SESSION Ⅱ

STATUS OF RADIATION EDUCATION IN SEVERAL COUNTRIES

TUESDAY, AUGUST 24

2.1 'Catch Them Young Strategy' for the Ethical Education on Radiation Technology: A Concept of 7 'Es'

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It is the ethics which makes human to make the justifiable use of radiation; there are always two sides of coin; the benefits in the use of ionising radiation and radionuclide should weigh with the risk. Radiation technology has both, the advantages and disadvantages with certain shortcomings; however abandonment of any technology at this juncture may be threat to human civilization. There should always be a rapid evolving process in the development of technology-and so in radiation techniques for the sustenance of human welfare. Hence a "strategy" is intended to be proposed and formulated through this Conference; some in-depth and deep rooted engravings on the young minds are proposed which are going to be the part of an enlightened citizens and policy makers of tomorrow who could justifiably implement the right and better use of radiation technology. Thus nowhere it could be taken as the liberal use of double-edged sword.

The proposed strategy in the presentation will emphasize on educational policy from light learning activities in the classroom to a **short term and long-lasting impact for the young children through planned lessons** which could make a mind-etching luminous part of their curriculum. Ethics is an engrave on the minds which are formed after prolonged exposure of stimuli to brain through receptor organs by various ways like by a regular 'dinner table chats', 'company chat on playground' and 'off-hour chat by teacher' or by self-experience. Radiation education leading to ethics certainly can not be by self-experiences – however the narration, pictures and movies on some of incidences like that of Hiroshima and Nagasaki should be very often and religiously given and shown to them world wide. An impressive and 'sugar-coated' informal ways of radiation education is needed.

The principle of 7 Es *i.e.* how **exposure** to **experiences**, **education, enrichment** of knowledge, **elimination** of fear and **engravings** in mind lead to **ethics for radiation** which will give us enlightened citizens, policy-makers and leaders. Author will advocate the inclusion of certain lessons in curriculum whereby child should cultivate rationality of the use of radiation and eliminate fear against radiation. This would enable adolescent brains to permeate the judicious learning leading to the formation of their mindset and related behaviour. The psychological and sociological impact of radiation education with the possible questions in the minds of august audience and luminaries are also intended to be discussed. The logics based upon the **adolescent brain and age-related behavioral manifestations** will further advocate the proposed strategic and premeditated theory on ethical education on the use of radiation technology.

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INTRODUCTION

It is the ethics which makes human to make the justifiable use of radiation; there are always two sides of coin; the benefits in the use of ionising radiation and radionuclide should weigh with the risk. Radiation technology has both, the advantages and disadvantages with certain shortcomings; however abandonment of any technology at this juncture may be threat to human civilization. There should always be a rapid evolving process in the development of technology-and so in radiation techniques for the sustenance of human welfare. Hence a "strategy" is intended to be proposed and formulated through this Conference; some in-depth and deep rooted engravings on the young minds are proposed which are going to be the part of an enlightened citizens and policy makers of tomorrow who could justifiably implement the right and better use of radiation technology. Thus nowhere it could be taken as the liberal use of double-edged sword.

1.1 The Nature and Scope of Risks and Benefits

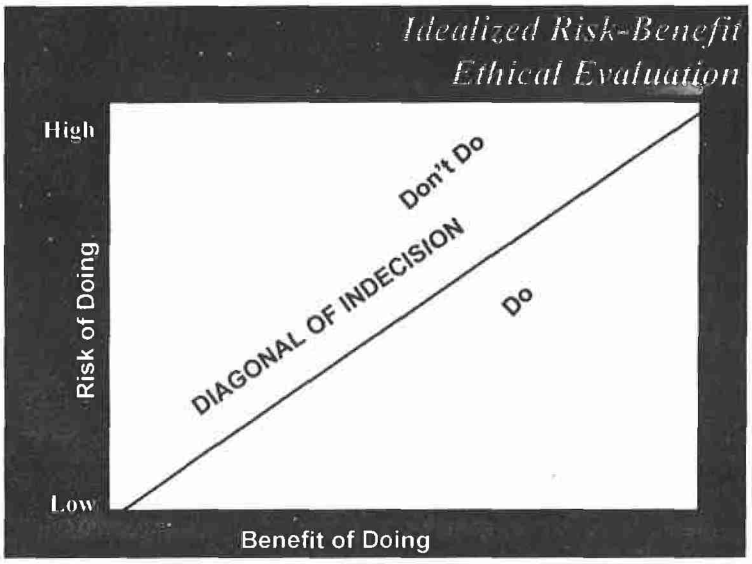
The requirement that research be justified on the basis of a favorable risk / benefit assessment, bears a close relation to the principle of beneficence, just as the moral requirement that informed consent be obtained is derived primarily from the principle of respect for persons.

The term "risk" refers to a possibility that harm may occur. However, when expressions such as "small risk" or "high risk" are used, they usually refer (often ambiguously) both to the chance (probability) of experiencing a harm, and the severity (magnitude) of the envisioned harm.

The term "benefit" is used in the research context to refer to something of positive value related to health or welfare. Unlike "risk", "benefit" is not a term that expresses probabilities. Risk is properly contrasted to probability of benefits, and benefits are properly contrasted with harms rather than risks of harm. Accordingly, so-called risk / benefit assessments are concerned with the probabilities and magnitudes of possible harms, and anticipated benefits (Figure 1). Many kinds of possible harms and benefits need to be taken into account. There are, for example, risks of psychological harm, physical harm, legal harm, social harm and economic harm, and the corresponding benefits. While the most likely types of harms to research subjects are those of psychological or physical pain or injury, other possible kinds should not be overlooked.

Risks and benefits of research may affect the individual subjects, the families of the individual subjects, and society at large (or special groups of subjects in society). Previous codes and Federal regulations have required that risks to subjects be outweighed by the sum of both the anticipated benefit to the subject, if any, and the anticipated benefit to society in the form of knowledge to be gained from the research. In balancing these different elements, the risks and benefits affecting the immediate research subject will normally carry special weight. On the other hand, interests, other than those of the subject, may on some occasions be sufficient by themselves to justify the risks involved in the research, so long as the subjects' rights have been protected. Beneficence thus requires that we protect against risk of harm to subjects, and also that we be concerned about the loss of the substantial benefits that might be gained from research.

1.2 Role of Agencies



Now the **ICRP** guidelines are that *"any risk must be kept much smaller than that from other hazards"* and *"the probability of developing radiation-dependent diseases, characteristically cancers, is directly proportional to the dose received"*. That is, there is no threshold. By the late 1970s the question had become one as to what is 'reasonable'. **Utilitarian cost-benefit analysis** was in vogue. The key questions were seen as: How many lives will be saved? What will it cost? Protect society, it was thought, and the individual will be protected. But by the time the 1990s arrived the emphasis had changed. A concern for individual risk was uppermost. An important question was that of inequity. It was not acceptable if a single individual was at high risk even if the population at large were relatively safe. Standards must therefore address the question of the individual risk.

Now that we are in the 2000s the focus has become one of looking at individual risks, sometimes from single sources. But the threshold effect is still debated. The French Academy (the reporter notes the dependence of French industry upon nuclear power and of French military prestige upon nuclear weapons) has produced a report that says such a threshold exists. In the US Senate, Sen. Pete Domenici has introduced a resolution demanding recognition of such a threshold by bodies such as ICRP. Yet, says, ICRP, there is no threshold.[2]

It is the ethics which makes human to make the justifiable use of an inventory like radiation and radioactive substances. There are 2 sides of coin- the benefits in the use of ionising radiation and radio-nuclides should weigh the risk. While irradiation of humans in medical and other researches can present certain calculable risks, such irradiation, when properly controlled, carries a smaller risk to health than many chemicals, pharmaceuticals and other agents in common use. The **International Commission on Radiological Protection (ICRP)**, established in 1928 by the International Congress of Radiology, has published comprehensive recommendations on the protection of man from ionising radiation, including recommendations on exposure in the context of medical research. In addition, the World Health Organisation published a report on the use of ionising radiation and radionuclides on human beings for medical research, training and non-medical purposes.

One of the actions of **International Radiation Protection Agency (IRPA)** on the Executive Council from Hiroshima was to operate a forum for discussion of different

[2] http://www.pugwash.org/reports/nw/nw11.htm **The Effects of Low Level Radiation Report of the British Pugwash Group** 18 April 2000; Chair: Sebastian Pease Rapporteur: Peter Nicholls, British Institute of Radiology, London, UK

Codes of Ethics with a view to preparing a proposal for adoption in Madrid. This proposal prepared is based on the common elements of the Codes adopted by the **US Health Physics Society, The UK Society for Radiological Protection and the Australasian Radiation Protection Society**. Note has also been taken of the Canadian Radiation Protection Association Code of Professional Ethics where its coverage was similar to that of the other Codes. It is commendable that societies and individual IRPA Members are encouraged to review the proposal and make comments or suggestions. Though, the principles have been primarily intended to aid members of IRPA Associate Societies in maintaining a **professional level of ethical conduct, however** their significance and relevance can not be safely ruled out in policy making. They are to be regarded as guidelines using which members may determine the propriety of their conduct in all relationships in which they are exercising their professional expertise. *"If there is reason to believe that a member had breached this Code of [Ethics / Ethical Conduct], the Society to which the member belongs [shall/should] investigate and [take appropriate measures. /, if substantiated, the member may be required to forfeit membership of the Society and of IRPA*]."[3]

1.3 Present Scenario of Use of Radiation Technology

Renewable energy sources other than hydro have high generating costs but are suitable for small intermittent-load electricity demand. Nuclear power generation is an established part of the world's electricity mix providing over 16% of world electricity[4] (cf. coal 40%, oil 10%, natural gas 15% and hydro & other 19%). It is especially suitable for large-scale, base-load electricity demand.

A total of 438 nuclear power plants were operating around the world at the end of 2000, according to data reported to the IAEA's Power Reactor Information System.

Asia is the only region in the world where electricity generating capacity and specifically nuclear power is growing significantly. In East and South Asia there are currently about 100 nuclear power reactors in operation, 20under construction and plans to build about a further forty. The greatest growth in nuclear generation is expected in China, Japan, South Korea and India. India is a pioneer in developing the thorium fuel cycle, and has several advanced facilities related to this.[5]

In India14 units in operation (2.5 GWe), 8 under construction, 5 planned or proposed, also 5 research reactors. India[6] has achieved independence in its nuclear fuel cycle. However, nuclear power currently supplies less than 4% of electricity in India. The units under construction are due for completion by 2010. A further five units are planned or proposed. In contrast with North America and most of Western Europe where growth in electricity generating capacity and particularly nuclear power has levelled out, a number of countries in East and Southeast Asia are planning and building new power reactors to meet their increasing demands for electricity.

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[3] [IRPA Code of Ethics (Draft 1 June 2002] [Ethics / Ethical Conduct] (Draft 2 October 2003)]

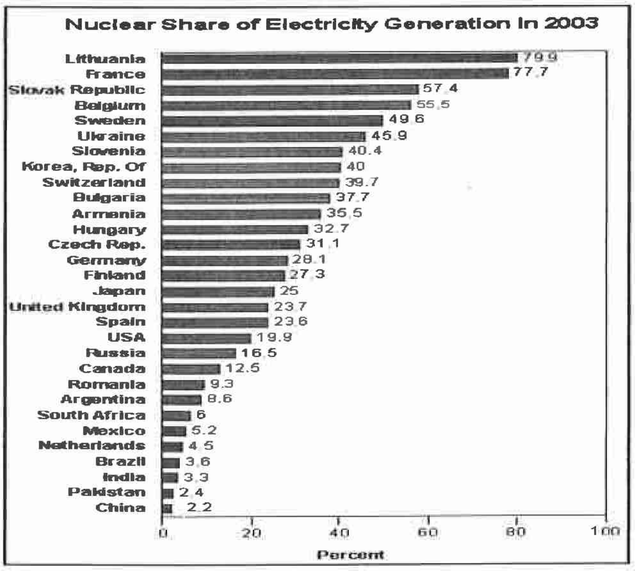
[4] http://www.uic.com.au/nip07.htm

[5] Asia's Nuclear Energy Growth, Nuclear Issues Briefing Paper 2, November 2003; http://www.uic.com.au/nip02.htm

[6] http://www.uic.com.au/nip07.htm

	Power Reactors in Operation	Power Reactors Under Construction	Power Reactors Planned or Proposed	Research Reactors	Other Stages of the Fuel Cycle
Japan	53	3	12	17+1	*C, E, FF, R, WM*
S. Korea	18	2	8	2	*C, FF*
N. Korea		2		1	*C?,FF?,R*
China NNC	8	3	10	13	*UM, C, E, FF*
China Taipower	6	2		4	
India	14	8	5	5	*UM, FF, R, WM*
Pakistan	2		1	1	*UM, E, FF*
Indonesia			2	3	*FF*
Philippines				1	
Thailand				1+1	
Vietnam			2	1	
Bangladesh				1	
Malaysia				1	
Total	101	20	40	56*	

Nuclear Power in Asia, and Involvement with the Nuclear Fuel Cycle[7]



*54 operable, 2 under construction **Key:** *UM Uranium Mining, C Conversion, E Enrichment, FF Fuel Fabrication, R Reprocessing, WM Waste Management facilities for spent fuel away from reactors.*[8]

Figure 2: Nuclear Share of Electricity Generation in 2003

[7] Asia's Nuclear Energy Growth, Nuclear Issues Briefing Paper 2, November 2003; http://www.uic.com.au/nip02.htm
http://www.world-nuclear.org/info/inf47.htm

[8] IAEA's Power Reactor Information System

2. ISSUES OF ETHICS AND MORALS

Law and morals don't always meet, new area, old questions or new area with new questions? Does the medium bring new ethical questions to bear? e.g. security and safety; we have the same information (and possibly more) but the problems come from easier handling of that information. Ethics is the study of morals which are the (right or good) habits which people have in a society (lat. *Mores).* Applied ethics tries to simplify the questions of ethics/morals so that they can be discussed. Ethics have been and are still (albeit to a lesser degree) used to formulate policies in societies. Therefore the **aim(s) of Ethics are** the **good** of the people to understand what it would be – meta-ethics, to build a system to solve how to get there, to apply the system(s) to actual questions coherently and consistently and to aid us in our moral problems.

2.1 Ethics for Radiation

Why ethics for radiation technology is needed ? Any Technology has advanced faster than ethical values, morals and laws and it warrants discussion between relevant parties, ethicists, professionals, 'intelligentsia', organization representatives, politicians, media, 'normal' people, etc. And so is with the technology using radiation and radioactivity. Therefore for the advancement of radiation technology both **ethicists and professionals (i.e. users and policy makers) are needed** to understand *both* to be able to discuss rationally (and emotionally, at that) the – Ethics and – Technology whereby the conceptual and usage muddles could be avoided. Professionals can provide the necessary facts of the details and Ethicists can clarify the questions so that discussion is possible whereby users at one juncture have better understanding with general public. This understanding is highly desirable for the growth of technology and development of any country. At this point the Darwinism should be evaluated with a view of self evolving process of countries and races. As **Social Darwinism says that** some individuals or 'races' based on some of their features are 'better' than others and thus ought be favoured above others. How to measure these traits? What to do with those less 'good' in term of developed and developing and underdeveloped countries.

2.2 '7-Es'-Ruled Ethics for Radiation Use

Guidelines are hereby recommended as **7 rules** on the basis for ethics on use of radiation and radiation technology.

I. **Elementary Rule :** The use of radiation technology should be useful to society.

II. **Experiment Rule** : Experiments should be based on animal research. No further experimentation if death or disability occurs.

III. **Evasive Rule** : No unnecessary physical or psychological harm to the subjects and students.

IV. **Economic Rule :** In radiation technology the risk involved should be proportional to the benefits.

V. **Employee Rule :** Protect the worker/employee or any subject from harm. ()

VI. **Ethical Rule :** Policies should be prepared by highly qualified scientists with ethical background only.

VII. **Elimination Rule :** The researcher must be prepared to discontinue the experiment in the event of any results untoward to the society.

And I hereby make an **eloquent** appeal for action. The rules require continuous dialogue. Assessment of risks as a percentage of natural background may be the most useful. This then also enables us to consider the question of environmental radiation protection policy--an area which current human-focused guidelines do not address. Because the environment is not one of individuals, such risks are direct and not statistical in nature. What will be the effect on oak trees? Or shellfish? Note that some organisms are much less sensitive to radiation than are human beings (cockroaches are the famous example) but others more so (including some plants and perhaps trees).

2.2.1 Three fundamental principles: But justifying acceptable levels of radiation involves invoking more than science; it is also a matter of policy into which technical radiological issues are but a minor input. At the moment all we can say technically that:-

- Keep radiation as low as reasonably practicable to minimise long term effects
- Justify all exposure by considering the benefits
- Keep all exposure within legal limits

2.2.2 Limits: The guideline should be set to prevent acute effects and to provide a legal backstop. Just exceeding a limit is not a life or death matter but it does show that safety needs to be given the right level of management priority. Safety should be achieved by gaining the trust of people by an honest approach on the risks of radiation, discussing safety openly. This is done with regular staff training, working with Trades Union appointed Safety representatives and regular meetings with representatives of the local community. The ability to empathise with the full cross-section of society, from managing directors to shop stewards to concerned members of the public is a key quality of radiological protection specialists.

2.2.3 People should have dialogues together: People from all radiation organisations and businesses should meet with common man together, to provide a forum for radiation safety issues to be debated in a proper scientific manner. I will likely to have 2 aspects, one, scientific which is the correct way to proceed and another philosophical which have different value systems. However, victory through ethics has one motto "that the benefits of working and living with radiation will always outweigh the risks". The necessity for such a meet is that many people worried on account of radiation and its effects; they are confused by the contradictions also. For example, diagnostic x-rays and therapeutic gamma rays are considered good whereas radioactive wastes are bad. We believe that to help workers, patients and the public deal safely and rationally with radiation, they should understand something about it. Radiation Education Forum can do this independent of both the nuclear industry and anti-nuclear protest groups.

