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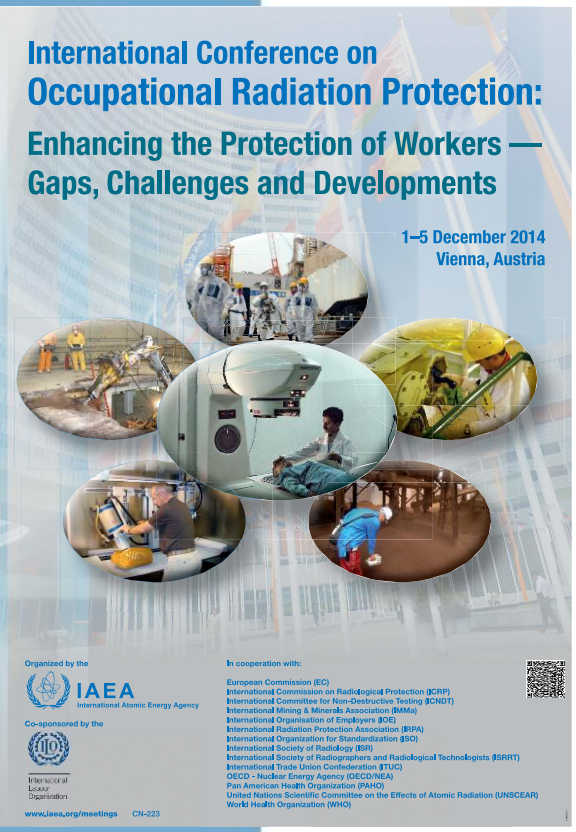
CENTRE D'ÉTUDE SUR L'ÉVALUATION DE LA PROTECTION DANS LE DOMAINE NUCLÉAIRE




# 2nd International Conference on Occupational Radiation Protection

## Enhancing the Protection of Workers - Gaps, Challenges and Developments

# Summary of Conclusions from Sessions and Round Tables


***Caroline SCHIEBER***

***Chair of Programme Committee***

# 2nd International Conference on Occupational Radiation Protection

## Enhancing the Protection of Workers - Gaps, Challenges and Developments


**1 – 5 December, 2014 – Vienna, Austria**

Organised by: the **International Atomic Energy Agency (IAEA)**

Co-sponsored by: the **International Labour Organization (ILO)**

In cooperation with the:

- European Commission (EC)
- International Commission on Radiological Protection (ICRP)
- International Committee for Non-Destructive Testing (ICNDT)
- International Mining and Minerals Association (IMMA)
- International Organisation of Employers (IOE)
- International Radiation Protection Association (IRPA)
- International Organization for Standardization (ISO)
- International Society of Radiology (ISR)
- International Society of Radiographers and Radiological Technologists (ISRRT)
- International Trade Union Confederation (ITUC)
- Nuclear Energy Agency (OECD/NEA)
- Pan American Health Organization (PAHO)
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
- World Health Organization (WHO)

