

**ETRAP 2017 : 6th International Conference on
Education and Training in Radiological Protection
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**Teaching Radiation Levels, Effects and Protection:
International Efforts for Coaching Nuclear Decision
Makers about Radiation**

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Aims

1. to summarize international efforts undertaken for teaching about ionizing radiation and its protection paradigm, to **nuclear decision makers** including managers and legal experts.

(this experience is subtly but significantly different than the traditional radiological protection education which is usually aimed at radiation protection practitioners)

2. to share lessons learned.

Efforts by 3 indispensable international educational institutions

- **World Nuclear University**
- **Joint School of Nuclear Energy Management**
(Jointly organized the Abdus Salam International Centre for Theoretical Physics and, the International Atomic Energy Agency)
- **International School of Nuclear Law**
(jointly organized by the University of Montpellier and the Nuclear Energy Agency (NEA) of the Organization for Economic Co-operation and Development)

Role of the Argentine Nuclear Regulatory Authority (ARN)

- **ARN fully supported these institutions and courses**
- **ARN has one of the longest institutional traditions on education and training in radiation protection.**
- **'Ad-hoc' ARN post-grade courses were offered to more than thousand practitioners from all over the world for nearly half a century; these efforts are being summarized elsewhere in this Conference.**



The World Nuclear University

The World Nuclear University

- **Worldwide network of nuclear education and research institutions inaugurated in 2003**
- **Offers training courses for future leaders on nuclear energy, on production and on applications of radiation and radioisotopes.**
- **Four founding members:**
 - **the World Nuclear Association,**
 - **the World Association of Nuclear Operators,**
 - **the IAEA and**
 - **the NEA.**

Main WNU educational initiatives

- **The WNU Summer Institute;**
- **The WNU's "The World Nuclear Industry Today";**
and,
- **The WNU School on Radiation Technologies.**

**More than 5000 participants from over 80 countries
have attended the WNU programmes**

The WNU Summer Institute

- Intensive six-week programme for future nuclear leaders held annually in different locations.
- Offers lectures, tutorials, field trips to nuclear and industrial facilities, and team projects.
- Full week on the '3S' of nuclear energy, namely:
 - safety;
 - security; and
 - safeguards.
- Including sessions on:
 - the scientific basis of radiological protection; and,
 - lessons learned from past accidents.

The WNU course "The World Nuclear Industry Today"

- A one-week long intensive refreshing course to enhance knowledge about today's nuclear science and technology.
- It provides a wide perspective of radiation, including:
 - global levels of radiation exposure;
 - attributable and inferable radiation risk of health effects;
 - basic elements of the radiation safety paradigm; and,
 - the intergovernmental international safety regime.
- Lectures have also covered major accidents and specific issues such as siting of nuclear facilities.

WNU School on Radiation Technologies

- **Two-week course aimed at future leaders in the radiation and radioisotope industry and medicine.**
- **Open to potential leaders of companies and governments expected to play key roles.**
- **Supported by:**
 - **the World Council on Isotopes,**
 - **the Australian Nuclear Science and Technology Organization,**
 - **the Association of Imaging Producers and Equipment Suppliers and**
 - **the IAEA**

WNU School on Radiation Technologies

- Teaches on issues associated with radiation protection on various radiation technologies.
- Includes practical exercises on specific radiation protection problems.
- For instance, practical desk-top exercises on the optimization of ventilation systems at radioisotope production plants.



The Abdus Salam

**International Centre
for Theoretical Physics**

The Joint School of Nuclear Energy Management

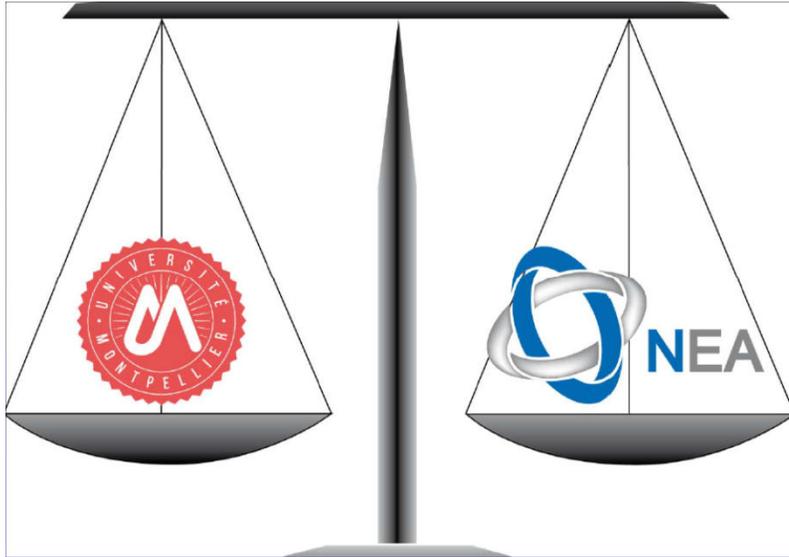
**(Jointly organized the Abdus Salam International Centre for Theoretical
Physics and, the International Atomic Energy Agency)**

The Joint ICTP/IAEA School of Nuclear Energy Management

- **It is offered to generate a global cadre of competent nuclear managers.**
- **2-week format following a standard curriculum for managerial courses.**
- **It includes extensive information on radiation levels, effects and protection.**

The Joint ICTP/IAEA School of Nuclear Energy Management

- It tackles intensively radiation issues
- Full session is dedicated to radiation protection in planned and emergency situations.
- It includes lectures on:
 - basic principles of radiation protection under normal operation and emergencies;
 - nuclear accidents preparedness and management, planning for unexpected scenarios, onsite and offsite preparedness, and emergency communication; and,
 - lessons learned from world radiation accidents.