3. STRATEGY

3.1 "Catch Them Young Strategy": From that we are all humans, certain intersubjective norms follow. All humans subscribe to certain normative facts, like 'protect your young', 'try to maximize your own survival' etc. Teaching anything new or transferring a thought or an idea to a youngster is far easier than teaching or transferring to a grown up. Western nations are fully aware of this fact and have fully developed programmes for energy awareness and environment for school kids. In India the same kind of detailed attention or concentration to inculcating the values of environment protection and nuclear energy is lacking. From these follows the need to act socially by the morals of the society which can be seen as basis for all developing society that is the society making the best and 'optimal' and 'rationale' use of technology like those of radiation which is based on the psychological and sociological impact of radiation education with the possible questions in the minds of august audience and luminaries need to be addressed at this juncture. The logics based upon the adolescent brain and age-related behavioral manifestations will further advocate the proposed strategic and premeditated theory on ethical education for the use of radiation technology.

Now what is most important that a "strategy" for some in-depth and deep rooted engravement on the young mind needs to be chalked out and formulated through this Conference which could produce the enlightened citizens and policy makers of tomorrow who could justify the right and better use of radiation and radionuclides.

The principle of 7 Es *i.e.* how **exposure** to **experiences**, **education, enrichment** of knowledge, **elimination** of fear and **engravings** in mind lead to **ethics for radiation** which will give us enlightened citizens, policy-makers and leaders. Author will advocate the inclusion of certain lessons in curriculum whereby child should cultivate rationality of the use of radiation and eliminate fear against radiation. This would enable adolescent brains to permeate the judicious learning leading to the formation of their mindset and related behaviour (Figures 3 and 4).

Figure 3 : Pyramidal Representation of Strategy of Radiation Education

Most schools consider these topics as a "chore" imposed from "above" to be "got over with". Not only at school but also at home these topics deserve to be given more attention and a gentle emphasis by parents. Of course Government plays a key role in education and awareness as it alone has the resources to mobilize such programmes and run awareness programmes country-wise.

3.2 Proposed Strategy: The author intends to propose through his presentation a short term and long-lasting impact educational strategy for the young children with certain proposed lessons which could make a 'light' part of their studies. Strategy includes

1. Classroom but burden free activities involving the use of Geiger Muller Counter, microwave, radio waves and full spectrum of light, its energy and its relationship with the frequency.
2. Use of Radiopharmaceuticals involves the use of medicines labelled with a radionuclide in order to evaluate their biokinetic behaviour. In some instances the radionuclide may be administered separately from the medicine.
3. Radiography of the subject may sometimes be necessary to assess the action of the medicine, particularly where medicines affecting bone metabolism are involved.

4. **Diagnostic applications:** Most of such research is incidental to the irradiation of patients in the course of diagnosis and treatment, but it will sometimes be necessary to evaluate normal subjects as well. The establishment of medical and biological reference values based on an adequate selection of known normal subjects provides standards against which abnormalities can be judged.
5. **Other Uses:** This category covers studies in physiology, pathology and anthropology and includes studies on volunteers involving the use of compounds labelled with radioactivity to investigate, for instance, iron absorption, the fate of food additives and pesticides that are swallowed or inhaled.
6. Models of Nuclear Power Plants, X-rays, Primary Idea on Dose-dependent Effects

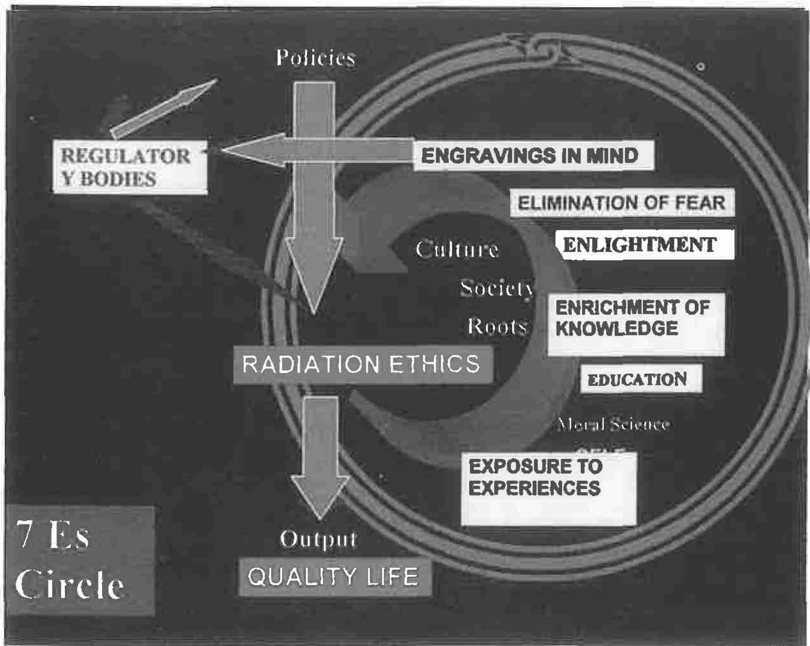


Figure 4: 7 Es Circle for Radiation Education Strategy

Interactions: Questions in normative ethics, or the study of philosophical ideas about right, virtue and happiness, including the question, "Why be moral?" are very much heeded upon to discuss. Introduces students to communication and conflict resolution skills pertinent to health care. Other topics include an overview of ethical theories and current legal and ethical issues in health care (specifically in oncology).

Difficult interactions are not unique to science, but the dynamic of the research setting provides a distinct context for such relationships to develop. Interaction to the scientific research endeavour should not be appalling. The National Academies should issue many reports and publications on responsible conduct in radiation science. Read free online or purchase in bulk.

4. SHORT TERM AND LONG-LASTING IMPACT

4.1 Imprinting - Role of Brain: Neurologically it can be hypothesized that the term mind is an abbreviation of ill-defined groups of mental activities, memory, emotions, intelligence and behaviour. Anatomically such activities are governed by certain areas of the brain. These are frontal neocortex, limbic lobe, hypothalamus and upper brain stem. At the core of these structures lies the medial forebrain bundle, the complex set of ascending and descending fibres that connect these structures rostrally and caudally.

4.2 Adolescent Brain: Impressions and engravement of new and newer learnings in mind are the results of formation of new and newer connectivities of neurons, qualitatively and quantitatively as well as formation of new proteins. But it is all depending on the types and quality of stimuli being fed to the young brain through sensory organs or one can say exposure to the atmosphere created around him. The bare fact should not ignored that more strenuously you put a fact in this developing brain more it gets disenchanted from that very learning. It is also to be included in his curriculum that he or she should cultivate rationality, eliminate fear towards radiation only then he will be able to permeate the right learning in his mind forming his behaviour.

Recent developments in brain research provide scientific support to the theories on the limitations of youth's decision-making. The development of a child's brain to adulthood has been traced. It is found that biologically, adolescents do not have the same abilities as adults to control their actions and make sound decisions (Researchers at UCLA, Harvard Medical School and the National Institute of Mental Health). However, a process called "myelination" a normal healthy adolescent brain develops during adolescence, as researchers have discovered through neuroimaging technology.

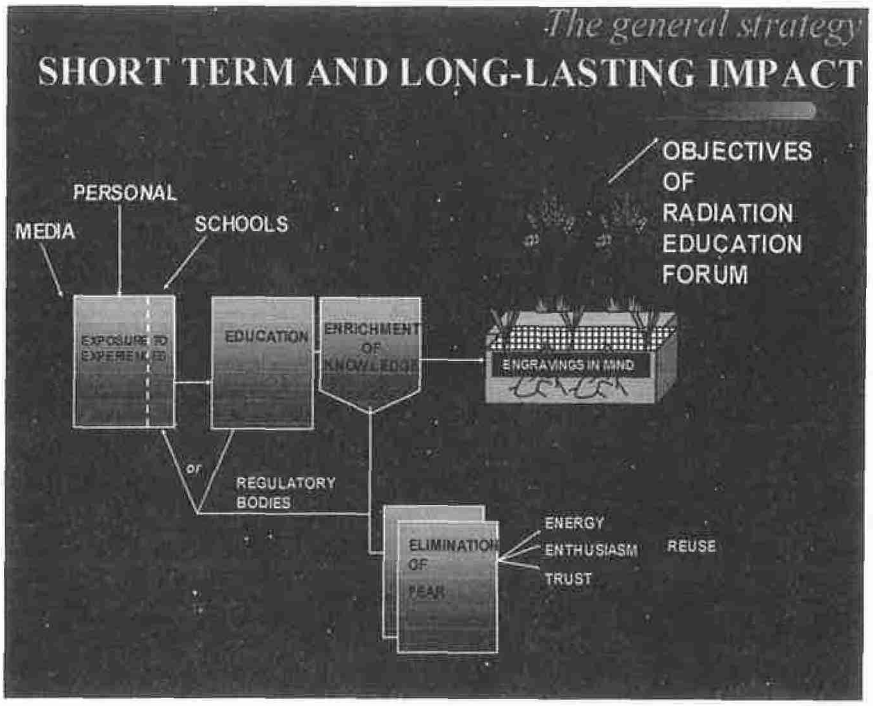


Figure 5 : The General Strategy for Radiation Education

The brain's maturation process continues through adolescence and is not complete until the early 20's. The area not yet fully refined and focused in the adolescent mind is called the prefrontal cortex. The prefrontal cortex is the largest section of the brain, slowest to develop, and undergoes the most drastic changes during adolescence. The prefrontal cortex is responsible for complex thinking. It allows the mind to organize, perform abstract thinking, prioritize, anticipate consequences, control impulses and conform behavior accordingly.

The frontal lobes play important roles in a variety of higher psychological processes - like planning, decision making, impulse control, language, memory, and others (Figure 6). There is mounting evidence that neuronal circuitry in the frontal lobes is shaped and fine tuned during adolescence, and that experience plays a prominent role in these changes

To compensate for the underdevelopment of the prefrontal cortex, the adolescent brain relies heavily on another area of the brain called the amygdala, which creates a tendency to react on instincts.

Pubertal increases in gonadal hormones are a hallmark of adolescence, although there is little evidence for a simple association of these hormones with behavioral change during adolescence. Prominent developmental transform-ations are seen in prefrontal cortex and limbic brain regions of adolescents across a variety of species, alterations that include an apparent shift in the balance between mesocortical and mesolimbic dopamine systems.

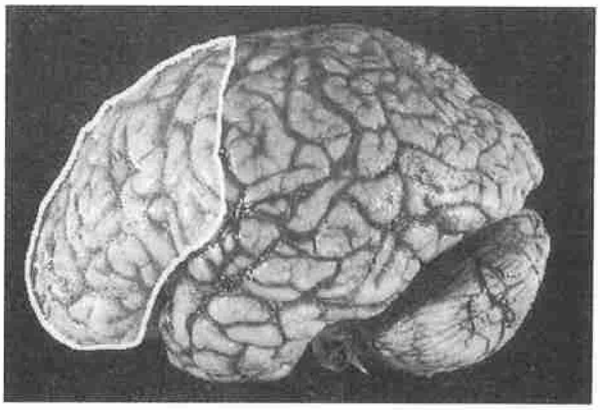


Figure 6: The Frontal Lobe of Brain

Developmental changes in these stressor-sensitive regions, which are critical for attributing incentive salience to drugs and other stimuli, likely contribute to the unique characteristics of adolescence[9].

Developmental transformations of the adolescent brain may have been evolutionarily advantageous in promoting behavioral adaptations to avoid inbreeding and to facilitate the transition to independence. These brain transformations may also alter sensitivity of adolescents to a number of alcohol effects, leading perhaps in some cases to higher intakes to attain reinforcing effects. These features of the adolescent brain may also increase the sensitivity of adolescents to stressors, further escalating their propensity to initiate any use. Additional investigations are needed to resolve whether ethanol use during adolescence disrupts maturational processes in ethanol-sensitive brain regions[10]. It's no wonder that the adolescent years—the transition between childhood and adulthood—can be the most sensitive time in a person's life. Indeed, although physical strength and reaction times peak in these years, morbidity and mortality increase by 300% in this group.[11],[12]

4.3 Environmental Influence: Much of the behavior characterizing adolescence is rooted in biology, intermingling with environmental influences to cause teens to assimilate the surrounding, take more risks, and experience wide swings in emotion.

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[9] **Spear LP. (2002) The adolescent brain and age-related behavioral manifestations.** Neurosci Biobehav Rev. 24(4):417-63.

[10] . **Spear LP. (2002): The adolescent brain and the college drinker: biological basis of propensity to use and misuse alcohol.** J Stud Alcohol Suppl. (14):71-81.

[11] Robert Wood Johnson Foundation: http://www.rwjf.org/index.jsp

[12] http://www.tern.org/

On September 18-20, 2003, experts gathered In New York to address the changes and challenges of adolescence at a meeting called *Adolescence Brain Development: Vulnerabilities and Opportunities*. The conference was hosted in collaboration with the Robert Wood Johnson Foundation and the Tobacco Etiology Research Network, with support from the National Institutes of Health.

Whether this kind of instability may be of any use? Yes. A physically mature body and a still-maturing nervous system may be of great use for imprinting several ethical facts and moral values. The interaction of biological changes and environmental challenges makes adolescence a time of increased vulnerability and provide a great opportunity to the policy makers. The adolescent brain is built to learn, amassing more knowledge in high school and college than at any other time. With the right dose of guidance and understanding, adolescence can be a relatively smooth transition. And for most individuals, that's exactly the case, with the majority of teens getting through those difficult years just fine.

5. THE ETHICS OF RADIATION STUDY-PREREQUISITE

Ethical and philosophical issues arising in and from the health care system. Problems and conflicts in society are generally being posed by interpersonal, professional and teacher-students relationships. Questions dealing with the right to learn and leave, the right to discard are the limitations in implementation our strategy.

The multi-dimensional nature of study and complexities in providing RADIATION information to diverse populations required streamlining. Students' self awareness, knowledge, and skills addressed through discussions of readings, videos and practice exercises.

5.1 Integrity and Trust: These are the hallmarks of the scientific discovery and use of technology. Being objective is critical to this process, because communicating one's research to the scientific community is at the heart of what keeps science alive. It's also the principal way that scientists make their reputations, get jobs and promotions, and obtain sustained research support. In the current climate of radiation research, ethical education has become trickier than ever. Therefore efforts need to be more collaborative. Institutions need to be more aggressive in turning radiation knowledge into products.

Even though universities, professional societies, and journal publishers have radiation policies and ethical guidelines outlining the standards that researchers should strive for, no one is adequately prepared to deal with disputes. When problems do arise, the system still relies on trust that those involved will act responsibly. ***Although the research community agrees that high ethical standards are worthy goals, few of these junior members of the scientific community receive any explicit training on publication practices and mores.*** Instead, they are expected to absorb their respective disciplines' standards by osmosis. Teaching ethics to researchers is not the key point--"***ethics are caught, not taught***," one saying goes. Rather, many think the focus needs to be on helping researchers to be prepared to work through problems together so that everyone in public involved will be satisfied with the outcome. But it is not true. Agencies should have dialogues directly with public and it only possible when they have clear fundamentals the seeds of which were sown during their teenage years.

5.2 Discourse on Radiation Ethics: Talking to one's trainees about radiation ethics is like talking to one's children about something boring. Topics such as the use of radiation and nuclear power in the public place may be experienced as highly personal and potentially embarrassing and generally thought to be restricted to only intuition and work place. A further parallel between radiation education and sex education is that if not given good information and opportunities to get answers to their questions, not only children but adults too will certainly pick up potentially damaging misinformation and share misunderstandings.

- Knowledge on the radiation technology exerts many pressures on beginning and experienced ones alike. All parts of the research system have a responsibility to recognize and respond to these pressures. Institutions must review their own policies, foster awareness of radiation ethics, and ensure that researchers are aware of the policies that are in place. And researchers should constantly be aware of the extent to which ethically based decisions will influence their success as nuclear scientists.

- Radiation Scientists should seek to advance nuclear science, understand the limitations of their knowledge, and respect the truth. They should ensure that their scientific contributions, and those of their collaborators, are thorough, accurate, and unbiased in design, implementation, and presentation.

- Guidelines should be offered not in the sense that there is any immediate crisis in ethical behaviour, but rather from a conviction that the observance of high ethical standards is so vital to the whole scientific enterprise that a definition of those standards should be brought to the attention of all concerned.[13]

Surely many problems can be ameliorated by a constant awareness of the special duty of faculty to foster the intellectual growth and independence of their students, by a habit of generosity in giving as much credit to their contributions as is consistent with realistic appraisal, and by the meticulous observation of strict standards of citation and acknowledgment.[14]

6. JOINT EFFORTS FOR QUALITY OF LIFE

Radiation Society should provide a broad forum for ethical, legal, social, and other issues related to nuclear science and technology (Figure 7), including the online Professional Ethics Reports. Hence it becomes not only the ethical but social and political issues to deal with. As shown in the Figure quality of life of individual, society and polity depends on 4 other factors like system quality, accountability, rights and obligation and ethics. Accountability, liability & control are related to following issues:-

- Ethical issues: who is morally responsible for consequences of abuse of radiation energy or power cut?

- Social issues: what should society expect and allow?

- Political issues: to what extent should government owe the responsibility? Where does it fail?