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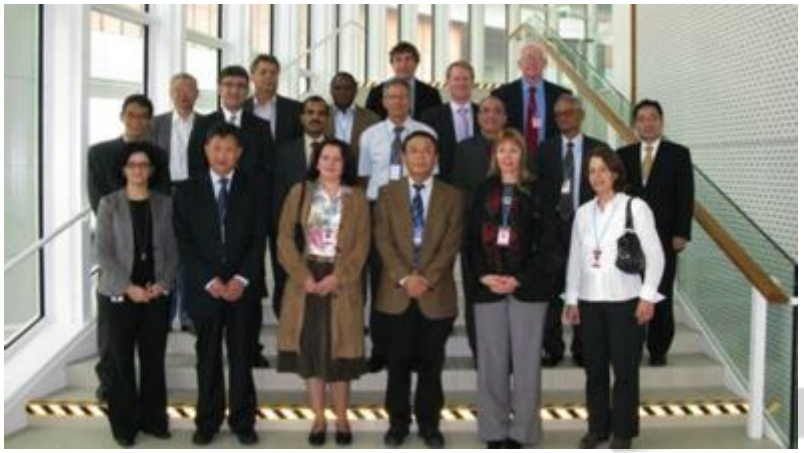
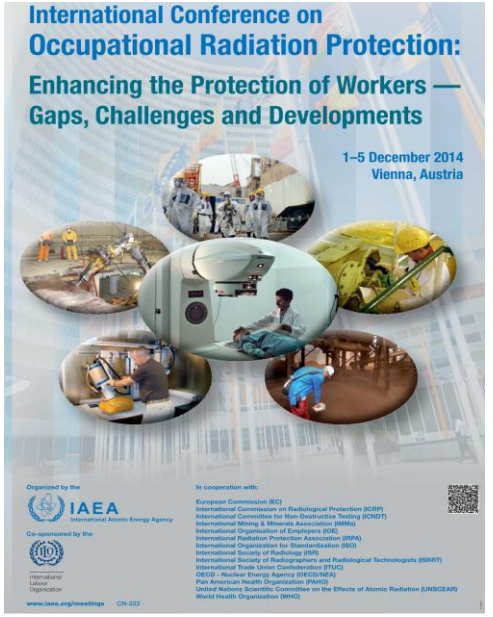
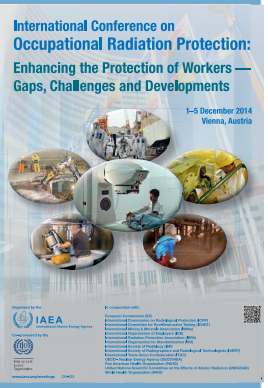


# Conference Participation

- Around 500 Participants
  - 95 Member States
  - 21 International Organisations / Associations
- 20 Exhibitors
  - Sponsors of coffee-breaks and Conference
- 12 Thematic Sessions – 4 Roundtables
  - Nearly 100 invited speakers / chair persons
- More than 120 Contributed Papers
- Around 100 Posters



# Opening Session – Setting the scene / Briefing Session




**IAEA, ILO, EU, OECD_NEA, UNSCEAR, WHO, ICRP, IRPA**

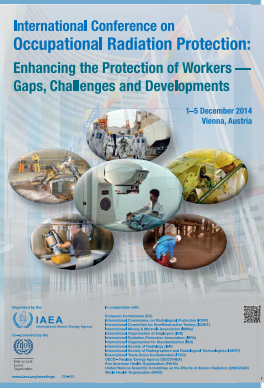
**Overview of past and present perspectives in ORP, Special focus on nuclear industry**

- Highlighted the progress since the 2002 Geneva Conference
- Implementation of all actions of the Action Plan
- Development of guidances, regulations,….
- Networking

***Remaining challenges***

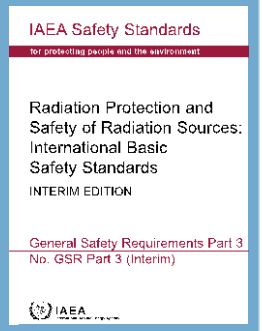
- **Recent changes in ICRP recommendations and international Basic Safety Standards** from the ORP point of view
- **Medical field**
  - Increasing number of exposed workers
  - Monitoring of staff dose
  - Education and training

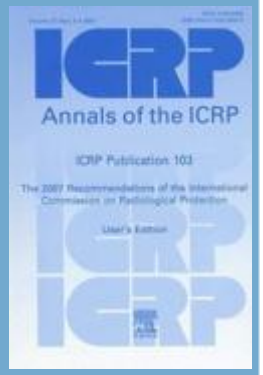
# Opening Session – Setting the scene / Briefing Session




- **Nuclear Power Plants**
  - Existing NPPs: foster RP culture for the young generation
  - New built – partly in currently non-nuclear power countries
  - Decommissioning: RP together with industrial safety issues
- **Emergency situations**
  - Approaches, measures and actions for radiation protection of emergency / responder workers
- **Itinerant workers**
- **Pregnant women**