International School of Nuclear Law

(Jointly organized by the University of Montpellier and the Nuclear Energy Agency of the Organization for Economic Co-operation and Development)

International School of Nuclear Law

- **Established by the University of Montpellier and the NEA in 2001.**
- **Provides lawyers with a comprehensive understanding of the various interrelated legal issues relating to the safe, efficient and secure use of nuclear energy.**

International School of Nuclear Law

- Major element: understanding of radiation, of the risks and effects of radiation exposure and of its legal implications.
- Emphasis given to the following epistemological issues:
 - **attributability of radiation effects;**
 - **inferability of radiation risk; and,**
 - **legal imputability of radiation harm.**

Lessons Learned

Lessons learned

- **Traditional international endeavors of education and training in radiological protection issues are usually targeted at future radiation protection practitioners.**
- **Lessons have been learned from interacting with the distinct students of the courses described in this paper, namely future managers and lawyers**

Lessons learned

- **Why the number of issues described hereinafter do not usually arise during traditional international efforts on education and training activities in radiological protection?**
- **Why they are a matter of hot debate for the students the courses described in this paper?**
- **There is not an easy answer to these questions**

Lessons learned

- The 'conventional' students of radiation protection seems more willing to accept concepts and paradigm as 'granted'.
-to learning 'dogma' and proliferating that dogma.
- Conversely, potential managers and lawyers have a more critical attitude:
 - They question concepts and paradigms in a manner that they suspect members of the public and authorities will question them.
 - They are not only interested in *what* but also in *why* questions.
 - And they expect that the 'whys' have to be easily conveyable to the audience that they expect to confront in their future carriers as nuclear managers and lawyers.

8 lessons learned:

**A simplified synthesis of some of
the issues presented by the
students of these courses**

1. The radiation protection language is cumbersome

Cumbersome language

- Cumbersome terminology of quantities
- Untranslatable expressions: e.g., '*detriment-adjusted nominal risk coefficients*'.
- 'Existing' versus 'extant'.
- 'Dose *limits*' than can be exceeded.
- 'Contamination' (kosher?) and 'remediation' (prescribe a remedy?)

2. The misuse of radiation risk coefficients is problematic

Misuse of radiation risk

- In the aftermath of an accident, hypothetical deaths are calculated by simply multiplying theoretically calculated collective effective doses by the detriment-adjusted nominal risk coefficients that are used in international standards.
- Nonsense and confusion

**3. The sophisticated system for
restricting internal exposure is
difficult to grasp**

Restricting internal exposure

- A given dose of internal exposure is perceived as more dangerous than the same dose from external exposure.
- This seems to be an issue of concern.
- Lectures are on controlling the accumulation of radiation dose over time (the prospective accumulated dose over time, or *committed* dose) namely the committed equivalent dose and the committed effective dose.
- But this practice of controlling hypothetical dose commitments rather than actually incurred doses is strange to the industrial managerial practice and also to the legal practice.

**4. The lack of *ad hoc* radiation
protection standards for *rescuers*
is surprising**

Standards for *rescuers*

- Students are surprised that an *ad hoc* safety regime has not been specifically established for *rescuers* in radiation accidents as it is the case for other emergency disciplines (e.g., firefighters).
- After the Fukushima accident positive steps have been taken to close the gap but still there is a lack of appropriate labor regulations.

5. There is a wide confusion on the concepts of dose limits, constraints and reference levels

Dose limits that are not 'limits'

- The unclear concepts of dose limits, constraints and reference levels for public protection are issues of concern for managers and lawyers.
- They argue cannot understand why the dose limit, which is a legally valid dose restriction before an accident, could be exceeded after the accident—at a time when people expect to be better protected!
- The two-order-of-magnitude range existing in current standards between the numerical values of annual limits *vis-à-vis* the numerical values of reference levels are not easily conveyable to a skeptical audience of lawyers and managers.

6. The protection of children is viewed as an unresolved issue

Protection of children

- Parents are not convinced that their children are well protected by applying to them the same dose restrictions than to adults.
- UNSCEAR estimates that lifetime cancer risk estimates for those exposed as children might be a factor of 2–3 times higher.
- However, the current protection system is based on the concept of nominal risk coefficient, where the difference in the cancer risk between a population that includes children and one that excludes them is less than 30%.

CONFUSION!

7. The incoherence and inconsistency among the international intergovernmental agreements on acceptable levels of radioactivity in consumer products is major issue

Consumer products

- **Students are concerned that,**
- **on one hand, the presence of radioactive elements attributable an the accident in consumer products creates alarm and apprehension and problems for managers and lawyers, and**
- **on the other hand, the existing international intergovernmental agreements on acceptable levels of radioactivity in consumer products are clearly incoherent and inconsistent**

8. The remediation of 'contaminated' territories and the disposal of 'contaminated' rubble is confusing to say the least

'Contaminated' territories

- Following the presence of radioactive substances over a territory, experts are unable to respond to a simple and straightforward question from the general public:
Is it safe for me and my family to live here?
- They explain that, while the territory is 'contaminated', 'remediation' had to be 'optimized', and depending on many factors they might or might not remain there.
- Providing non-conclusive and inconsistent answers to that simple enquiry is most unhelpful, and the students demand an answer.

Epilogue

- **It seems essential for the renaissance of nuclear energy, that future nuclear decision makers, particularly managers and lawyers, be properly coached in the essential elements of radiation, on its levels and effects and on the paradigm of protection against radiation exposure.**
- **This is being achieved at the international level through the efforts of inter alia the WNU, the JSNEM and the ISNL, which are described in this paper.**
- **Lessons were learned with these distinctive students.**
- **These are applicable to the international efforts on education and training in radiological protection.**