When it comes to quality of life, it should have following major issues

- centralization vs. decentralization

- rapid change: reduced response time to competition

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[13] modified http://pubs.acs.org/instruct/ethic2000.pdf

[14] Written in 1985 by then-university-president Donald Kennedy, who is now editor-in-chief of Science

- maintaining boundaries: family, work, leisure
- dependence and vulnerability
- crime & abuse vs. rationale & optimal use
- employment: trickle-down technology; reengineering job loss
- equity & access: increasing racial & social class cleavages
- health risks

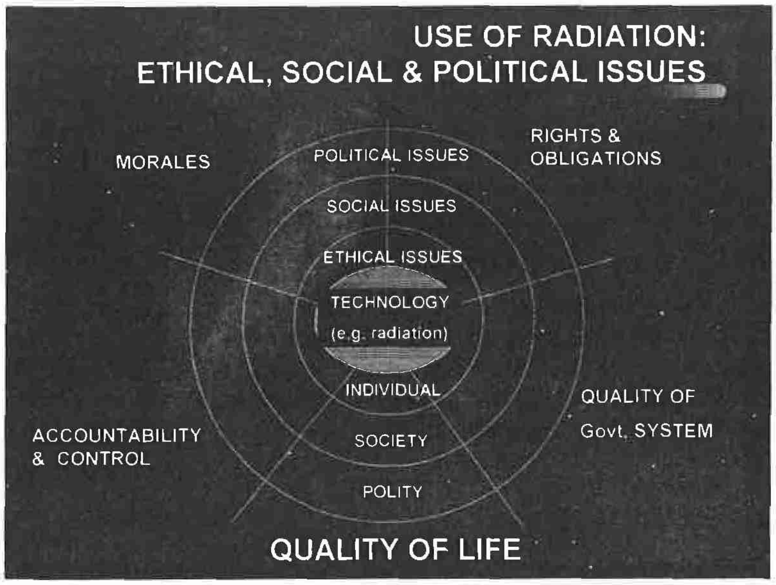

Figure 7: an improvement of quality of life: the Ethical Social and Political Contributions

Assessment of Risks and Benefits: The codes consist of rules, some general, others specific that guide the investigators or the reviewers of research in their work. Such rules often are inadequate to cover complex situations; at times they come into conflict, and they are frequently difficult to interpret or apply. Broader ethical principles will provide a basis on which specific rules may be formulated, criticized and interpreted. The assessment presents both an opportunity and a responsibility to gather systematic and comprehensive information.

APPENDIX

Questions in the minds of August Audience and Luminaries

1. What is the need to have such a strategy in the wake of large exposure of knowledge to public through various means like media, availability of such material e.g. brochures, leaflets, booklets etc., available in plenty of numbers and being freely circulated by various agencies

Answer: Such literature is primarily meant for adults and computer illiterates. By this time it is mainly confined to either media or researchers.

2. Media people take such educational material to this may be adequate.

Answer: Yes, they do so but primarily they themselves do not understand the intricacy of technological development with radiation and radioisotopes due to lack of primary radiation knowledge. Secondly, general public and common man is hardly interested in such material. Thirdly such material is reached to public only in the wake of unusual situations or in any untoward incidence like Chernobyl accidents or any sensational stories related to leakage of radioactive materials or theft of any diagnostic or therapeutic medical instrument (may be out of ignorance). Or during the movement by people which also includes research of epidemiological importance, e.g. tuberculosis and silicosis surveys and case-finding work in the field of industrial medicine and occupational health.

3. Whether such education to children on radiation is not redundant?

Answer: Ethics results from engravings of the minds which are laid down after prolonged exposure of stimuli to brain either by a regular 'dinner table chats', 'company chat on playground' and 'off-hour chat with their teachers' or by self-experience. Certainly the self-experiences in case of radiation education can not be considered a safe mean. However the narration, pictures and movies on some of incidences like that of Hiroshima and Nagasaki should be very often and religiously given and shown to them. I advocate only an impressive and 'sugar-coated' informal ways of education.

4. How much and what part it should consist of normal ones?

Answer: From VI to VIII Standard Classes, the moral education is being taught globally but formally and that too with marks-carrying weightage. It makes a routine reading for them without much impact on their brain. I believe half of this curriculum should now be devoted to technology and ethics part and half of the this technology ethics (i.e. 1/4 of the total curriculum) should be dedicated to an informal deliverance of radiation education and ethics.

5. Radiation is Utility – or a problem?

Utility is hard to measure and hard to define. If 10'000 people gain "utility" (what ever it might then be) from killing one, is it right? If 10'000 people gain "utility" from ignoring one persons IPR's in their digital media, is it right?

6. What kind of principle fits in well on the use of radiation technology ?

Utilitarianism ! It states :-

- Greatest amount of **good** to greatest amount of people
- Utilitarianism Act: Do what maximizes good in a given situation, good will follow
- Good does not necessarily equal happiness.
- Hospitals and health care are typical areas of implementation for utilitarian thinking

2.2 How to balance the future in a small country with huge traditions of nuclear applications: the Swedish example

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1. Introduction: some historical facts

To understand the way how the Swedish energy situation and in particular the nuclear energy sector has reached its present status, it is worth taking a short historical perspective. As is known and will be described in more detail, the two main sources of electricity generation in Sweden are hydro power and nuclear power, in a roughly equal share. The build-up of hydroelectric power was completed first, and the nuclear capacity was built up afterwards. The building of hydroelectric stations started in larger scale in the 1930's, and the main surge of work was completed during the 1950s and 60's. Nuclear power, whose build-up started in an industrial scale in the 1970's, was considered as an energy alternative already immediately after WW II. In the 1950's and 60's a broad national program was created for research in and development of nuclear science and technology. This has lead to the creation of a very strong nuclear industry in two ways: Sweden has the highest value for nuclearly generated kWhrs per capita in the world, and it is the smallest country (by inhabitants) which has a capacity of building nuclear reactors.

The fact that nuclear energy was taken as an option, and indeed became one of the main energy sources, had a few different reasons. Firstly, there has been traditionally a strong interest in research in nuclear physics in Sweden. The first, relatively small cyclotron was built already in 1938 at the Nobel Institute in Stockholm, capable of accelerating deuterons to 7 MeV. After the Second World War, more ambitious plans emerged. The Nobel Chemistry Laureate The (Theodor) Svedberg (with whom the late Yoshio Nishina had scientific contact) was one of the driving forces to build a more powerful cyclotron for the production of radionuclides. An interesting circumstance is that the funding for the cyclotron came as a donation from the Göteborg textile magnate Gustaf Werner, who was the richest person in Sweden at that time. His company offered to finance a cyclotron, in the hope that the quality of synthetic fibres can be improved by neutron irradiation, as he was told by The Svedberg.

This interest in nuclear science got a substantial amplification by the international enthusiasm on the perspectives of peaceful applications of nuclear power as a new and very effective, cheap and clean source of energy. One has envisaged a strong increase in energy demand in the post-war industrial boom, and nuclear power seemed to be a very strong candidate. Since Sweden does not have natural resources of fossil fuels in any appreciable extent, nuclear seemed to be a good alternative for an energy policy that did not make the country dependent on foreign suppliers. Being self-supporting, and hence not being dependent on different alliances, was an important feeling in post-war Sweden, which more or less managed to conduct a neutrality policy for a long period. Also, there are rather large resources of uranium in the Swedish soil, and according to the original plans these would be used in Swedish reactors. Later it turned out that it was easier and simpler to buy enriched uranium from abroad, and Swedish uranium was never used for energy production.

Already in the years after WW II an "Atomic Committee" was initiated by the government for the exploration of the potentials of nuclear science and technology, with specific governmental funding. The non-alliance policy also had the effect that Sweden was in a relatively comfortable situation to share information on nuclear technology with other countries, or to get hold of nuclear technology and materials. The first Swedish research reactor, R1, was built with Norwegian heavy water and French uranium, and it was started up nearly exactly 50 years ago (in July 1954). During the 1970's and 80's, Sweden has completed the world's most intensive nuclear energy program: 12 reactor units were built in a country of (then) 8 million inhabitants. 9 out of these reactors were built by the Swedish company ASEA-Atom.

One can also wonder how a country with the size of Sweden could afford developing a reactor manufacturing industry. Construction of a nuclear reactor is a very resource-demanding industry, both in terms of expertise and advanced technology. However, nuclear technology is not the only case where such a question could be put. In the history of modern industrial Sweden, a few strong, centralized industries played the major role. Sweden has, for instance, two car manufacturers, Volvo and SAAB, which is also unusual for a country of Sweden's size.

Developing a nuclear industry to such an extent required of course highly qualified technical personnel. Some of them made a significant international career. The devotion of Sweden to the nuclear line (and partly its position as a non-allied country) is also underlined by the fact that two of the General Secretaries of the IAEA were Swedes: Sigvar Eklund and Hans Blix.

One can summarize by saying that the interplay of many beneficial circumstances put Sweden into the nuclear track with the goal of peaceful utilization of nuclear energy and technology at a very early stage of nuclear development in Europe.

2. The immediate past and the present energy mix in Sweden

Sweden has, per inhabitant, the fourth largest energy consumption in the world, after Norway, Canada and Iceland. This is a consequence of an energy (and electricity) demanding industry, and a cold climate. Since the share of nuclear electricity generation is high in Sweden, around 45%, whereas two of the other three countries, Norway and Iceland, do not have nuclear power, and in Canada nuclear stands only for about 10% of all electricity generation, these facts together put Sweden into the position of largest nuclear energy producer per inhabitant. There are several countries with a percentage of nuclear electricity that is higher than that of Sweden, such as France with about 75%, but the consumption of electricity per capita is much less in those countries.

Some statistics are shown in the two tables below. Table I shows the production in absolute terms (GWh per year), whereas Table II and Fig. 1. show the relative contributions of the domestic energy types (imports not included) for the past few years. The values naturally fluctuate from year to year, but there is a larger jump between 1999 and 2000 which will be explained soon.

Table I. Electricity consumption in Sweden 1998-2001

GWh	1998	1999	2000	2001
Hydro power	73,829	70,862	77,848	78,558
Nuclear power	70,500	70,200	54,772	69,211
Fossil	9,915	9,350	8,797	9,489
Import	6,102	8,456	18,308	11,135

Table II. Relative contribution of the various energy types

	1998	1999	2000	2001
Hydro power	48%	47%	55%	50%
Nuclear power	46%	47%	39%	44%
Fossil	6%	6%	6%	6%

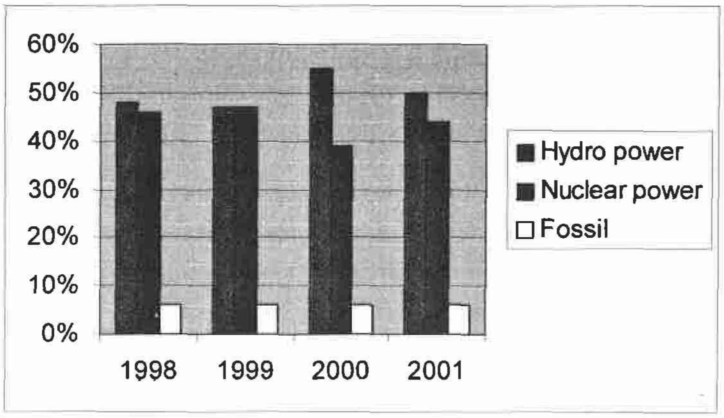

Figure 1. Relative share of the electricity production forms

Fig. 2. shows the geographic position of the reactors, as well as other nuclear facilities in Sweden. These latter include a nuclear fuel factory of Westinghouse Atom (formerly ABB Atom), two research reactors at the Studsvik site, the central interim storage facility for spent fuel at Oskarshamn, and the final repository for radioactive waste (medium and low level) at Forsmark. The site of the first power reactor at Ågesta, Stockholm, which

produced a total of 50 MW for partly central heating and partly electricity generation, and which was decommissioned in 1972, is not shown. The first large power reactor went on the grid in 1972, and the last two in 1985. Barsebäck 1 was closed down in 1999. This has its roots in the public opinion and the political situation in Sweden as described below.

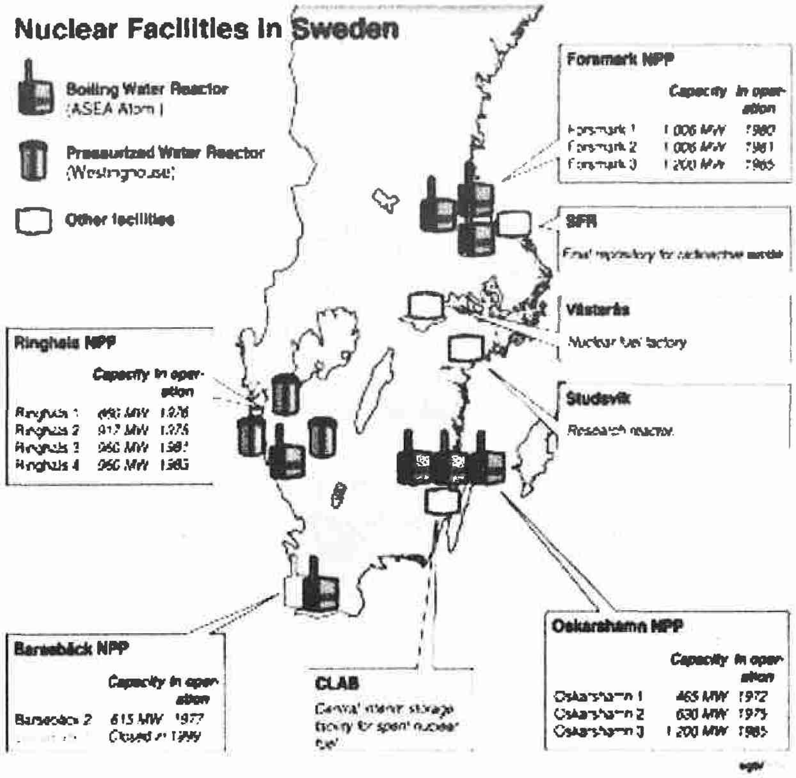

Figure 2. An overview of the nuclear facilities in Sweden

3. Nuclear power as a political issue in Sweden

Even before more than half of the 12 reactors totally installed were completed, the nuclear debate was started in Sweden. This in itself was not unique, similar trends could be observed in many other industrialized countries using nuclear power. The special with the Swedish case was that nuclear power has become not only a public, but to a much larger extent also a political issue. The position of the parties for or against nuclear power became an important and decisive question in elections, and it led to fall of governments twice in the pre-1980 period. After the Three Mile Island accident in the US in 1979, this situation and the increasing opposition resulted in a national vote (referendum) in March 1980 on the future use of nuclear power in Sweden. The referendum was unique in the sense that there was no option available for the continued use, not to mention extension of nuclear power. All alternatives available aimed at phasing out nuclear power, the only difference being in how fast this should happen.

The outcome of the referendum was that no more than the already planned 12 reactors should be built. At that time 6 units were already in operation, and another 6 being build or just about to be started up. Further, according to the vote, nuclear power must be phased out on the long run and replaced by renewable energy sources. The existing reactors can be used as long as they are safe and economical. The phasing out has to be achieved in such a way that the welfare and employment levels must be maintained. The referendum did not specify any date for the phasing out of nuclear power, i.e. when the above goals with the availability of alternative energy sources can be secured. The government set 2010 as the deadline after the referendum in 1981. There were several, and partly contradictory reasons for setting this date, but one strong belief, emphasized by the opponents of nuclear power, was that clean, cheap, and abundant/renewable energy will be available to replace nuclear by that time. Interestingly, fusion power was claimed to be one of the main candidates.

The aftermaths of this referendum have been influencing the Swedish energy politics since then. Although after 1980, the intensity of the public debate and the political significance of the question have reduced, the Chernobyl accident has put back the nuclear debate in the political scene. The reaction from the public was strong, but, remarkably, quite short. The ratio in the public opinion between opponents/proponents leveled out already the year after. The political consequences were much longer lasting and significant. One consequence of the accident was a decision on the accelerated phase-out, proposed by the reigning Social Democrat Party and accepted in Parliament in 1988. According to this plan the first two reactor units should be closed down already in 1995-96. This proposition, designated as "non-withdrawable", was withdrawn already at the next election.

A more peculiar post-Chernobyl decision, actually very little known outside Sweden, was the so-called "Brain-wash paragraph" or "ban on free thought", i.e. §6 in the Law on Nuclear Technology, Law 1987:3. This item in the Law declares that any activity, whose expressed purpose is to lead to the construction of a new reactor unit in Sweden, including economical calculation, is criminal and violation of it leads to prosecution at a low court. Although the law does not explicitly forbid studying new technologies and performing research on new reactor as long as the purpose is not related to building a new reactor in Sweden, such a law has obviously significant negative consequences on the governmental funding of research in nuclear engineering, and the attractiveness of the field to young bright students.

A long and complicated period followed during the 1990's. In 1991 a so-called New Energy Policy was launched by government and accepted in Parliament. The main purpose was the strengthening the research efforts on alternative energy sources. Changes of government and an official canceling of the accelerated phase-out followed. From the view of public opinion, the majority has been permanently in favour of continued use of nuclear power, with about 20% of the population being in favour of building new reactors (which, of course, is in conflict with Swedish legislation due to the §6 mentioned above). Mainly due to the recognition of the fact that no significant step towards a "natural phase-out" was taken (i.e. aging of the reactors, obvious abundance of alternative energy forms as predicted and requested in the 1980 national vote, or a strong opposition in the public opinion), the

Parliament made a decision in 1997 that nuclear power can be phased out without the fulfilling of the conditions of the referendum. This is the Law on Nuclear Phasing Out, which means that the nuclear plants can be closed down based on solely political arguments, even if they are safe, economical, and no alternative energy forms are available.
Shortly thereafter, a Parliament decision was taken, by the help of the new law, on the closing down of Barsebäck 1 by the end of June 1998. The closing down was postponed due to an appeal of the utility Sydkraft which runs the reactor to the High Court, but finally the reactor was closed down on 30 November 1999. One reason for selecting the Barsebäck reactor to be closed down (in comparison with other reactors) was the permanent pressure from the Danish politicians, who pointed out the geographical closeness of Barsebäck to Copenhagen. (No such protests were raised when the site was selected for the construction, in consultation with Denmark).

As is seen in Table 1, the energy imports increased immediately thereafter. Part of the decreased energy production is covered by imported Danish electricity from coal-fired power plants.

The Parliament commissioned the Government to close down also the second unit at the Barsebäck site. However, this was connected to certain conditions, namely that the energy produced or purchased to replace the fallout of Barsebäck 2 should be produced in an environmentally-friendly way, such that the emission of greenhouse gases should not increase. Those conditions have not been fulfilled yet, so Barsebäck 2 is in operation, and there is no designated date for its closing down. The negotiations around this question are actually being made in a wider setting, which will be described soon.

Concurrent with the closing down of Barsebäck 1, the Parliament also cancelled the date 2010 for the complete phase-out of nuclear power. This has lead to a new and significant opening in the energy policy which, together with several important concurrent international events, altered the energy scene, as will be described below.