# International Recommendations and Standards on ORP: Recent Changes and the Challenges in their Practical Implementation -1

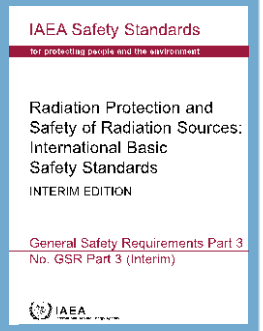



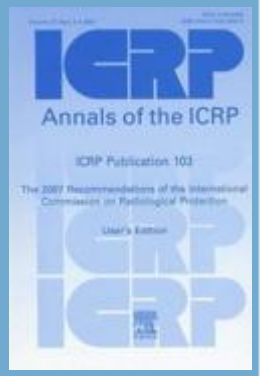




## IAEA BSS 2014, EU BSS 2013, IAEA SG OPR, ICRP 103

- **Objective of ICRP system of RP**: prevent deterministic effects and maintain stochastic effects "ALARA"
- **Relative stability in the existing RP system / standards:** Justification, Optimisation, Limitation remains the three fundamental principles
- Changes to ensure **a better worker protection and unified approach**:
  - Planned, existing, emergency situations
  - New standards broader the scope of OPR to better deal with NORM, Radon, outside workers, emergency situation
  - Changes should be logical and based on feedback (i.e. lens of the eye, emergency workers or responders)

# International Recommendations and Standards on ORP: Recent Changes and the Challenges in their Practical Implementation -2


- **Optimisation is now used in all exposure situations and should continue to be the key in ORP** (dose constraint / reference level for ensuring equity in individual dose distribution). *"Should be a process to reach expected levels".*
- **Graded approach** to be implemented to all situations
- **Foster radiation protection culture**: effective implementation requires awareness, dialogue and engagement of stakeholders
- **No need for further refinement of Standards**: needs are in enhancing assistance to countries with less developed programs for ORP to support practical implementation of the Standards

# Dose Assessment of Occupational Radiation Exposures -1

- **Requirements on dose assessment, Technical aspects of external and internal dosimetry, Dose assessment for the lens of the eye**
- **Effective dose *E* : protection quantity** which allows the summation of external and internal exposure. *"risk informed quantity"*
- ICRP radiation protection quantities and related measurement quantities have proved to play **a fundamental role** for the implementation of the limitation and optimization principle

- **Challenges**
  - **Up-dating the units** (established 30 years ago) to cover high energy radiation fields.
  - **Radiation weighting factors** are still based on few, not always pertinent scientific data (RBE values).
  - An open question is whether the **use of equivalent organ doses**is suitable at high radiation doses.

# Dose Assessment of Occupational Radiation Exposures -2

## External dosimetry

- Description of the **current status of external monitoring** including use of recent DIS active/passive device.
- **More restrictive quality requirements for service accreditation** (ISO 17025) => Reduced number of services, larger size
- **Further intercomparisons** for extremity dosemeters and neutron personal dosemeters are needed – results show need for improvement.
- The future:
  - Possible **narrowing of the performance requirements** (*Every uncertainty gained is positive* )
  - Better **neutron personal dosemeters**, better r**esponse to low-energy beta-radiation**, **active dosemeters**.
  - Possibly increased use of **computational methods**

# Dose Assessment of Occupational Radiation Exposures - 3

## Internal dosimetry

- Current status of **internal dosimetry methods**, International standard and guidelines, especially recent ISO standards
- **Networking and coordination of research** is essential
  - Notable examples include the EURADOSE initiative, the CURE project , MELODI and OPERA.
- **Revision of the dose coefficients** for internal exposures needed (ICRP 103 - new phantom, update of WR and WT, …) new publication under preparation
- Future:
  - **Accreditation** of internal dosimetry laboratories / services
  - Implementation of **OIR biokinetic models** (ICRP)
  - **Harmonization** of methods and (new) tools

