapeutic procedures must be RECORDED and EVALUATED

"Diagnostic Reference Levels in Thirty-Six European Countries, Radiation Protection Report 180, European Commission, Directorate General for Energy and Transport, Radiation Protection, 2014"

Dose Datamed 2

THE EUROPEAN ALARA NETWORK

- Objectives are to promote implementation of ALARA in all ES and provide mechanism for exchange/dissemination of ALARA (notably through workshops)
  - 18 Members (organizations) in Europe
  - + working groups
  - + active sub-networks (ERPAN, EANNORM, ...)
  - + in relation with other organisations ... Including ICRP

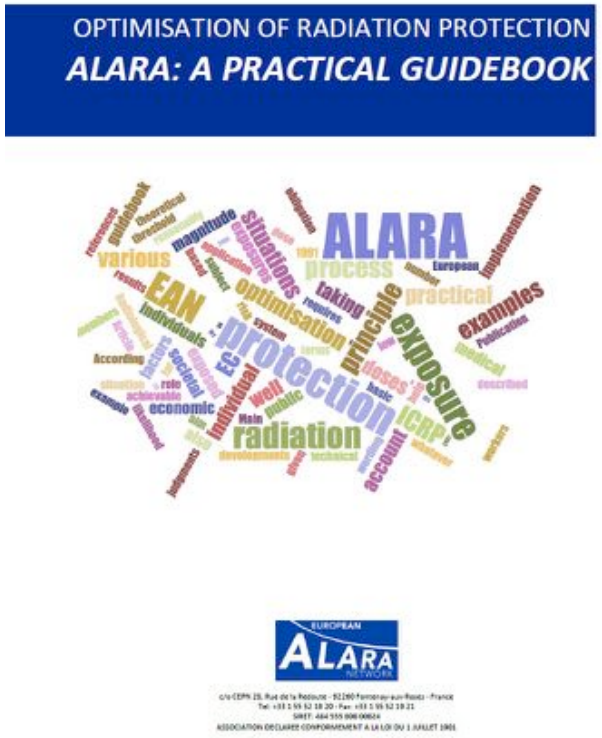
WHO

THE EUROPEAN ALARA NETWORK

- ACTIVITIES / OUTPUT
  - EAN Workshops
  - Support to European Surveys
  - EAN subnetworks
  - ALARA Newsletter
  - EAN Website: https://www.eu-alara.net/

WHO

THE EUROPEAN ALARA NETWORK



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WHO