4. The recent situation and future prospects

The immediate consequence of the abandoning of the date 2010 was that the first time since long, the nuclear industry could prepare for a period of operation much longer than the gradually shrinking space of about one decade or less until 2010. The planned investments include, among others, also a power upgrade at several of the operating units. Several power plants have recently applied for power upgrade at the safety authority. All this developments mean not only investments and hardware upgrades, but also a long-term need of highly qualified labour for the nuclear industry. As in many other countries, due to cutting budgets for universities and institutes of technology, the support for nuclear engineering education was permanently decreasing. Due to the above mentioned §6, very little funding was available from science councils for research in nuclear engineering.

In this situation the nuclear industry took responsibility for sponsoring both education and research at the main Swedish universities (The Royal Institute of Technology in Stockholm, Chalmers University of Technology, and Uppsala University). The Swedish Centre for Nuclear Technology (SKC) was founded, whose task is to distribute research and educational funds for universities, primarily to the above mentioned three establishments from the nuclear industry and the safety authority (SKI). In 2000, 6-year contracts were signed between SKC and the local centres at the three largest universities, in the frame of which partly support was given to certain positions, and partly to PhD projects. The support for the lecturers and professors was also meant to support undergraduate education.

Approximately at the beginning of the above procedure, significant changes took place in the international nuclear arena. An energy survey performed in the USA, ordered by the President in 1997, resulted in the conclusion by the Department of Energy, DoE, that on the medium long term, nuclear is one of the most important and promising energy sources because "nuclear reactors have an excellent operating record, and are generating electricity in a reliable, environmentally safe, and affordable manner without emitting noxious gases into the atmosphere". Thus DoE started up the so-called Nuclear Energy Research Initiative (NERI). This means, among others, increased financial support to university research groups. It has also initiated the "Generation IV Nuclear Energy System Initiative", whose purpose is to elaborate the next generation types of nuclear power plants, that will excel in safety, economy, waste management and non-proliferation points of view.

Further aspects came from the plans of the transition to hydrogen as an energy carrier, instead of oil or petrol. The recent development of fuel cells, running on hydrogen, makes this option a realistic possibility in the immediate future. Production of hydrogen in amounts that would supply the whole transport industry (to replace oil products which hydrogen) requires practically a doubling of the electricity (or corresponding thermal energy) generation. Many arguments can be said in favour of nuclear energy as the source of hydrogen, at least in the USA. For instance the most effective way of producing hydrogen is high temperature catalytic dissociation. High-temperature nuclear reactors are very suitable for that purpose, and indeed such reactors are being studied and planned, among others, in the US.

In addition to the recent developments in the US and the countries taking part in the so-called "Generation IV International Forum", significant changes have occurred also in the closer neighbourhood of Sweden. In 2002, Finland has decided to build one more, fifth, reactor unit. The question of building a fifth plant has been discussed during nearly two decades now, but before 2002 it has never passed Parliament and/or government. The AREVA and Siemens consortium has been awarded by TVO, the utility, a contract to build an EPR (European pressurized water reactor) nuclear power plant, and the preparations for the construction have been started. In addition, Finland was the first Nordic country to decide on the site of an underground spent-fuel repository. Both decisions were passed in Parliament, and hence are approved through a democratic process.

These developments on the international scene have naturally affected the Swedish situation. The technical developments in nuclear technology, the increasing consciousness about the greenhouse effect, but also the increased global threat since 11 September 2001, lead to a re-evaluation of the views, opinions and long term policies.

From the public point of view, since the beginning of the 1990's, the public opinion has been constantly in favour of continued use of nuclear power, in which the consciousness of the greenhouse problem and development of nuclear technology and safety has played a major role. A large majority of the population is in favour of continued use of nuclear energy in the near future; a clear majority exists for the long-term use of nuclear power, and about 20% of the population is in favour of building more nuclear reactors.

This fact is nevertheless not reflected in the policy of the reigning Social Democrat party, whose standpoint is still a rhetoric repetition of the results of the national vote, taken approximately 25 years ago. The only exception on the political scene is the Liberal Party, which recently announced its support for building new nuclear power plants in Sweden.

Due to the changed international situation, both the technical developments and the renewed interest in nuclear power in the US, the longer than planned (i.e. beyond 2010) operation of the Swedish plants, as well as due to the increased global hot from terrorism, the Ministry of Environment has designated an inquiry by an independent expert group into the safety of the Swedish nuclear installations assuming a long-term operation. The inquiry found that the safety is satisfactory despite the increased threat situation. On the other hand, the first time since its creation, the suitability and feasibility of the formerly mentioned §6 in the Law on Nuclear Technology was severely questioned by a government-appointed group. I was explicitly recommended by the final report of the inquiry that this paragraph be abolished.

To achieve a consolidated energy policy situation with the long-term operation of nuclear plants in Sweden, the Government has appointed a special negotiator, Bo Bylund, director of the Road Infrastructure Institute, with the task of elaborating guidelines for the long-term operation of nuclear plants in Sweden. The ultimate goal of the negotiations is the phasing out nuclear power but without any negative effect on economy and environment. The idea was to find an agreement between industry and government which regulates the conditions of long-term phasing out by having in mind the "German model". These negotiations are currently on-going. Several earlier deadlines for the achieving of the agreement have already passed. The question of whether Barsebäck-2 should be closed down, and in that case when, was also included into these negotiations. It turned out that to reach an agreement which is appealing to both sides is not an easy task. The replacement of the extensive nuclear production with a better alternative has just turned out to be more complicated than it had appeared.

One can summarize by saying that the future of nuclear power in Sweden, just as in the previous decades, is not predictable in detail. It is however rather likely that nuclear power remains a significant contributor of electricity production in the coming decades, either at the same or an increased level, in the frame of a long-term agreement and consensus between industry and government.

Epilogue

After the end of the conference, some facts happened that are worth mentioning in addendum to this paper. The above mentioned negotiations between the government and the industry on the conditions of a long-term phasing out of nuclear power broke down. On 4 October the appointed negotiator, Bo Bylund, announced a final deadlock in the negotiations. Shortly thereafter the three-party coalition with the reigning Social Democrats together with the Left Party and the Centre Party announced that they plan ordering the closing down the reactor Barsebäck 2 during 2005. The recent legislation makes the political forcing of the closing down possible, even if the earlier necessary conditions on the availability of renewable energy to replace the reactor are not fulfilled. The political scene is divided on this plan. This can be seen by the fact that even among the members of and voters to the Social Democrat party, an overwhelming majority are against this plan. This notwithstanding, on 16 December the Government announced the decision that Barsebäck 2 shall be shut down by the end of May 2005.

At the same time the nuclear industry follows up the plans for the power upgrade program. Most of the 10 reactor units, that will be in operation after the summer of 2005, plan power upgrades, and several of them have already applied of permission and the safety authority, the Swedish Nuclear Power Inspectorate. The sum of these power upgrades is actually significantly higher than the electric power of Barsebäck 2 (615 MWe). Hence, in the long run, Sweden's nuclear capacity will increase and gets modernized, despite the closing down of Barsebäck 2.

2.3 Radiation Education in Japan
－Present situation and how it should be in the future－

学校における放射線教育の在り方と日本の現状

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Abstract

Although there are wide uses of radiation in various area in Japan, pupils are less literate about radiation than those of advanced countries.

Radiation education has been implemented mainly in social studies and science in lower secondary schools and upper secondary schools in Japan, but few periods were allocated for it.

In 2002, the national curriculum has reformed and radiation education can be carried out also in the new content free subject 'Period for Integrated Study' which is set for fostering pupil's problem solving abilities.

On the other hand, teachers' experiences in teaching radiation are not still sufficient, nor curriculum is undeveloped so far.

In order to cope with the energy, environmental issues, population and food problems in the future, it is essential to promote radiation education by raising teachers' skills through the cooperation of schools and society.

1 放射線教育の意義

学校における放射線の意義は次のような点にある。

(1) 身の回りにも存在するエネルギーの一つであること

放射線は身の回りにも存在するエネルギーの一つであるにもかかわらず、その存在を知らない生徒が多い。いろいろな種類のエネルギーの変換を学習する中で、放射線のエネルギーというものがあることを理解することが大切である。

(2) 医療・工業・農業、原子力発電等で広く利用されていること

日本では、医療、工業、農業、原子力発電等広い分野で放射線が利用されているにもかかわらず、生徒の基礎知識は少ない。それらの基礎知識を習得することが大切である。

(3) 安全な管理が必要であること

放射性物質は安全な管理が必要であることを理解し、安全管理についての基礎的な知識を身に付けることが大切である。

(4) 平和利用が大切であること

2. 放射線教育で身に付ける資質・能力

放射線教育では、単に放射線についての知識を覚えればよいというものではなく判断力や表現力などを身に付けさせる必要がある。放射線教育を通して身に付けさせるべき資質・能力はどのようなものが考えられるだろうか。

文部科学省の「環境教育指導資料」[1]の中には「環境教育」を通して身に付けさせる資質・能力として次の(1)～(5)が上げられている。筆者は放射線教育についても、この五項目がそのまま当てはまると考える。

(1) 問題解決能力

放射線について疑問をもち、調べたり、探究したりする能力を育てる。このためには、課題解決型の学習を推進することが有効である。

(2) 数理的能力

放射線の強さや働きを数量的にとらえる能力を育てる。このため主に数学や理科の学習と関連させて進めることが大切である。

(3) 情報処理能力

放射線についての情報を収集・分析・整理する能力を育てる。このためには、コンピュータやインターネットなど情報通信ネットワークの利用が有効である。

(4) コミュニケーション能力

放射線について意思を伝えたり合意形成したりする能力を育てる。このためには、発表や討論を行うことが有効である。

(5) 環境を評価する能力

放射線と環境のかかわりについて評価する能力を育てる。このためには、実験や観察などフィールドワークが効果的である。

3. 放射線教育の困難点

学校で放射線教育を行おうすると様々な困難に直面する。その主な点は以下のようなことである。

(1) 指導要領に記述が少ない

学習指導要領この数十年にわたり内容の過密と授業日数減少のため削減され続けてきた。このため小・中学校段階での放射線にかかわる内容も削減され、教科書にも記載が少なくなりしたがって学習機会が少ないという現状がある。

(2) 放射線は目に見えない、実験が困難

放射線は目に見えない上に、それを検出するには特殊で高価な装置が必要である。これは放射線教育の大きなネックになっている。

(3) 放射線の利用には価値対立的議論がある

原子力の利用、放射線照射食品などについては賛否両論がある。このため教師はどちらかといえば消極的になりがちである。

4. 学校における放射線教育の実態

2002 年に（社）日本原子力文化振興財団は全国の小・中・高校の教師から任意抽出した約 500 人の回答者のアンケート調査によって放射線教育の実態を調べた [2]。その結果は以下のようになっている。

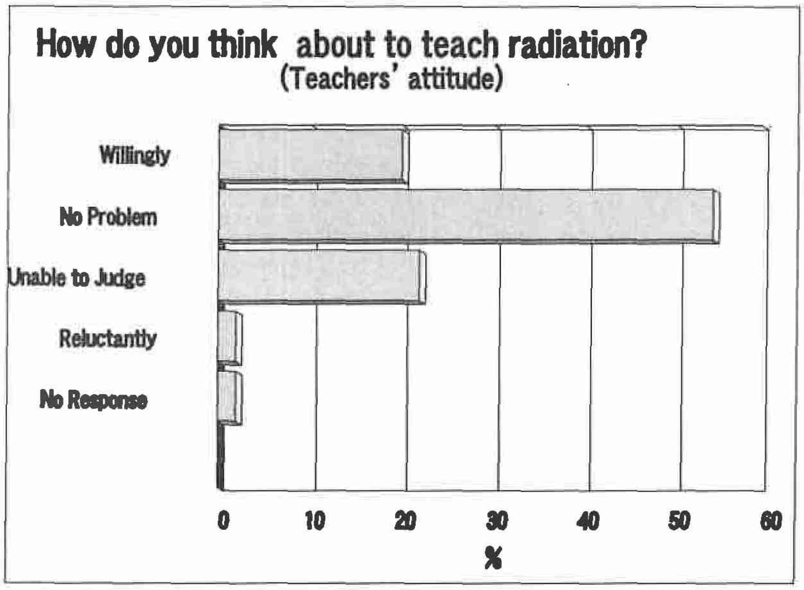

Fig 1 Teachers' attitude toward teaching radiation

図１から分かることは、放射線について積極的に教えたい又は教えてもよいと答えた教師が 70%を越していることから決して否定的な教師が多いわけではないということである。

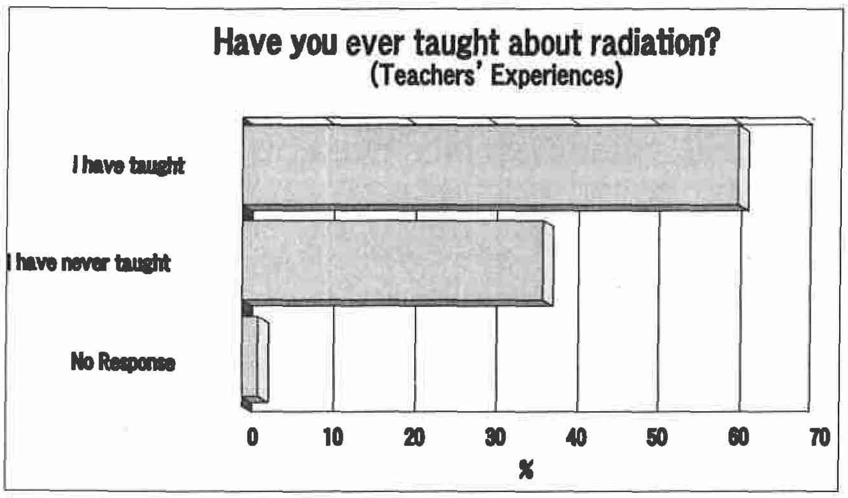

Fig.2 Teachers' experiences about teaching radiation

図２から分かることは、放射線について教えた経験をもつ教師が 60%いることである。この割合が多いか少ないかの判断は難しいが、半数を超えているということはまずは満足と言ってよいだろう。

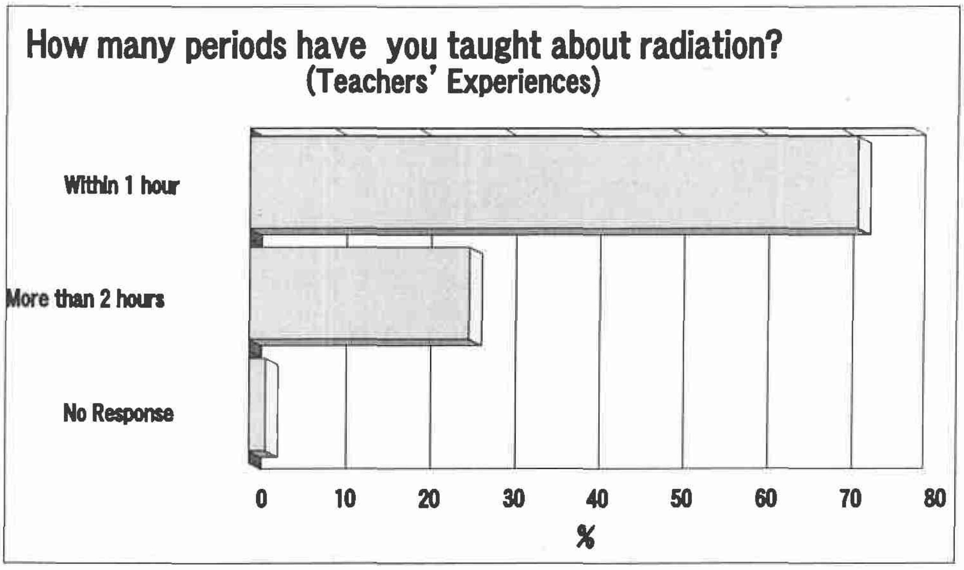

Fig.3 Periods for teaching radiation

図3から分かることは、教えた経験があるといっても約70%は年間1時間以内であるということである。

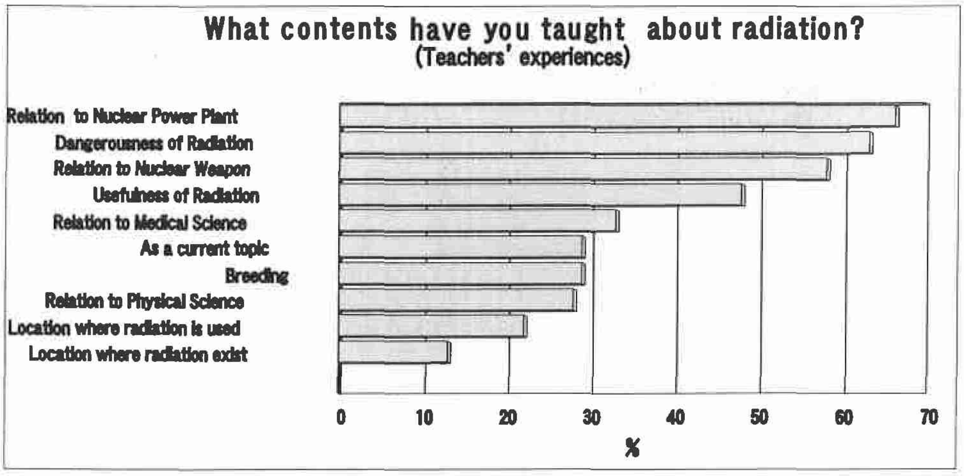

Fig.4 Related topics in teaching radiation

図4から分かることは、放射線について教えるときは、それぞれの学校がある地域の原子力発電所に関連させて教えることが最も多いということである。また、放射線の危険性(約60%)だけでなく、有益性(約45%)も教えているということである。