# Dose Assessment of Occupational Radiation Exposures – 4

## Eye lens dosimetry

- **Revision of the ISO 15382** : "procedures for monitoring the dose to the lens of the eye, the skin and the extremities"
- New version will cover procedures for monitoring the dose to skin, extremities, and the eye lens, Photon exposures (8 keV - 10 MeV) and electron/positron exposure (60 keV - 10 MeV).
- More **dosimeters for Hp(3) are becoming available** and intercomparison initiatives are welcome.

# Radiation Effects and Health Risks from Radiation Exposure at the Workplace -1

**Knowledge on radiation effects (deterministic, stochastic), health risks, including on eye lens and cardiovascular system risks, and developments on concepts of probability of causation**

- *"health effect" (something that is actually observed) and "health risk" (something that is expected)*

- For stochastic effects, **a specific health effect <u>in an individual</u> cannot be attributed with certainty to ionizing radiation**: radiation exposure is not the only cause, no biomarkers, uncertainty increases with decreasing dose
  - Biological arguments exist for models other than LNT, especially at low and very low doses but not confirmed: assumptions have to be made
  - Major criticisms to calculating numbers of cases of death by multiplying low doses, or in particular very low doses, by the number of individuals affected and a notional risk factor

# Radiation Effects and Health Risks from Radiation Exposure at the Workplace -2

- **Lens of the eye:** one of most radiosensitive organs of the body – radiation cataract is a specific subset of lens opacities
  - **Epidemiological studies** (radiological technologists and other occupationally-exposed personnel)
  - Threshold in absorbed dose is now considered to be **0.5 Gy.**
  - **Not clear whether cataracts are stochastic or deterministic**
  - Some issues related to the relative detriment of cataracts and cancer, but the treatment (surgical) has consequences and risk of complications
- **Cardiovascular diseases (CVDs)**
  - Impact clear at high doses
  - At low to moderate doses some epidemiological results, but importance of background risk factors for different groups of workers not adequately defined
  - At lower doses still, the situation is even more unclear
  - **Not clear whether CVDs are stochastic or deterministic**
  - Further work on the possible mechanisms needed

# Radiation Effects and Health Risks from Radiation Exposure at the Workplace -3

- **Probability of causation**
  - **Guidance document** co-sponsored by ILO, IAEA and WHO (2010)
  - Based on epidemiological approach, draw inferences from large exposed populations to individual cases
  - Knowledge used to make a science-based judgement on the question of causality.
  - Uncertainty from various sources needs to be taken into account
  - Compensation criteria are legally based, not science
  - **New software tools** becoming available to readily assess probability of causation, possibly including additional risk-relevant information such as for ethnicity, smoking status etc.

# Health Risk Management -1

- **The public is nowadays more interested in health and healthy working conditions**
- **Promotion of health needs an integrated approach**
  - Health promotion strategy includes three parallel and sequential processes:
    - Regulation
    - Implementation assessment with data collection
    - Health promotion and disease prevention activities to be integrated in the whole life cycle of an individual

# Health Risk Management -2

**Incorporation of RP occupational health surveillance into health surveillance of workers (a way forward?)**

- The mission is to **create a multi-dimensional perspective of protecting and safeguarding the individual,** taking into account the whole life exposure to radiation and its implication. The issue is complex due to the knowledge of genetics and its influence over health and the need for "personalized medicine".
- Ways should be found **to combine health records data on the individual from different databases** in order to have the "whole picture" regarding the individual's health.