5. 総合的学習で行われている放射線教育の主な内容

新しく始まった「総合的な学習の時間」では、生徒や学校の判断で横断的、総合的なテ

ーマで課題追究学習ができるようになった。放射線教育は環境学習の中で行われる可能性が高いので環境学習の多寡が放射線教育の実施状況に反映すると考えられる。

図5は、2002年に文部科学省が中学校の「総合的な学習の時間」でどのようなテーマを設定しているかを調べた結果である[3)]。

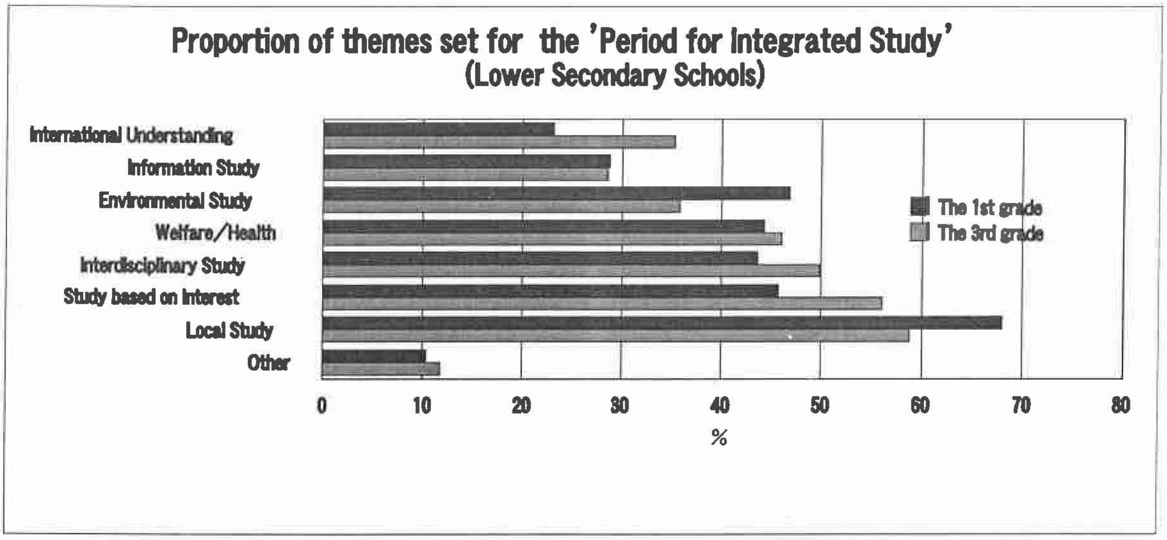

Fig.5 The proportion of themes set for the 'Period for Integrated Study'

図5から分かることは、中学校において「環境」というテーマを設定した学校の割合は約40%前後である。これは文部科学省が示した四つのテーマ例「国際理解」「情報」「環境」「福祉・健康」の中では「福祉・健康」に次いで2番目に多い数字である。

ただし、1学年と3学年を比較すると学年が上がるにつれてテーマとして設定される割合が減るのは受験勉強への対応と考えられる。環境教育の重要さを考えると今後、高学年で減らないよう対策を考えていく必要があろう。

「総合的な学習の時間」の中で一部の学校で行われるようになった放射線教育にかかわる学習活動としては次のような内容がある。

(1) 原子力発電所の見学
(2) 霧箱の実験
(3)「はかる君」で自然放射線を検知
(4) 放射線に関するビデオや講演の視聴

このような活動は（社）放射線振興協会等の民間団体の支援により少しずつ広がってきている。今後の課題は、これらの体験を単発的なイベントとして終わらせるのではなく、一連の放射線教育のカリキュラムの一環として位置づけることである。

6. 理科学習指導要領の中における放射線の扱い

6-1 中学校における放射線の扱いの変遷

放射線についての学習内容は学習指導要領の中で示されてきたが、それぞれの時代背景を反映して以下のように変遷してきた。

(1) 昭和５０年代以前

理科学習指導要領には「放射性元素の原子は、放射線を出して、ほかの原子に変わること」と述べられていた。教科書にはかなり詳しい説明がなされ放射線による写真フィルムの感光やシンチレーションの実験が記載されていた。

(2) 昭和５０年代以後

学習内容の過密と授業時間数の削減から学習内容の軽減が行われた。昭和50年代以後現在の学習指導要領[4]までは「人間が利用しているエネルギー源には、水力、火力、原子力などがあること」とされ、「放射線」という言葉は消え、原子力という用語だけが放射線とのかかわりをもつ用語として残された。

これを受けて、現在の中学校理科の教科書(東京書籍)の原子力の説明は次のように記述されている。

「原子力発電: 原子力発電では、燃料として放射線を出す物質が用いられる。放射線は、医療技術や農作物の改良などに利用され、生活に役立っている反面、人体や作物などに大量に当たると危険なので、常に厳しく監視して、安全を確保する必要がある。また、万一、事故が起きたときの放射能汚染の防止や、使用済み核燃料の安全な処理など、今後さらに研究して解決しなければならない問題が残されている。」

放射線という用語が一応関連事項として登場している。

学校では、この記述に基づきどの程度肉付けして教えているか明確ではないが、恐らくごく簡単な説明で終わっているものと推測される。

もう一つの問題は学習指導要領が「観察、実験に基づき○○を理解する」ことが基本となっていることである。このため、放射線のように実験の困難な内容は指導内容となりにくい。筆者は、例え実験や観察が困難であっても、放射線という言葉を中学校理科指導要領に入れることを提案したい。

6-2 高等学校理科学習指導要領における放射線の扱い

高校で放射線についてやや詳しく扱うのは「物理」であった。中学校で放射線が扱われないにもかかわらず高校では一部の生徒だけが選択する「物理」で学ぶという不十分な教育課程であった。現行の教育課程の改訂が進められていた2000年にＪＣＯ事故が起こり、当時の有馬朗人文部大臣から放射線にかかわる内容の充実が緊急に指示された。その結果、次のような改善が行われた

(1) 「理科総合Ａ」に放射性同位体、α、β、γ線の性質を追加した。
(2) 「物理Ⅱ」で「臨界」「中性子」を追加した。
(3) 「化学Ⅰ」で放射性同位体を追加した。

その結果、多くの生徒が履修する「理科総合Ａ」で放射線の基礎知識を学習することとなった。2004年度の「理科総合Ａ」の履修率を教科書の販売数から推測してみると、「理科総合Ａ」の教科書販売数は９０.４万冊で全国の１学年の高校生数は１２７万人で

あることから、理科総合Ａの履修率=９０．４／１２７＝７１％
となり、およそ７０％の生徒は放射線の基礎的な知識を学んでいることになる。

7. 放射線教育推進の方策

今後、放射線教育を推進していくためには、次のような点に重点を置くことが大切である。

(1)　先進的教師の育成

意欲ある教師の発掘と育成が極めて大切である。まず、リーダーとなる教師や学校を育て、彼らが中核となって広めていくことが効果的である。

(2)　体験的な学習の重視

実験・観察、実習、見学など体験に基づく理解が何より大切である。そのためには、手軽に測定できる器具の普及と供給が求められる。

(3)　学び方の習得

放射線に関する知識の習得にとどまらず、情報の収集・整理、討論の仕方、合意形成の仕方、発表の仕方などを学ぶことが大切である。

(4)　教科間・教師間の連携

複数の教科にまたがる教科横断的な学習の推進が大切である。そのためには、様々な教科や教師どうしの協力が欠かせない。また、地域の人材・施設との連携も重要である。

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2.4 A Study of Professional Competence for Radiological Technology Department Students in Taiwan Area

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Abstract:

Recently, so many medical institutions established and the increasing use of the high technological medical imaging equipment, it makes radiological technology become the main instrument for the medical diagnostic and radiation therapy. However, the medical radiological technologists play the important role to operate all the related radiological machines. If they do not use the machines adequately, it will increase the patients' radiation absorbed dose. Then, the whole society health may be influenced. Therefore, constructing the professional competence of the medical radiological technologists is an important course.

The purpose of this research are:(1) to construct the index of professional competence with radiological technology students, (2) to discuss the professional competence for the graduates from the department of radiological technology to be the reference for the Ministry of Examination for the license test of radiological technologists, (3) to provide the direction of the radiological technology department development。

Keywords: Professional Competence, Radiological Technology

Introduction:

Ever since 1996, the domestic technical-vocational education system has been conducted the reform practices as the junior colleges which aimed to educating domestic junior (middle) technical talents in earlier years have been reorganized into technical institutes or even into technical universities, with such act making the structure of technical-vocational education system integrated gradually (for students trained under technical-vocational education system, on the other hand, it indicates the wider channel of for technical education). However, what is the position for technical-vocational education? What is the difference of professionals trained under the career and technical education from those educated under general four-year colleges? Currently, domestic technical education system and general four-year college education have three and six institutes/universities respectively instituted with radiological technology department about which while there is still short of the related research and report featuring educational goal, curriculum planning and issue of position; Yuanpei Institute of Science and Technology (formerly known as Yuanpei Junior College) and ChungTai Institute of Health Sciences and Technology (formerly known as ChungTai Junior College), both under the technical-vocational education system, have instituted the radiological technology program at the five-year program on a basis of the junior college since 1965 to train professional radiological technologists. After both Yuanpei and Chung Tai were reorganized into institute of technology in 1998, the two institutes started to institute the two-year program by offering students graduated from five-year junior college a channel to further their studies and earn bachelor degrees; nevertheless, there still lacks related research and report concerning the educational goal and curriculum design for radiological technology department as well as the issue regarding the position for students graduating from radiological technology department under the technical-vocational education system.

With the change of the society and reform of the educational system, there appears changes for educational goal set by institute of technology as well; technical-vocational education in earlier years aimed to educating students' professional skills required for their future career and guiding them to develop their careers after graduation, and the educational goal for institute of technology and university of technology, however, puts emphasis on offering students holistic education featuring humanistic cultivation and basic academic competency, in hope of further guiding them to pursue an advanced study-oriented academic goal; the issue concerning "If the orientation of educational goal for technical-vocational education, however, would have any effect on the intention by radiological technology education to train students' professional competency?" is still worthy of further discussion.

The professional field of medical radiology covers diagnostic radiology, radiotherapy and nuclear medicine with the entire medical group consisting of radiologist, radiological technologist, nurse, medical physicist, and file personnel, among which radiological technologist who is good at operating radiological instruments or radioactive material to be in great demand; in a retrospection of the development of domestic radiology education, there had no any formal education for this subject from 1951 to 1965 during which radiological personnel were trained under the radiological training class held by National Taiwan University Hospital and Taipei Veterans General Hospital. Not until 1965 and 1966, did Yuanpei Junior College (currently Yuanpei Institute of Science and Technology) and ChungTai Junior College (currently ChungTai Institute of Health Sciences and Technology) start to establish radiological technology department respectively, heralding an era for the formal education of radiological technology in Taiwan, subsequently followed by the radiological technology department by National Yang Ming University, Kaohsiung Medical University, Chang Gung University and Tzuchi Institute with an aim to educating bachelor-degree radiological technologist, thus helping enhance the whole radiological technology education. Ever since the three junior colleges were reorganized into institute of technology, the urgent issue arising out of a recruitment of students for the radiological technology department in four-year division of the junior college appears as the one that vocational schools (senior industrial and vocational high schools) have not instituted radiological technology program that might impossible to recruit students from the upstream schools directly when conducting the recruitment for four-year division of the junior college. In term of the background of basic medicine for students majoring in nursing and background of electricity for electronics-major students, the three institutes decided to enroll students for radiological technology departments, half from nursing and electronics graduates respectively. Even the practice is still in a probationary stage, planning for the four-year technology program of the three institutes still lacks common consensus. For recent years, many scholars have been delving into general issues concerning radiological technology, with the issues featuring "Survey and Planning for Human Power of Radiological Technologists" (Hsu, Shih-Tsung, 1984), "Survey of Training and Supply for Human Power for Radiological Technology" (Sung, Wen-Chuan et al., 1999), "Analysis of Education, Examination and Employment System for Radiological Technology" (Chen, Fu-Du, 1987), "Development for Medical Science & Pharmacology Education under Technical-Vocational Education System" (Chen, Chao-Yang et al., 2000), "Practice for Students under Cooperative System" (Cheng, Kai-Yuan et al., 2001), and "Advice for Human Power Policy of Medical Radiological Technology" (Chen, Fu-Du, 2001); with regarding to constructing the index of radiological technology students' professional competency, there is still in want of related articles and reports for in-depth discussion.

In sum, if it would be effective to construct and explore into the index of radiological technology students' professional competency, it might guide the planning of development and educational goal for curriculum of radiological technology education correctly.

This research aims to constructing the index of radiological technology students' professional competency, in hope of benefiting to the three institutes in the development of radiological technology department and curriculum design as well as offering reference basis to education training and career planning for domestic radiological technology and national examination for professionals and technologists. This research expects to achieve the following three goals:

(1) Construct the index of radiological technology students' professional competency.

(2) Discuss the professional competency those radiological technology students shall be possessed, in hope of offering reference basis for guiding students in their career planning and preparing them in national examinations for professionals and technologists held by Ministry of Examination of Examination Yuan of R.O.C.

(3) Discuss the professional competency those radiological technology students shall be possessed, so as to offer reference bases covering direction of development,

curriculum planning, employment of teachers with professionalism for radiological technology department and purchase of teaching facilities, etc., in hope of offering reference to the radiological technology departments for the curriculum amendment in the future with the analysis and suggestion of results for the integral research.

Methods:

A series of questionnaires for this research are conducted by employing Delphi Method which adopts methods pooling experiences, opinions and suggestions from experts and scholars, followed by an analysis of all information and data to produce useful results which are served as reference for principles of policy. Delphi Method features an anonymous-correspondence questionnaire that collects, analyze and induce experts and scholars' opinion followed by making one questionnaire, with repeated process in collecting and analyzing all information to achieve the unanimous conclusion. This method works ideally to avoid some factors, such as time schedule and selection of venue, for participants when they must conduct the face-to-face communication and discussion to achieve a unanimous agreement during the traditional policy-making course; help prevent experts from being intervened when filling in questionnaire separately; enhance experts and scholars' sense of participation.

This research takes questionnaire as a major method with its design in conducting survey on 44 subjects including full-time professors of radiological technology from six universities/institutes and radiological technology experts at some hospitals in Taiwan. In open-ended questions, the first questionnaire, "The First Questionnaire in Delphi Method for Index of Radiological Technology Students' Professional Competency" provides experts and scholars with specious room for thinking. A majority of 44 questionnaires were returned as expected, and, eventually, a total of 34 were collected after numerous follow-ups through telephone that makes a response rate of 77.3%. According to interviewees' opinions collected from the returned questionnaires, index of radiological technology students' professional competency can be classified into three categories: (1) Basic competency, (2) professional competency, (3) humanistic cultivation. Moreover, 69 indexes of professional competency are sorted out to be edited into the second questionnaire, "The Second Questionnaire in Delphi Method for Index of Radiological Technology Students' Professional Competency" which was then mailed to the 34 experts and scholars who returned the first questionnaire; eventually, a total of 30 questionnaires for the second one are returned, making a response rate of 88%, with the experts and scholars' opinions from those 30 questionnaires conducted the preliminary statistical analysis with the SPSS that extends the original 69 indexes of professional competency to 76 ones which are then edited into the third questionnaire, "The Third Questionnaire in Delphi Method for Index of Radiological Technology Students' Professional Competency". Opinions from the second questionnaire and important quantified analysis data are enclosed to the third questionnaire, offered to those experts and scholars who have participated in the third questionnaire to make them decide if they need to adjust each item, from which consensus index of radiological technology students' professional competency is constructed after a series of integrated collection, arrangement and analysis; finally, a total of 29 questionnaires are collected (achieving a response rate of 96.7%), achieving the whole Delphi Method.

Results and Discussion:

Members of this research then conducted SPSS statistical analysis on quantified items ticked by experts and scholars from those 29 returned questionnaires. Among those 29 interviewees, three with seniority up to five years, five with seniority from 6～10 years, and 21 with a minimum of 10 years of seniority; on the aspect of educational background, two with diplomas conferred by junior colleges, twelve with bachelor degrees, and fifteen with master or doctoral degrees; in terms of occupation, twelve of them are doctors, five are professors, and three are medical physicists in hospitals, and nine are radiological technologists.

Among the twenty four indexes of professional competency listed by Category One Basic Competency in this research, a minimum of 58% (17/29) interviewees think that English, anatomy and cross-sectional anatomy are very important; among the forty seven indexes of professional competency listed by Category Two Basic Competency in this research, a minimum of 52% (15/29) interviewees think that radiation physics, radiation safety, X-ray principle and technology, computed tomography principle and technology, magnetic resonance imaging principle and technology, ultrasound principle and technology, radiological equipment, Anger camera principle and technology, SPECT principle and technology, PET principle and technology, nuclear medicine equipment, external beam radiation therapy principle and technology, brachytherapy principle and technology, treatment planning, radiotherapy equipment, medical image processing principle and technology, quality assurance theory of radiological equipment, quality assurance theory of nuclear medicine equipment, and quality assurance theory of radiotherapy equipment are very important indexes of professional competency for radiological technology students; besides, 52% (15/29) among these interviewees think that psychology is one very important index of competency in the five indexes of professional competency listed by Category Three Humanistic Cultivation in this research.

Results of analysis given above indicate that in addition to complete clinical training, professional knowledge and technology, English and psychology are inevitable for one excellent radiological technology student. As most of radiological technology students would serve in radiology-related departments in hospital in the future, radiological technologists shall be enterprising enough to absorb all kinds of new medical knowledge from a variety of newspapers and periodicals that English competency is required, in addition to the above professional skills; as radiological technologists have great opportunity of facing patients directly during their service in hospitals, the need for them to establish good interpersonality with patients and takes the concept of "taking patients as your relatives" are significant issue that makes psychology considered by those interviewees as one of indexes of professional competency for radiological technology students.

There still has no related research and report working in in-depth exploration into the construction of the index of radiological technology students' professional competency, and results of this research can:

(1) Offer reference to curriculum planning for radiological technology department as well as work as indexes of radiological technology students' professional competence, in hope of enabling students to possess competency required for their career.

(2) Offer reference basis for guiding students in their career planning and preparing them in national examinations for professionals and technologists held by Ministry of Examination of Examination Yuan of R.O.C.

This research employs Delphi Method to conduct three questionnaire surveys on selected radiological experts. Even it is a time-consuming task on the edition, delivery, follow-up by telephone and return for the questionnaires as well as some interviewees can hardly fill in three questionnaires patiently that causes the loss of questionnaire, and results of this research are quite satisfactory.