**Cooperation is needed between different regulatory ministries and agencies pertaining to radiation protection (Safety authorities, occupational health authorities,…)**

⇒ foster collaboration and efficient networking

⇒ Synchronize policy

⇒ win – win – situation for all

# Dose Record Management of Occupational Radiation Exposures -1

**National dose record management systems (Spain, China, Canada)**

- **National dose registers** provide benefits to workers, employers and regulators.
- National registers may also be used as **indicators for good radiation protection** and to monitor the success of optimisation.
- Need for a **well defined legislative framework** for data sharing, data protection to ensure personal confidentiality, and for measures to ensure long-term preservation of worker doses.
- **Some issues:**
  - Categorisation of Workers / Work activities
  - QA of data (eg. Medical sector: not unified way to wear dosemeter)
  - Exposed workers not yet monitored (eg mines, medical sector,..)
- ***Action*:** There is significant action required to be done at the national level to set up and maintain a national dose registry. This is applicable for both developed and developing countries.

# Dose Record Management of Occupational Radiation Exposures - 2

**UNSCEAR and ESOREX: international cooperation activities to collect and evaluate data on occupational exposure.**

- **UNSCEAR:**
  - Needs to have robust database that reflects the real picture of the global situation on occupational radiation exposure.
  - Has conducted assessments of global occupational radiation exposure since 1975 and has reiterated the need for a good international coordination and cooperation of all national authorities for data collection on occupational radiation exposure.
- **The European Study on Occupational Exposure (ESOREX)**
  - A WEB-based platform for exchange of information between EU national dose registers.
  - a good example on how to synergize efforts on a regional level to collect and evaluate data on occupational exposure.
- ***Action***: National authorities should be encouraged to support UNSCEAR and ESOREX by sharing information on occupational exposure.

# ORP in Industrial and Research & Education Facilities - 1

**Industrial Radiography: general ORP issues, regulator and provider's views, education & training**

- **ORP relatively mature:** systematic approach involving RPOs, training and qualification following IAEA recommendations.
- **However still high doses in some cases, occasional accidents, lack of training for some radiographers (country specific)..**
  - Improvements in **harmonization** (and recognition) of **training**, **equipment**, and **communications** is needed
  - Recommendations and Role of the Industrial Radiography Working Group of **ISEMIR**
  - Main challenge: **get involvement from the NDT industry**
  - Assistance should be sought from other international bodies which can help (e.g., ICNDT and its members).
- **Consideration of replacement techniques was evaluated :**
  - Replacing X or gamma radiography with a different technique was found to be difficult and they will continue to have an important role and industrial radiography in NDT.

# ORP in Industrial and Research & Education Facilities - 2

## ORP in accelerator facility

- Accelerator use is growing at a rapid pace; there are many challenges that need to be addressed.
- Consideration should be given to the **development of area monitors and survey meters** suitable for monitoring high, low energy, pulsed radiation with RF shielding.
- Due to dose estimation uncertainties, consideration should be given to **engineered**, **redundant radiation safety systems** like various interlocks, **shielding** (with safety margin), **zoning**, **access control** and strict adherence to training and operational procedures.
- Efforts should be made in **standardizing radiation safety systems** for accelerator facilities.

# ORP in Emergencies and Post-Accident Exposure Situations -1

**Challenges encountered, lessons identified and follow-up actions taken with regard to protection of emergency workers in response to the Fukushima Daiichi accident (regulatory bodies and operators view), including a comparison to the Chernobyl accident**

- Lessons learned, notably in the field of:
  - Management, assessment, control and reduction of radiation exposure
  - Medical and health care management
- The **quantification of radiation exposure** during an accident continues to be an issue that requires further attention considering that the radiation protection quantities in normal operations have been defined for low doses.
- Issue of **unclear and competing responsibilities for occupational radiation protection** as most of the workers involved are not the traditional 'nuclear' workers under the responsibility of the licensee.
- **Transition from planned exposure situation to emergency exposure** situation in a case of major accident is also a crucial issue

# ORP in Emergencies and Post-Accident Exposure Situations -2

- These lessons learned show the need to improve the integration of various aspects of the emergency worker protection into **emergency preparedness plans**
  - Some guidance have been elaborated in the report from nuclear operators and regulatory bodies of ISOE
- Further work is also necessary to **support the practical implementation of international standard**s on emergency preparedness and response (existing as well as forthcoming) which provide a comprehensive requirements and guidance for protection of emergency workers
- It appeared to be **not cleared if ILO policies were covering emergency workers**. This issue requires priority attention and it should include ethical considerations that sometime could be competing
- The time allocated to this complicated subject did not permitted a full discussion of the many issues.
  - **IAEA and ILO should consider to call for a meeting** (e.g., a symposia) fully dedicated to the protection of emergency workers taking into account future planned activities in this area.

# Application and Interpretation of International Standards in Emergencies Preparedness and Response -1

**International standards (IAEA, ICRP), feed-back experience from Japan**

- Need to **establish a solid basis for the protection of emergency workers and helpers** based on existing standards, recommendations and guidance.
- Require an **open discussion between the radiation protection community and external stakeholders** (in particular: policy and administrative organizations and the legal experts).
- Need to **improve the qualification of the management and the workers in taking decisions under emergency situations or difficult situations** (balance between individual risks of emergency workers and the risks of people seriously affected by an emergency such as life saving actions).
- Need to **improve the specific situation of helpers in emergencies** (in term of administrative measures related to the allocation of responsibilities for provisions of information and personal protection, dose record keeping, medical follow up).

# Application and Interpretation of International Standards in Emergencies Preparedness and Response -2

- **Further guidance and better explanation** of existing standards and guidance is needed on
  - **The use of dose limits or reference levels or guidance values** (pre-defined and fix or flexible, multiple levels for different workers or for specific work situations?) including clarification of the various dose levels proposed;
  - **The protection standards** during the transition from a planned exposure situation to an emergency exposure situation as well as from an emergency exposure situation to a existing exposure situation;
  - The necessity for a **specific exposure control of workers** who are exposed to more than the 100 mSv (5-year dose limit) during emergency work to keep lifetime exposure below 1 Sv **or** any work restrictions for further work by highly/over-exposed workers;
  - The necessity for **special medical surveillance requirements** for highly/over-exposed worker (what type of requirements, for what time period?).

# ORP in the Workplaces Involving Exposure to NORM and Cosmic rays -1

- **Implementing new BSS in NORM Industry, oil & gaz industry experience (Brazil), coal mining and rare earth regulatroy status (China)**
- Industries involving NORM have been identified and characterised, but now need to implement a **proportionate system of control.**
- Planned vs Existing Exposure situations has caused confusion and delay. However, **graded controls are required for both.**
- Need to consider the **application of optimisation in practice,** need **realistic dose estimates** for NORM workers using workplace measurements, not models that overestimate exposures.
- More guidance is required on **Dose Constraints and Reference Levels** – for NORM industries in practice.
  - The use of reference level instead of action levels requires also a change of philosophy and in protective measures
- **Industry specific** approach essential.
- Management of **residues/wastes** – a radiation protection issue.
- More emphasis is still needed on **awareness and training.**

# ORP in the Workplaces Involving Exposure to NORM and Cosmic rays -2

- **Aircrew exposure**
- Exposures are (can be) well characterised.
- Individual and collective occupational exposures are **significant**, and are **increasing**.
- **Scope for optimisation is limited** (work planning, flight planning, optimization en route) and not easy to implement (issues notably in terms of cost, human factors, feasibility)
- **A future issue to be followed and analysed**

# ORP in the Workplaces Involving Exposure to Radon

**Overview of radon occupational exposure, ICRP recommendations regarding radon dosimetry, Regulatory perspective, Practical implementation of dosimetry in mining industry**

- **Overview**
  - Radon levels vary widely with geology, mineralogy, & work practices
  - Radiation protection standards for radon are well established at an international and national level
  - Radon levels in modern uranium mines are low and well controlled in most circumstances
- **New developments**
  - ICRP recommended an approximate doubling of the risk from radon
  - Calculated risks from epidemiology studies and dosimetric approach are in reasonable agreement
  - ICRP recommended an integrated approach to managing radon exposures