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2.5 PUBLIC EDUCATION THROUGH SAFETY CULTURE DEMONSTRATION

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Abstract[1]

The activities relating to nuclear energy have been world widely opposed against, because there have existed scars in the past; atomic bombs and a few accidents in nuclear facilities. It cannot be denied that the most effective education of public is through Medias such as news or documentary on newspaper and television. Once such cases appeared to public, it is difficult to erase the bad pictures from their memory. Since education for public is mainly depending on media, it is recommended putting harder effort on dissemination of information on regulation and regulatory function to public. The regulatory function of each country is the key of safe utilization of nuclear energy. Since prime responsibility of maintenance and operation are rested on the operators. To achieve the goal of safety, regulatory authority's task now is emphasized on encouraging operators of nuclear facilities to implement their safety culture. This will reduce the probability of unwanted events and therefore raising credit of nuclear energy.

Introduction

Thailand is a non nuclear energy country; we do not have nuclear power. Though the country starts nuclear program at the same age as Japan and Korea, we could not reach that stage. Some said that it is due to unstable of government; others said that it is due to less understanding of public on nuclear energy. But radiation technology is well adopted in the country. Modern equipment utilizing radiation technology appears in almost everywhere, in hospitals, in industry and in research laboratories. Thailand has enacted a law called Atomic Energy For Peace Act, 1961. Under the Act, several Ministerial regulations were laying out necessary elements for regulating the use of ionizing radiation. Thailand is also a member of International Atomic Energy Agency. After the accident involving Cobalt-60 source happened in February 2000, the regulations have been revised to the updated information provided on safety and security of radiation sources.

Public Information through Media in the Accident

Cobalt-60 is the most useful radioactive material utilizing for cancer treatment or radiotherapy. There was a question we got after the accident that if it is such dangerous material it should not be imported in the country. From that question, revealed us with the situation that public has very little knowledge of Nuclear Technology, no use to mention of nuclear power. Evermore, remedial actions taken on the accident was badly criticized by newspapers.

[1] Responsibility for the content of this paper rests with the author: it does not necessarily reflect the views of her employer.

Radiological Protection and Safety of Radiation Sources

Radiation hazard was well recognized for a long time. In every practice employing radiation, there must be existing radiation protection programme. This has been guided by several international organizations; BEIR, ICRP, and IAEA. Recently, 11 Principles are laid down by the IAEA in the document on Radiation Protection and the Safety of Radiation Sources (1). The principles divide into four groups; Principles for Practices, Principles for intervention, Implementation Principles, and Infrastructure for Protection and Safety. IAEA eventually launch a rule that any assistance required from IAEA will not be approved without radiation protection infrastructure in the requested member country. In this way, safety in the operation of nuclear technology is guaranteed. The infrastructure for protection and safety is included legal framework and responsibility within the legal framework. In legal framework, legislation and regulatory authority has to be established. Responsibilities of other relevant authorities must also be clearly document in the legal framework.

Responsibilities and functions of Regulatory Body (2)

In order to fulfill its statutory obligations, the regulatory body shall define policies, safety principles and associated criteria as a basis for its regulatory actions. The functions of regulatory body are:

- To <u>assess</u> applications for authorizations of practices and to issue, renew and alter authorizations as appropriate.
- To <u>inspect</u> authorized practices to confirm that regulatory requirements are being met.
- To <u>enforce</u> the regulatory requirements where non-compliance with the requirements are found.
- To encourage the development of a <u>safety culture</u>.

Encouragement of Safety Culture (2)

Safety culture is the attitude of individuals and organizations to radiation protection and safety issues. Where there is a good safety culture, such issues receive appropriate attention without the intervention of the regulatory authority. The need for a good safety culture has been demonstrated by accidents such as the Chernobyl nuclear power plant accident, where poor safety culture was found to be one of the contributing factors that led to the accident.

The licensee, registrant or employer is responsible for the development of safety culture at a practice. The regulatory authority cannot impose safety culture, but it should encourage the development of the following safety culture characteristics:

- <u>Commitment</u> of workers, authorized persons and the regulatory authority to safety.
- <u>Accountability</u> of all individuals for protection and safety, including those at senior management level.
- <u>Positive attitudes</u> to safety which include a willingness to question and learn, and to discourage complacency on safety issues.

- Communication on safety issues throughout the organization by the authorized persons.

By developing these characteristics, a good safety culture should be established and maintained. This should ensure a safe working environment and in turn, avoid accident situations.

Influence of the Regulatory body (3)

In the interests of promoting safety culture in organizations under its jurisdiction, the regulatory body should consider the following:

- Allowing some flexibility, within the constraints of national legislation, for organizations to manage for safety and develop aims and goals that exceed legal requirements.
- Targeting inspection effort to areas of risk and recognizing that some plants may have effective safety management systems. At these plants, sufficient inspections of control processes and selective inspections of consequences to the plant may be adequate as a regulatory tool.
- Not seeking to allocate blame in the investigation of incidents, and avoiding inappropriate punitive action for reporting incidents.
- Showing the reasoning behind regulatory controls, e.g. by publishing them.
- Establishing predictability and stability in the regulatory process.
- Trying to agree on appropriate technical ground rules for safety cases and assessment methodologies.
- Having regular dialogue with organizations and encouraging openness in dealings.
- Training inspectors to communicate with the public on nuclear safety issues in a comprehensible manner.
- Training inspectors in safety management (including safety culture) and human factors.
- Encouraging inspectors to interact with workers at the facility and to be visible to them.

Public Information (3)

Public should have information on safety culture development in nuclear installation. Dissemination of the information could be done by both sides; operators and regulators. Communication of information on safety performance to external groups can assist in developing confidence in its safety. However, the information must be prepared and disseminated by competent staff in order to minimize misinterpretation.

Some organizations hold routine meetings, often referred to as 'local liaison meetings', with representatives of their local community and local government to share information about activities and performance. Sub-groups can be formed to deal with environmental and emergency planning issues. The meetings often include representatives from the regulatory bodies in order to assure the local community that there is an independent perspective.

In addition to local liaison meetings, some organizations publish regular newsletters containing information on safety related matters. The background, consequences and corrective actions applicable to any significant safety abnormality can be included. In some instances where a newsletter is used as a channel of communication, the information is picked up by the wider media (newspapers, radio, television) to report on events at the nuclear installation. This practice can result in a more factual and less emotional reporting of an abnormality.

Conclusion

Public acceptance of nuclear technology could be improved by successfully implementation of safety culture. In the case of cobalt-60 accident in Samut Prakarn, regulatory body had applied effective mitigation measures. A small group of overexposure persons were exposed before the accident was discovered. If safety culture has been frequently demonstated, public confusion and misunderstanding could be minimized.

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2.6 Radiation and Environment – *Impact Studies Awareness*

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Abstract

Radiation, which is simply defined as energy, that travels in the form of waves or particles has both positive and negative effects on humans. This has necessitated a careful study on how to create awareness on the 'two-edge sword'. Since radiation cannot be removed from our environment we, however, reduce our risks by controlling our exposure to it through various ways. Understanding radiation and radioactivity will help us make informed decisions about our exposure. Many different types of radiation have range of energy that form electromagnetic spectrum. Their sources include nuclear power plants, nuclear weapons, and medicine. Others include, microwaves, radar, electrical power lines, cellular phones, and sunlight' and so on. However, the radiation used in nuclear power, nuclear weapons, and medicine has enough energy to break chemical bonds, and is referred to as 'ionizing radiation', which is dangerous to life. Because of this negative effect of radiation there is common fear and myths related to radiation, radioactivity, uranium mining and milling, and the nuclear industry. This radiation education and energy-environmental education attempt to dispel the common fears and myths relating to them in so far as there is perfect protection from harmful exposure and abuse. The design of an integrated unit of study for radiation and environmental energy uses arts of language, life skills, skill designs, social studies and mathematical skills in creating understanding and abilities necessary to do scientific inquiry by the students without abuse or danger. The education unit is designed to assess materials for, factual information and appropriate language and identification of potential bias in environmental education materials and evaluate materials in perspective of cultural and ethnic upbringing.

1.0 Introduction

If the uses of radiation and radioactivity are limited to nuclear weapons there will have been no need for radiation education forum. Radiation and radioactivity are becoming indispensable in modern technology for saving lives and improving the quality of human life. They are not only used for medical diagnoses and treatments in saving lives they are also used in Nuclear power production, researches and applications in different areas of science and technology.

However, the indispensability of radiation and radioactivity in the field of scientific technology has been a propelling force for further research to solve the risky aspect and fearful side of the technology. The negative and disastrous use of nuclear energy including accidental occurrences in nuclear power plants is posing a serious treat to the use of nuclear technology. The possible health hazard caused by rays of ionizing radiation requires urgent solution.

What are the fundamental problems to be solved by radiation education? One would suggest that it is to give correct information about radiation in order to reduce the scaring factor among working personnel and advise them on how to be protected even when there is nuclear accident. It is therefore, important to search and define clearly the new direction in radiation education.

2.0 Background Studies

US Federal government(2002) “Fact Sheet: Guidance for Responding to Radiological and Nuclear Incidents” U.S. Department of State, Washington, D.C. has described the principal radionuclides for which the DILs were developed as (1) nuclear reactors (I-131; Cs-134 + Cs-137; Ru-103 + Ru-106) (2) nuclear fuel reprocessing plants (Sr-90; Cs-137; Pu-239 + Am-241), (3) nuclear waste storage facilities (Sr-90; Cs-137; Pu-239 + Am-241), (4) nuclear weapons (i.e., dispersal of nuclear material without nuclear detonation) (Pu-239), (5) radioisotope thermoelectric generators (RTGs) and (6) radioisotope heater units (RHUs) used in space vehicles (Pu-238).". Unesco: International Institute for Educational Planning (1967) presented methods for educational effectiveness. It also described conditions for success in education. The North American Association for Environmental Education has described guidelines for environmental education with respect to nuclear technology. The association attempts to dispel the common fears and myths related to radiation, radioactivity, uranium mining and milling, and the nuclear industry. It also encourages educators and students “to form their own opinions about these issues based upon investigations of the available facts and to consider ways to live in harmony with the powerful forces released by nuclear energy”. The association argued “with such an emotionally charged, controversial topic, we as educators have a responsibility to present a "balanced" view of the issues, to allow our students to form their own opinions”. Kruger, P. G. (1940) has analyzed some biological effects of nuclear disintegration products on neoplastic tissue. He gave various ways for nuclear technology applications. Many authors have expressed their views in relation with nuclear technology applications especially on medical uses and it’s side effects.

3.0 Methodology and Design Procedures

The radioactivity is the property of some atoms that spontaneously radiate energy as particles or rays. When these energy particles are lodged inside the body the internal organs are exposed as the radionuclides decay. Atoms are either stable or unstable. If the forces among the particles that makeup the nucleus are balanced then the atom is stable. But if these forces are unbalanced the atom is unstable. When the atom is unbalanced/unstable it is also radioactive. When the atom is radioactive the nucleus has an excess of internal energy. Radiation takes place when the nucleus is throwing away the excess of internal energy. Exposure to radiation is believed to be capable of causing serious illness, and even death. The threat of accidents in nuclear power technology and the possibility that nuclear materials could get into the wrong hands have contributed substantially to public fears about this nuclear technology. Even the normal operation of a nuclear power plant creates low-level radioactive waste.

3.1.0 Radiation Protection

Risks from Nuclear Accidents are possible through (1) Radioactive Accident (2) Contamination of Human Food (3) And Animal Feeds (4) Contamination of physical objects.

Sources of Exposure and Deposition Mechanisms: In any nuclear accident, the radioactive plume results in two types of deposition. Namely **dry deposition and wet deposition.** The dry deposition is the airborne plume while the wet deposition is the liquid effluent dispersal. The basic pathways of human exposure to contamination resulting from nuclear accidents of any kind include: external exposure, absorption, inhalation and ingestion. (1) External Exposure includes radiation shine in immediate accident location, plume cloud, and ground. (2) Absorption (Dermal Deposition (3) Inhalation exposure includes Plume Inhalation and Re-suspended ground deposition inhalation. (4) Ingestion exposure includes: Primary Ingestion from surface contamination, Secondary Ingestion of contamination via pathways to human consumption such as the forage - cow - milk pathway, and Tertiary Ingestion of contamination via indirect pathways to human consumption, e.g. the incorporation of contaminated whey into processed foods and their redistribution to markets in areas unaffected by ground deposition. Primary ingestion comes from raw agro-foods such as leafy green vegetables etc. Secondary contamination comes mainly from processed foods like milk etc. High-risk exposure occurs at early time of the accident through Inhalation of plume by external exposure to the plume and Absorption due to contamination of skin and clothes and physical materials. High-risk exposure also occurs through external exposure from ground deposition. It also occurs through Primary and secondary ingestion of contaminated food and water. It extends to Absorption due to contamination of clothes and re-contamination of skin from ground contamination and Inhalation of re-suspended ground deposition.

3.2.0 Protection Against exposure

In any nuclear accident, there are two fundamental protective majors against exposure namely evacuation and sheltering. All situations are characterized by the following safety precautions: Control to the contaminated area, Control and sheltering of livestock, Control and sheltering of animals if not already evacuated, Food and water controls, Decontamination efforts, and Relocation.

3.2.1 Evacuation

Persons living in the vicinity of any nuclear facility during a major nuclear accident have only one viable option: evacuation to an un-affected area.

3.2.2 Sheltering:

The first thing to do by the people staying near the nuclear accident zone is to seek immediate shelter far away from the area. In the likely event that no stocked fallout shelter is available, the safest option is usually sheltering within one's own residence. Dust mask is necessary if someone is outside and has not been able to seek shelter yet, or for some urgent reason must go outside during plume passage. A simple particulate respirator (dust mask) is an essential first line of protection against inhaling plume pulse particulates As soon as you reach shelter, close all windows and doors to minimize inhalation of passing plume.

3.2.3 Shielding

Barriers of lead, concrete or water give good protection from penetrating radiation such as gamma rays. Radioactive materials are therefore often stored or handled under water, or by remote control in rooms constructed of thick concrete or lined with lead.

3.2.4 Reduction of exposure time

For people who must be exposed to radiation in addition to natural background radiation because of their work, the dose is reduced and the risk of illness essentially eliminated by limiting exposure time.

3.2.5 Distance

When you are further away from radiation source, the intensity of radiation decreases with distance from its source.

3.2.6 Containment

Radioactive materials are confined and kept out of the environment. Radioactive isotopes for medical use, for example, are dispensed in closed handling facilities, while nuclear reactors operate within closed systems with multiple barriers, which keep the radioactive materials contained.

3.2.7 Necessary Actions to Take

Avoid using surface water supplies and rainwater. Avoid exposure of children to contaminated surface water (puddles and rain) and ground contamination. Avoid tracking in ground deposition: remove contaminated clothing and footwear. Avoid consumption of foods contaminated with surface deposition, especially leafy vegetables with foliar contamination. Also avoid fruits, which are difficult to wash and food which rapidly bio-accumulates contamination, such as mushrooms and sea vegetables. Avoid consuming foods subjected to secondary ingestion pathway contamination. Use food products produced and/or packaged prior to plume passage whenever possible. Shelter livestock and pets; use uncontaminated feeds. Avoid exposure to surface ground contamination by staying indoors as much as possible. Cover garden sites with tarps prior to plume passage if time permits. Utilize greens grown in a greenhouse situation whenever possible. Package, box or bag contaminated clothing and footwear and remove from immediate vicinity of the living quarters if possible. Due to filtering and/or diluting all subsurface water sources and most public drinking water, sources will remain relatively safe after most types of nuclear accidents. In the days after a nuclear accident, if you have avoided inhalation of the passing plume and if you can avoid extensive exposure to ground deposition, your principal pathway of exposure will be the ingestion pathway.

3.3.0 Design Procedures for Awareness

Radiation education has come up in our time as a challenge to educational administrators, planners and educational organizers throughout the entire world. In order to solve this great challenge posed by radiation effect, all controllers of education must come out with a definite direction and understanding about the radiation. There should be a defined objective in five component directions.

(1) The first component direction is on the research aspect.
(2) The second component direction is on content and teaching method.
(3) The third component direction is on system of communication and evaluation.
(4) The fourth component direction is on training provisions for teachers.
(5) The fifth component direction is on establishment of various controlling bodies.

The first component being research aspect means that there should be emphasis and promotion on research about radiation and radioactivity. The experts should concentrate their researches on those aspects of radiation and radioactivity, which form a treat to life. The results of the researches should be made available to teachers. The teachers should rely on the latest research findings made by the experts in the field of nuclear technology.

The second component is on the direction of the content and teaching method. The content of radiation education should be clearly determined based on the new research findings. The method of imparting the knowledge on the students derived.

The third component is on the aspect of system of communication and evaluation. The important facts should be simplified to the understanding level of the students. Important research findings, which are capable of correcting the negative perception of nuclear technology, should be simplified to understanding level of the students. Evaluation of students should be more on the simplified new research findings. This will encourage effort and concentration on the new research findings.

The fourth component is on the provision of trainings to teachers. Training for teachers should be being organized on regular basis to educate them on the latest research findings on nuclear technology. The teachers should have good understanding of the new research findings and be able to simplify and impart them on students.

The fifth component direction demands the creation of international association for radiation education. This international association should have various levels for effective control and administration. See figure1 bellow. There should be a world central body, which controls and coordinates the research activities in nuclear technology. Various continental bodies follow this world central body. The continental bodies should be responsible to the world central body in research controlling and coordinating. The third level is on various countries. They should have national bodies that report to the continental body. The creation of this international association with various levels of control and administrative bodies will not only disseminate new research findings but also create awareness for radiation education.

International Association for radiation education

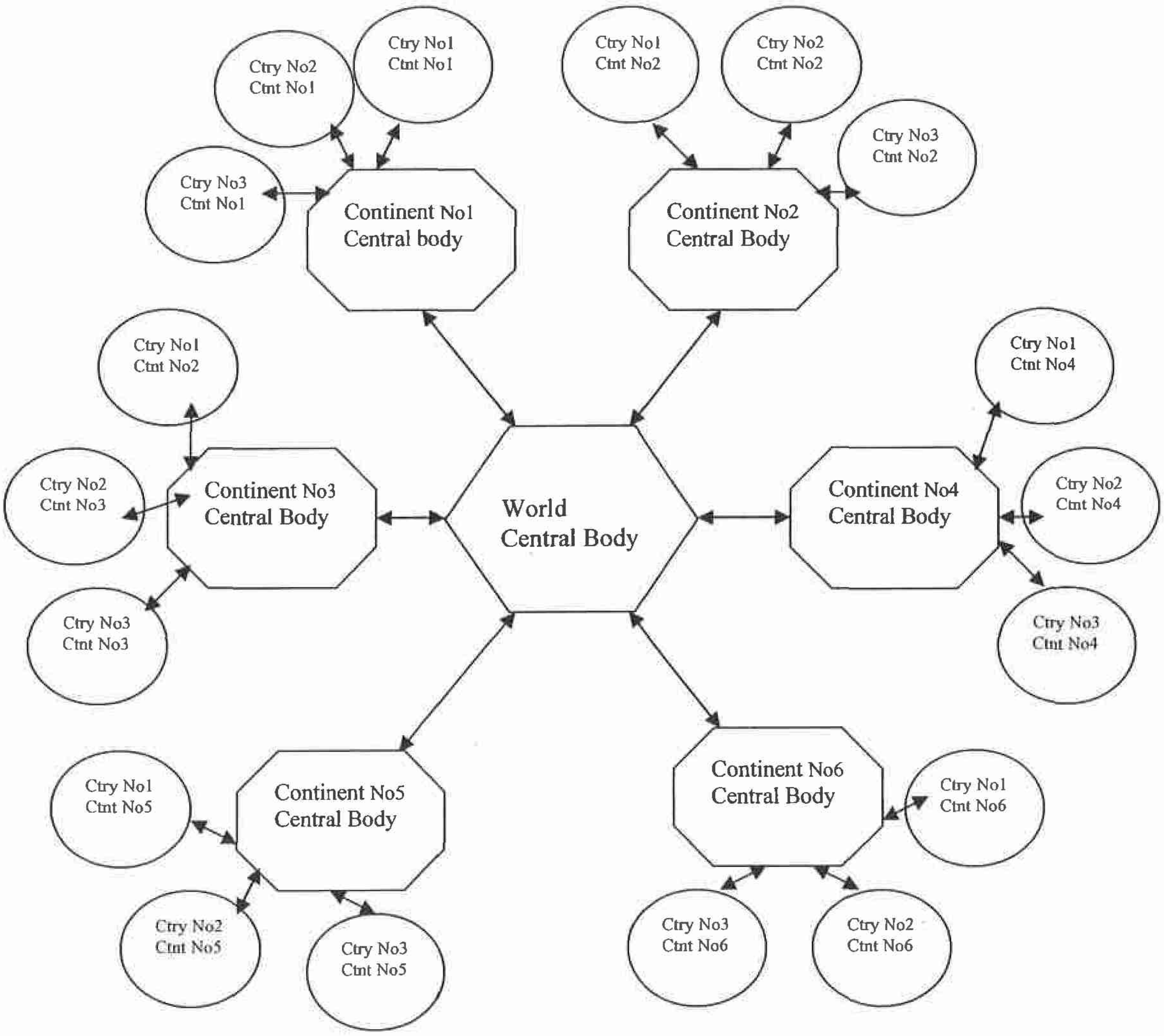

Figure1: Flowchart for Awareness Creation

3.4 Nuclear power plants

One of the challenges in the nuclear power plant maintenance is how to predict phenomena related to corrosion. These include stress corrosion cracking and activity build-up. It includes deposition of activated corrosion products onto the surfaces of the reactor cooling system. In nuclear power plants the temperature of the cooling water and the pressure should be being monitored. A good choice of the material must be made for the components in contact with the cooling water. This is because oxygen in water can react with the outermost layers of these metals, forming a thin oxide layer that slows down further corrosion. Example of the materials includes stainless steel or nickel base alloys. Minor alloys added to the steel may enhance the protectiveness of the layer. Corrosion effects are produced from the thin metal oxide layer by flowing of the cooling water. The corrosion effects are activated as they pass through the core of the reactor, and can be deposited in inner surface of the pathway. Stress and corrosion may enhance growth of cracks in metallic materials. More research is needed in order to develop accurate methods for predicting the progress of any phenomena relating to cracking due to corrosion and stress. We therefore, advocate in addition that development of intelligent sensors be made for the purpose of detecting any form of crack in the nuclear power plants. For protective measure against accident in nuclear power plant, there should be a new research direction on various types of intelligent sensors, which could be fitted in all around the nuclear power plant. The intelligent sensors will be capable of detecting any possibility of accident occurrence before it happens.

4.0 Conclusion

This work has shown basic protection majors against exposure during nuclear accident. Evacuation of people from the accident vicinity and sheltering them in a location far away from the accident zone or unaffected area are the fundamental protection against the risk of exposure. All livestock and all useful objects and materials should be evacuated to avoid contamination. A simple particulate respirator (dust mask) is very essential for protection against inhaling plume pulse particulates. For shielding radiation, concrete, water or barriers of lead, are good protections from penetrating radiation such as gamma rays. For nuclear workers who must be exposed to radiation in addition to natural background radiation due to the nature of their work, the dose is reduced and the danger of sickness essentially eliminated by reducing time of exposure. The nuclear workers should also try to be at a distant from the source in order to reduce the intensity of radiation. Radioactive materials are confined and kept out of the environment. Radioactive isotopes are dispensed in closed handling facilities, while nuclear reactors operate within closed systems with many barriers, which are capable of containing the radioactive materials. More researches are encouraged especially toward intelligent sensors for detecting any possible occurrence of accident in nuclear technology. Researches are also encouraged in the aspect of materials used in the nuclear industries. Awareness creation is very important to all. Establishment of international association and corporation for the propagating of radiation education will be very useful to humanity in this age and next generation.

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2.7 Physics teachers' nuclear in-service training in Hungary

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When I was a child, at school we had to make pictures or school compositions with the title „What will the year 2000 be like?" We had futuristic ideas: many people will live in Mars, our cars will fly, there will be eternal peace on the Earth, the cancer wont dangerous any more, we'll be able to produce pure unlimited energy, all the people will live more than hundred years.

This magic date is here now, here is the moment of the truth.
What do we have? We have fast computers, Internet, big jets, lots of cars, we have very effective weapons, global economy. On the other hand we have ozone hole, we have destroying rainforests, we have AIDS and we are afraid of global warming. I think the balance is neither positive, nor negative. But the most significant phenomena is the very quick change of technology, of knowledge, the accelerating time (George Marx). One thing is sure: The role of science, and the role of science education remain very important.

Our Country, Hungary is a very small country. The country occupies a territory of about 93 000 square kilometres. It has a population of about 10 million. We have good soils for crops and vegeteables but because of the agricultural overproduction all over the world it is difficult to find any market. Unfortunately we have no mineral resources, there are only a few oil-wells, we have no diamond and gold mines.

If we want to compete with the world's countries we can only rely on people, human understanding and creativity. The teacher has to bring to the surface, unearth this creativity and he/she must has to develop the found talent.

Teaching of science subjects, among them physics, demands revision and renewal syllabuses and methods. It is a banality to talk about the rapid increase of factual knowledge, abuot the progress of science at a quick pace. In our country the shift of social system adds to these things. These things cause anxiety because the future is uncertain and our knowledge is limited.

But the experiences show that hard times cultivate clever people, geniuses. There is an other thing against fear that who becomes a teacher, has to be always renewed. He/she has to be renewed because he/she has to face clever young people full of critical sense, has to hand his/her knowledge over to them.

The theme of this conference is the nuclear education. But please allow me to say some words about the past. I would like to talk about, how the modern physics got to Hungarian schools, what kinds of methods the physics teachers used for their in-service training and what was their success by these methods.

Leon Lederman writes about Martians in his book „The God Particle":
„These extraterrestrials achieved great results in science, they had strange, even fantastic ideas. Because they could not learn English without an alien accent, they claim to be Hungarians. Such Martians were Edward Teller, Eugene Wigner, Jonh von Neumann, Theodor von Kármán, Leo Szilárd. Nevertheless they became suspect because all they arrived in America from the same district of Budapest and moreover several of them attended the same grammar school. (Past decade two more joined this exclusive club: John C. Harsányi, economic Nobel laureate and George Oláh, chemical Nobel laureate.)
The man who as the Minister of Public Education established „the basis of the Martians" — the grammar schools of Budapest, himself was a worthy of them physicist, Baron Roland Eötvös. Every physicist and physics teacher knows his incredibily accurate gravitational measurements, the torsion pendulum made by him."
Overview Eötvös' scientific achievement is not my present task.

More than hundred years ago, in 1891 Roland Eötvös invited mathematics and physics teachers with the aim of founding a society for the study of a continous self-education.
This Mathematics and Physics Society later adopted its founder's name; and is the present Eötvös Society.
We, Hungarian physicists and physics teachers believe, that organization of a self education forum, the Physical Society (1891), establishment of Eötvös College (1894) and the first Hungarian teacher training workshop (1905) are also very important part of his life-work.
Due to this activity the physics teachers can have the most active professional life and they have the best contacts with the scientists and university professors.

<u>A historical example for the connection of modern science and education.</u>

At the end of 1895 Conrad Röntgen, Rector of Würzburg University discovered X-rays. The first newspaper article about this discovery was published in Wienna early in 1896.
Hungarian Natural Scientific Journal reported on this discovery in January 1896. This article was illustrated with an X-ray photograph made at Budapest University. The photograph depicted Roland Eötvös'hand.
On 18 th January X-rays were produced also at grammar school of a provincial town. The photograph was published in the school yearbook. The school leavers (17-18 years old) took part in making X-rays photographs.
Virgil Klatt, a grammar school teacher from Pozsony (the teacher of to be Nobel prize winner Philip Lenard) worked out experimentally photoluminescent materials which were used for making fluorescent screen.
Secondary school physics teachers were so enthusiastic that on their own initiative they equipped X-ray laboratories in physics equipment stores. In two towns sick persons had been examined for decades in these laboratories. The creator of one of these laboratories, Josephus Ireneus Károly took part in above mentioned first Hungarian trainingsseminar (1895). The X-ray laboratory established on money collected by him already worked in December 1896 (one year after discovery!).

Unfortunately today we cannot hope for such a direct connection between science and education. But every teacher who wants to do his job well has to inquire about contemporary scientific problems, mainly because his/her students are much more interested in the future then in the past. This demands a permanent self-education from all of us.

Physics teachers' in service training in Hungary

In 1985 the Hungarian government decided on the teacher in service training reform. It introduced the system of intensive courses. According to this plan every teacher has to take part in an in-service training at a given time for a year. The courses ended with a thesis, and an examination. Depending on their results the participants received wage-increase.

Nuclear physics intensive course

Physics teachers had a possibility to be absorbed in a topic on the nuclear physics intensive course of Nuclear Physics Departement at Eötvös University. This kind of training was exciting, it evoked the teachers' large interest.

Though nuclear physics was not born these days nevertheless, now it represents the most advanced technology, in connection with environmental protection and energy supply. The students' experienced interest also motivates the teacher to be well-informed of this field.

The curriculum was the following:

- Nuclear physics theoretical lectures	10 hours
- Nucleonics	10 hours
- Nuclear energetics	10 hours
- Radioprotection	20 hours
- Nuclear demonstration experiments	10 hours
- Nucleonics and radiatation protection measurements	40 hours
	100 hours

Topics of laboratory practice:

- Dosimetry
- Measuring thermal neutron flux in active zone of reactor
- Neutron activation analysis
- Nuclear spectroscopy
- Computational simulation
- Practical reactor operation

Lectures were given by professors of Eötvös University and Technical University.

Practice mostly was carried out in the reactor of the Technical University in Budapest. The greatest experience for the teachers was the praxis in the operation of swimming pool type reactor. We had possibility start, run and stop a reactor.

The course ended with a ground-level examination on radiation protection controlled by state.

The participants of courses after their succesful examinations received Geiger counters and simple radioactive sources for their schools as a present. The high popularity of this course is due to the teachers good connection with the University, with its Nuclear Physics Departement. We often go back with our students for school excursions to see the reactor.

Some dissertations of the course:

- Simulation of neutron scattering with computer
- Investigation of cosmic radiation with a Geiger counters in coincidence
- Measuring of lead content in air
- Observation of acid rain
- Indoor radon survey
- Radon in my village
- Investigation of heavy metal content of leaves with snapshots of gamma spectrum

The teachers took special visits in power plants, laboratories, mines, deposits of nuclear wasts, universities or research institutes.

Nuclear excursions

Not only the participants of course, but the interested Hungarian teachers had possibility to see Chernobil and Three Mile Island, the teachers and the best students visited the laboratories of CERN, we saw the heavy water factory in Turnu Severin, in Romania and we went down to the mine of uranium in Hungary.

I would like to mention an interesting and well established training form of Unversity of Debrecen. Each year one teacher can work at the Nuclear Research Institut getting a research scholarship. With a consultant's help he/she can engage in a real, daily research, he/she can solve a part of research problem. After one year the sponsored teacher gives an account of his/her finished work. If this account has a quite high level the theacher has an opportunity to improve it on as a PHD.

From these „nuclear teachers" a country-wide network has been created not only for inservice training of secondary school teachers, but for the dissemination of actual information as well. For example: Intended location of radioactive waste deposits, CO2 green house situation, international agreements and manifests about SO2, NOX, CO2, nuclear releases, future limitations, software for energy production, environmental models and risk education.

At least in half of the counties this network is alive, organizes seminars, visits the nuclear plant. Eight years ago these teachers formed the Teacher Branch of Hungarian Nuclear Society. Nowadays the most important task of the Teacher Branch is to organize the Leo Szilárd Nuclear Physics competition.

The start of Leo Szilard competition

At the centenary of Leo Szilard, in 1998 the Eötvös Physical Society proposed a countrywide student competition of secondary school graduates in nuclear physics.

The interest exceeded all our hopes. Each year over **400** students participate from dozens of schools, from all over the country.

(This means more than one percent of secondary school graduates of the year.) Even some younger students from grades 8,9,10, 11 (of the age 13, 14, 15, 16) participate.

Selecting Competitions

From the selecting competitions – organized locally in the schools - those had the chance to go to the final competition, who solved over **60 %** of the problems. (For juniors below the age of 16 a success rate of **40 %** was the threshold for participating the final competition.)

Final competitions

The final competitions are arranged in Paks, in the Energy Industry College of the Nuclear Power Plant.

At final competition

- the solution of ten more demanding theoretical problems (in 2 hours),
- one computer assisted problem (1 hour) Bemutatni egyet!!
- one experimental problem (2 hours) are the tasks.

About the results of competition

The encouraging fact is that these tasks are not exaggerated: each problem was solved perfectly well by a one or two students.
The success rate: above **60%** at senior students, near to **50 %** at junior students.
About the selective power of the Leo Szilárd Competion: in last year one of the winners brought home also a medal from the International Physics Student Olympiad.

The competition is made more attractive by the fact that in each year the **5 best students get free entrance** to the Hungarian universities.

The organizers

The Leo Szilard Student Competition is organized by an unselfish group of professors representing leading Hungarian universities and teacher training colleges, furthermore of secondary school teachers, under the umbrella of the Eötvös Physical Society and Hungarian Nuclear Society.

Autumn universities

On George Marx professors initiative in 1972 was born the tradition of autumn university.
The themes of these universities were energy, environment, global problems. The issues showed that we had to find connections with other natural sciences. These meetings had less participants, generally about 100 of the most active and innovative Hungarian physics teachers.

Titles of the Autumn Universities were:

- Energy and education
- Nuclear energy (Visiting the nuclear power plant in Paks, measuring here)
- After Rio's environment conference
- Global way of thinking, global responsibility
- The Gaia model
- Life in physics-physics in life (biophysics)

Famous lecturers from abroad and the most famous Hungarian professors spent time together with the physics teachers.

Not only physics teachers took part in these programs but biology and chemistry teachers were interested as well. This kind of training gave the experiences of real scientific conferences to the participants.

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2.8 Nuclear-Electrica Experience Related to the Public Information About Nuclear Energy and Its Benefits for Development of Society

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Abstract:

Recent events in Canada and Italy and the prediction for similar incidents to be produced in other high developed countries have highlighted public concerns about the nation's energy policies. The blackout that affected much of Ontario and the northeastern United States has focused attention on the adequacy and security of the everyone electricity supply . Meanwhile, gas and oil prices have soared across the continents and this is a very strong motivation for the countries governments to allocate financing funds for a range of policy initiatives related to the Kyoto Protocol, reminding to all of us about the need to make changes to the way in which we generate and use energy, in order to reduce the possibility of anthropogenic climate change and other types of damage to the environment.

The people of all over the world are concerned about the potential for global warming. There are also concerns about the health effects associated with the use of fossil fuels (smog and other forms of pollution). What alternative forms of energy are there? And could we help to solve these problems by changing the way we use energy in industry, for transportation, and in our daily lives? Government policies in these areas are incomplete, and the general public needs much more information if a consensus is to evolve about the necessary changes in energy use in our society.

Nuclearelectrica has developed a strategy of public information, following the basic objective principles of communication to inform the public about the facts on different aspects and events produced on nuclear field not only within Romanian territory but all over the world.

The elements needed by a communication plan are strictly followed as:

- clear objectives
- the audience according to the objectives
- the message to be communicated
- a communication plan with goals for each audience in order to achieve the objectives
- evaluation of the results to be included in future planning

It has been demonstrates that a quick access to information is mandatory for public credibility, so that the general principles as:

- the respect for the public
- to pay attention to all the major interest problems and fears of the public
- a large degree of transparency toward inhabitants of Romania
- the respect for the opponents' opinions
- the quality and content of the messages

- initiative in information supply

are strictly observed during the action taken by our company for public communication, developed by means of mass media, publications as books, pamphlets, presentation of events related to nuclear program developed by our company Nuclearelectrica.