# ORP in the Workplaces Involving Exposure to Radon -2

- **Challenges**
  - **Communicating new radon risk information to stakeholders**
  - **Increased doses from radon will require re-examination of past optimization efforts**

- **Gaps**
  - **Lack of measurement equipment**, techniques, and data with regard to dosimetric approach
  - **Very limited data on radon exposures for non-uranium mines workplaces**

# ORP in Medicine -1

**Safety Culture, optimization of radiation protection, education & training, interventional procedures**

- **SSS approach:** Standards for equipment; Shielding; Skills and knowledge
- Compliance with standards for medical radiological equipment is important
- Need of **global standards for shielding of medical facilities**
- Personal radiation protection devices should be **customized to individual**
- Staff dose reduction is evident, but **high doses still occur,** particularly in fluoroscopy guided interventional procedures and nuclear medicine
- Staff doses depend on the **equipment configuration, use of shielding and practice**
- **Monitoring** of staff doses is important and needs **harmonization**
- Protection doesn't work if not worn – efficient monitoring of practice is needed

# ORP in Medicine -2

- *"Law is good, a **good safety culture** is better"*
- **Regulatory authority** is important in promoting safety culture
- **Assessment** of radiation safety culture is needed
- **Radiation protection education and training** of the healthcare staff:
  - is crucial
  - not harmonized
  - should be tailored to practice
  - should be integrated into the clinical refresher training
- **Medical physicist** plays important role in the staff radiation protection
- **Radiation protection officer** plays important role for daily RP practice
- All the actions to protect patient protect the staff too
- **Occupational and patient protection should be considered together**

# ORP in Medicine – The Way Forward -1

**Round table: radiographer, medical physicist, regulator, Professional associations (manufacturers and medical), IRPA**

- **Medical exposure has a unique specificity**: the occupational exposure is related to patient exposure

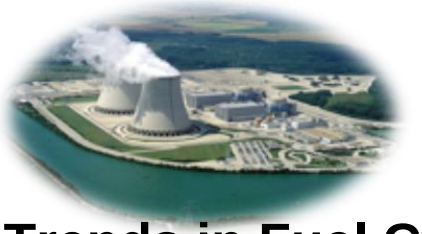
- **An harmonized approach to the RP of workers and patients is essential** for the application of the justification and optimization principles taking into account the two exposures.
  An harmonized approach will require a specific regulation and the promotion of the RP team work

- **An effective education and training of health professionals**, nowadays performed nearly as often outside as inside the departments of radiology, requires accredited programmes and individual certification of skill and competences acquired

# ORP in Medicine – The Way Forwad

- **Rapid development of imaging and therapy technologies**, providing great benefit to the health of the population, is requiring a **prompt answer of the regulators in the release of international safety standards and acceptance criteria** of equipment for their availability in the clinical practice. Manufacturer associations (e.g. COCIR) should support developments.

- IRPA and IAEA, in collaboration with WHO, IOMP, ISR and ISRRT, are **supporting inter-professional collaboration** setting up working groups aiming to revise safety standard for the medical sector, to support the implementation of the new eye-lens dose limits and, in general, to promote the safety culture and an ethic approach to RP in medicine.



# ORP in nuclear/fuel cycle facilities -1

**Trends in Fuel Cycle, Design of NPPs, Decommissioning of NPPs, Reprocessing Plant, "Regulatory framework in an "embarking country" (UAE)**

- **Operating NPP's :**
  - Practical/structured implementation of ALARA associated with networking and sharing of expereince => implementation Decrease of occupational exposure
- **Design stage of NPP's** (but not only):
  - from "a posteriori" to "a priori" approach towards radiation protection
  - Building for 40 years of operation : several generations of workers
  - Will save money, time and exposure
- **New nuclear country**
  - All has to be created: training, dosimetry services, regulations, inspection, operator RP programmes,…
  - Specificity of FARN with staff from many countries

# ORP in nuclear/fuel cycle facilities -2

- **Decommissioning**
  - Specificities for ORP
  - Need to share experience (within commercial restriction)
  - Need to improve maintaining knowledge (esp. on concepts and procedures)
  - Challenge to retain an appropriate level of awareness on radiation related risks during decommissioning
- **Reprocessing plant (Specificity of Sellafield)**
  - Wide range of different processes
  - Issue of legacy: need to learn from this experience to question what we will leave to the next generation
  - Judgement of what is ALARA is subjective (individuals perception of risk)
  - A flexible approach and a range of different techniques and needed to deliver risk reduction.

# Education and Training in ORP

**IAEA Actions, Region / Country experience (Latin America, Tanzania), IRPA, Networking**

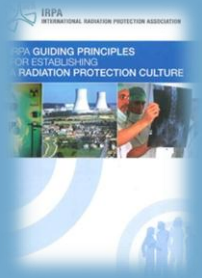
- Positive impact of IAEA TC Regional Projects in developing a national and regional strategy in education and training on RP and the steps of implementation
- Experience, challenges and gaps in the acknowledgment and accreditation process of training in RP and the partnership with universities
- Role of networks in keeping up-to-date radiation protection knowledge and experience
- Role of national and international professional associations in enhancing professional competences and development of RP culture.

# Education and Training in ORP -2

## Conclusions and recommendations

- IAEA: Continue to support MS on a national and regional level in developing and implementing a strategy on E&T in RP
- IAEA: Continue to support MS in their effort to develop and implement regulatory requirements with regard to E&T, as well as to introduce accreditation processes for training courses in radiation protection.
- IAEA: Continue to support the valuable role of regional ORP Networks in keeping up-to-date radiation protection knowledge and exchange of experience
- RP Associations: Continue to further promote continuous training of professionals in radiation protection and development of RP culture.


# Safety Culture




**IRPA Guidelines on RP Culture, Nuclear industry (INPO Safety culture), Nuclear Regulators' views**

- Main elements of "RP" / "Safety" Culture
  - Strong leadership at all level of the organization
  - Education and training
  - Proper behaviors
  - Communication
  - Learning from operating experience
- Practical implementation : organisations, tools, actions, ….
- Use of various indicators to measure performance, monitor the behaviors

- *A way of life - A way of working – A questioning attitude*
- *Ongoing process - has to be cultivated*

# Challenges in Implementing Occupational Radiation Protection

**Challenges in Africa, Asia, Latin America, Eastern Europe ; IAEA (ORPAS), Transport, IRPA**

- Common challenges in countries in terms of
  - Capacity building
  - Maintenance of a strong safety culture
  - Implementation of radiation protection programmes at end-user facilities
  - Provision of a quality dosimetry service
  - Dose record management of occupational radiation exposures
- Specific challenges for various stakeholders: Regulatory authorities, end users (various practices), Service providers, workers, trade unions
- Specific challenge of European countrie : EU Directives as well as IAEA BSS and Guidances (a few differences)
- Role of **Networks** (Asia , Europe)
- Role of **IAEA**: Technical cooperation programme and ORP Appraisal Service (124 countries)
- Role of **IRPA**: facilitate the sharing of information, training materials,…

# Challenges in Implementing Occupational Radiation Protection

**Challenges in Africa, Asia, Latin America, Eastern Europe ; IAEA (ORPAS), Transport, IRPA**

- **Specific issue of vehicle scanning**
  - Install appropriate information panels everywhere x-ray scanning is performed
  - Develop x-ray scanning certificates to avoid repetitive scanning and to accelerate the x-ray scanning process
  - Implement internationally recognised x-ray scanning procedures
  - Improve education of drivers, Customs officers and x-ray scanning operators on the functioning and risks of x-ray scanning

# Thank you for your attention