We have developed a very meticulous program for public information through different methods: special presentation in the school, visits organized for children and their teachers and parents on Cernavoda site, annual exhibitions with paintings having nuclear thematic, performed by children and organized by our company during Nuclear Energy Days and International Symposiums about Nuclear Energy (awards are given to children for special paintings, etc.).

The specific aspects of a good collaboration with the press are represented by the propagation of the relationships with reporters, simplicity and knowledge of being original.

The relationship with mass-media are generally developed through:

- elaboration of the support documentation for radio and television programs;
- initiating some radio programs, quizzes, eventually live talking to the listeners;
- initiating some TV programs on various topics mutually set out with the programs editors;
- issuing press releases for a prompt information of the public related to some events occurred during the operation of the subsidiaries reporting to "Nuclearelectrica" National Company – SA;
- adopting an "offensive" attitude at the press level by publishing articles on Cernavoda NPP operation, reliability, safety, economic, ecological and social advantages, on radioactivity and so on, as well as interviewing scientific, medical personalities, specialists involved in the nuclear power program, Romanian operators, representatives of the nuclear regulatory body and so on;
- organizing initiating courses on nuclear power for media representatives.

The main actions taken with view to inform promptly the public:

- prompt press releases and interviews on different subject of interest in the central press
- press conferences on site and at the headquarters
- radio programs, so called "nuclear radio pills"
- radio and TV round tables
- initiating courses for journalists about the history of nuclear energy and Cernavoda NPP , nuclear power generation, CANDU type reactor presentation – safety aspects, technical and economical performance, waste management, radiation levels, visits of the plant.

Main text:

The success of any activity depends on the way the problem is technically dealt with, and the support of the people ⇒ an efficient public information and communication policy.

Societatea Nationala NuclearelectricA SA - SNN SA - represents a Romanian state owned stock company, established in July 1998, following the restructuring of RENEL, the former centralized Romanian Utility and includes three main branches:

- "CNE Prod", operating Unit # 1 Cernavoda NPP (CANDU 6 Type)
- "CNE Invest", including Units # 2 to 5, actually in charge with the completion of Unit # 2 (CANDU 6)
- "FCN - Pitesti", the nuclear fuel factory that supplies the nuclear fuel for Cernavoda Unit#1 and with minor changes can double the production - the plant is qualified by AECL and ZPI-Canada as CANDU6 Nuclear Fuel Supplier

The total revenue of SNN SA in 2002 was about US$115 Million, having a staff of about 2400 employees at the end of February 2003.

Cernavoda Unit 1 NPP – is operated based on technology transfer process from Canada (CANDU 6 nuclear reactor), Italy (BOP) and United States (TG) :

- *"in service" since December 2, 1996*
- *gross capacity: 706,5 MWe;*
- *provides ~10% of the annual electricity output of Romania*

Cernavoda Unit 2 NPP – is under completion and SNN SA manages, together with AECL- Canada and ANSALDO - Italy, the construction work at:

- *The unit is ~ 68% complete, main equipment procured;*
- *Scheduled term for start-up : 2006*

- *Project Management Contract signed on May 2001;*

FCN Pitesti - Produces nuclear fuel for Cernavoda NPP, at its subsidiary in Pitesti;

- *uses natural Uranium dioxide, from a Romanian supplier*

In the year 1991 – started in Romania the first Public Information program

The presentation will focus on the Romanian nuclear utility experience in public information, considering the authors' position on different levels of communication, and direct involvement in the major information campaigns organized by SNN

The nuclear power has proved its potential to contribute substantially to electricity supply and to compete with the alternatives sources, to satisfy the need of more and more power consumption in the world. Nevertheless the implementation of nuclear power projects raises social concerns.
The social acceptance of nuclear energy can be approached by two ways, one based on increasing the public trust and the other is based on the technology development.

The trust based approach is referring to the public capability to decide whom and how to trust different groups of people involved in a way or in another in nuclear program and dealing with any issues of nuclear power.

The approach based on technology explanation has in view to make the public to decide alone if the technology is acceptable, based on the understanding of arguments and evidences provided by the experts. The international experience demonstrates that all efforts to improve acceptability of nuclear power based on the technology arguments have failed and that only the approach based on public trust was successful.
The communication strategies suitable for nuclear power are those considering the public as an equal partner for dialogue. The Aarhus Convention, now in force in Romania, provides an adequate framework for development of public trust, based on the dialogue and partnership.

The main obstacle for a rapid growth of nuclear power is the anxiety, distrust and lack of enthusiasm of the public versus this energy source. The public attitude regarding the nuclear energy varies in function of the geographical area, being identified three categories. In the west, the public has a critical or hesitant attitude. In the east, the

communist experience induced to the public a listless and tiredness attitude. In the fare east and in the south the public shows awareness and interest.
The variability in time of public opinion as concerns the nuclear energy is illustrated by its status in the USA. If in the first years of the nuclear era the public was ambivalent, after the
Three Miles Islands accident (1979) in the USA and the Cernobyl accident (1986) in Ukraine, the majority of the Americans opposed to erection of new nuclear power plants, even if they accepted the nuclear energy as an important alternative on long term. Now the situation tends to be more well-balanced.
The apparently paradoxical behavior of the public can be understood if we have in view the nuclear energy history, the communication deficiencies and the lack of trust in authorities and the technologic progress. The distrust was feed by the low involvement of the public in decision making in this field.

The nuclear energy is reflected in the public consciousness as clichés. The first cliché represent s the atomic mushroom produced by explosions in Hiroshima and Nagasaki, or by the nuclear weapons tests which followed, and by the radioactive cloud produced at Cernobyl. The impression produced by this cliché is so strong that many people are convinced that the nuclear power plants may explode like an atomic bombs.

Another cliché refers to the vulnerability of nuclear energy in front of terrorist attacks. The idea that the nuclear materials may fall in the terrorists hands, or that the sabotage actions may severely affect the safety of nuclear installations is easily accepted by the public and regarded as a real possibility.
The handling, conditioning and disposal of radioactive wastes are the main objection in all talks about nuclear energy. The subject of nuclear wastes is difficult to debate because the public regards these activities as unwanted and that the only the alternative is to oppose.
Surprisingly, the industry did not tried, until recently, to struggle against these clichés by promoting a more realistic image.

The governmental policy in this field was based on mistaken assumptions that the public is ignorant and irrational, and that its education and information assures a better acceptance of nuclear energy. Gradually, the scientific community began to understand the necessity of a more consistent involvement of the public in decision making regarding the nuclear energy.

THE SOCIAL ACCEPTABILITY

The social acceptability is essential for redefinition of nuclear energy role in the modern society. The basic understanding of the social attitude versus the nuclear energy will enable us to highlight the economic and ecological benefits of this energy source.
There are two approaches to explain the acceptability of nuclear energy: one based on the technology and another one based on trust.
The technology-based argument explains the social acceptance of nuclear energy as a result of the cumulated effort to build more safe power plants and the public information programs on the risks and merits of this technology.

The alternative for the way based on technology is that based on trust. This way is based on the observation that the public is not actually trying to form and independent opinion concerning how well the technology will likely perform, but rather is trying to decide which group of people to trust concerning how it should be managed.
The members of the public try to understand at the basic level only the issues considered as vital, but the nuclear energy is not included. All non vital issues are accepted function of their benefits and the trust in their managers.
The Society do not see the nuclear electricity as a basic issue, and the frequent negative signals from the media are reasons for anxiety. The fact that the present nuclear power plants have no impact on public health is exciting nobody. The free of incidents operation history of nuclear plants is a necessary but not a sufficient argument to obtain the social support. The social support for nuclear energy may increase as the public understand its active role in avoiding crisis in power systems, noticed in the last years, in reducing the green house emissions and in diversifying its applications in economy and social life. Therefore, the social acceptability is affected by three factors: technology quality, organization competence and especially public trust in users of that technology. The nuclear energy acceptability should be assessed within a larger context of public concern for environmental protection.

At the European level, the Aarhus Convention gave to the public the right to information, to access in justice, and to be involved in making the decisions that affect the environment, such as the nuclear energy.
The involvement of the public in such decisions is vital for sustainable development policy.

Additionally, the involvement is one of the ways to improve the trust and implicitly, the social support for nuclear energy.
The involvement of the public in making the decisions that affect the environment, both in the home country and in neighboring countries became at the European level a requirement, according to Council Directives 97/11/EC and 85/337/EEC. At the same time, the Convention on environmental impact assessment in the trans-boundary context, adopted at Espoo on February 25th 1991, exceeds the framework of the European Union, providing clear explanations for the minimal content of the environmental impact assessment (EIA) submitted to public debate, as well as public consultation procedures in the potentially affected zones, outside the territory of the polluting party.

- The main obstacle: anxiety, distrust and lack of enthusiasm of the public.
- The public attitude varies in function of geographical area:
    - West: a critical and hesitant attitude;
    - East: a listless and tiredness attitude induced by the communist experience;
    - Fare East and South: awareness and interest.
- The public perception of the nuclear energy problems, in general and of nuclear power, in particular, is generated by the lack of sufficient information in the domain, communication deficiencies, lack of trust in authorities and technology progress.
- The public fear for their health; the main reasons: the radiation and the latest one - the waste.

Clichés:
- the atomic mushroom and weapons tests
- fear of terrorist attacks or sabotage actions

The technology-based argument: more safe power plants and the public information programms on the risks and merits of this technology

The slogan of this way to obtain the social acceptability : *"if you would know what I know, you will believe what I believe"*

But this approach has few effects in changing the rejection attitude of the public

The alternative for the way based on technology is that based on trust

The members of the public try to understand at the basic level only the issues considered as vital, but the nuclear energy is not included. All non vital issues are accepted function of their benefits and the trust in their managers.

- The Society do not see the nuclear electricity as a basic issue

- The free of incidents operation history of nuclear plants is a necessary but not a sufficient argument to obtain the social support. The fact that the present nuclear power plants have no impact on public health is exciting nobody

- The social support for nuclear energy may increase as the public understand its active role in avoiding crisis in power systems, in reducing the green house emissions and in diversifying its applications in economy and social life

- The social acceptability is affected by three factors: technology quality, organization competence and especially public trust in users of that technology.

THE STATUS OF PUBLIC ACCEPTANCE OF NUCLEAR PROGRAM DEVELOPMENT IN ROMANIA

The nuclear energy program was initiated in Romania in the 80's by means of a political decision. The authoritative regime of that period granted no role to the public and enveloped the nuclear program in full secrecy. The secrecy veil was removed only after the revolution in 1989, when was found out that the involvement of political factors in implementation of the nuclear project had extremely negative effects. Reconsidering the nuclear program, on the unanimously accepted bases in developed countries and international organizations , enabled us the completion of the first unit of Cernavoda NPP and supply of electricity since 1996. The main issue changed at that time includes the removal of secrecy and starting a new relationship with the public.

This new attitude versus the public materialized in few actions:
- . A better relationship with mass-media, including visual media;
- . Publishing of information materials about nuclear activities, issues and prospective

- Organizing seminars and symposia and cooperation with professional and industrial organizations promoting nuclear energy
- The open doors policy
- Actions for the new generation
- Public participation in decision making and extension of this approach for neighboring countries
- Information of decision makers at local or national level
- The use of internal communication instruments

The cooperation with mass-media was carried on better and better, both partners could have the initiative. As the cooperation improved, the different issues of nuclear energy were most adequately reflected by mass-media. In these days the mass-media interest for nuclear issues is low and circumstantial. In the same time, this positive aspect reflects the maturity and professionalism of Romanian nuclear industry management.

Another important communication tool, due to the nuclear energy specificity, is the organizing of seminars for journalists, to explain the basic processes in nuclear plants. Granting interviews or participation in debates, some of them on line, at national or local stations are communication tools with positive impact on the public. A special attention was given to crisis communication, a good example being the period of dry-out in August – September 2003, when the regular meetings with mass-media enabled us to operatively inform the public on this phenomenon and its consequences. In this way the decision to shut down the Cernavoda NPP Unit 1 when the Danube reached the emergency level was understood and accepted without any negative comments.

A basic communication tool was the public information about all issues of nuclear energy.
During the last 10 years a whole series of good quality and accessibility informative materials was published. These materials dealt with the important issues of nuclear energy: radiations and the public health, environmental protection, nuclear accidents, the nuclear energy advantages, etc. The informative materials were prepared by professionals from nuclear industry or from NGOs and argued both pros and anti opinions. Of course, when the anti nuclear positions were based on unfounded and untrue arguments, the experts from SNN or from pro nuclear NGOs took position, based on solid arguments.

A modern tool for public information is Internet, and our company has its own site available to the public, together with other web pages dedicated to nuclear activities and issues and many of these sites are available in Romanian language:
http://www.nuclearelectrica.ro
http://www.cne.ro
http://www.aren.ro
http://nuclearinfo.ro
http://www.ecolo.org/base/basero.htm

Other important method for communication with the public are seminars and symposia organized with different subjects regarding the nuclear power. On this way is transmitted information for some target public categories such as: medical workers, industry and research professionals, administration staff, etc. In this respect, the cooperation between Nuclearelectrica National Company and the professional and industrial associations suc h as the Romanian Association Nuclear Energy, the Romanian Atomic Forum, the Romanian National Committee for World Energy Forum or the Romanian Radioprotection Society is very important, their professionalism increasing the trust in the messages given to the public.

The open doors policy is the most useful means for improving the trust and increasing the social acceptability of nuclear energy. Anybody like it may visit the Cernavoda nuclear plant and may see that the nuclear energy is clean, safe and efficient. The visitors of all ages are more numerous, this proving the fact that the public overtaken the period of obsessions and distrust.
In many occasions the plant received foreign visitors which have noticed and positively mentioned the high technological and managerial level, comparable with that of developed countries.

It should be noticed that after the September 11th 2001events in New York, many countries gave up the open doors policy. In Romania, like in other European countries (e.g. Spain), the visitors access at Cernavoda NPP was maintained, and we have 200-250 Romanian and foreign visitors per year. The Cernavoda public information center will be an element of attraction and an increased number of visitors are expected.

In relation with the young generation, we stressed the fact that the nuclear energy is clean, non- polluting and without impact on the environment. A particular interest was noticed between low age pupils for the drawings contest on the relationship nuclear energy and environment.

Another vital component of the relationship with the public is the involvement and participation. The public involvement in making the decisions with impact on environment and public heath is going to become a general practice at the European level, and a legal requirement in our country.
The Aarhus and Espoo conventions ratified by Romania and the requirement of the accession process in the European Union regarding the implementation of the aquis, outlined the legal framework for public involvement in the decision making process for nuclear objectives.
The environmental regulations have provisions for public debates, and the local public begins to involve himself more and more, like in the Cernavoda Unit 2 and the Interim Spent Fuel Dry Storage Facility.

The local public is generally for the nuclear program, because is better informed and trusts in the plant management. The opposition groups are generally international environmental organizations with very low local and national audience.
The messages reach the national and local decision makers by through the published documents.

The on site visits and meetings, especially at Cernavoda, with top decision makers, provided the opportunity for direct contacts with the realities and needs of the national nuclear program, as well as the implementation of the right decisions.

In the same time, the internal communication is an important tool for a good understanding by all staff of the managerial decisions, and of the processes, as well as a communication way with families of the employs and their friends, with partners (subcontractors, suppliers, etc). In this respect we publish periodically information bulletins or dedicated publications for special events
(emergency exercises, outages, etc.).

COOPERATION WITH THE CIVIL SOCIETY

Areas and methods of cooperation:

- ✓ Organizing symposiums and seminars, main sponsor for "The Romanian Energy Days" – ZEN and the "International Symposium on Nuclear Energy" – SIEN, organized by the Romanian "Nuclear Energy" Association.
- ✓ Inviting NGOs to participate to public debates
- ✓ Sending representatives to managing boards of AREN and ROMATOM
- ✓ Publishing articles in "Energia Nucleara", the magazine issued by AREN and ROMATOM

- ➢ The Society do not see the nuclear electricity as a basic issue

- ➢ The free of incidents operation history of nuclear plants is a necessary but not a sufficient argument to obtain the social support. The fact that the present nuclear power plants have no impact on public health is exciting nobody

- ➢ The social support for nuclear energy may increase as the public understand its active role in avoiding crisis in power systems, in reducing the green house emissions and in diversifying its applications in economy and social life

- ➢ The social acceptability is affected by three factors: technology quality, organization competence and especially public trust in users of that technology.

RSRP is a professional association of the Romanian specialists in radiation protection field, is an independent, non-profit and nongovernmental organization.
* RSRP was founded in May 30, 1990 as a organization for scientific information in radiation protection to public.
* RSRP is IRPA Associate Society since 1992 and is member of the Central European Association of IRPA Associate Societies since 2000.
* RSRP aims are to:
- protect population and radiation workers against the harmful effects of ionizing radiation;
- develop and make known the scientific, technical, medical and legal aspects of radiation protection on a nationwide scale;
- imply the civil society in the benefit/risk analyses for the ionizing radiation uses.
* RSRP has a presentation leaflet that can be obtained from the e-mail address: cmilu@ispb.ro and has a Web page hosted at:
www.ispb.ro/rsrp.htm.

RSRP organized annually national conferences with the subjects on radiation protection of the human population and environment with the participation of the Romanian specialists, specialists from many countries, environmental NGOs, local authorities, students and other interested peoples.

RSRP specialists published many books and leaflets informing public about radioactivity and the potential risks for environment and human health, presenting concepts about radiation protection, impact of radiation on day by day population life, medical irradiation of population, etc.

RSRP published years before a Bulletin for interested NGOs about the following subjects: radioactivity of atmospheric deposition, radioactivity of water and milk and exposure dose at the height of 1 m from the soil.

A lot of news about the Radiation Protection and the RSRP activities where inserted in the review called "The Courier of Physics"

RSRP, through its specialists organized few Press Conferences on Radiation Protection and participate at 6 TV or Radio broadcastings on uses of nuclear energy, radiation protection of humans and environment, the radioactivity of miscellaneous foods, etc..

By participation of the RSRP members at different activities organized by mass media, environmental NGOs, etc., a massive implication of the specialists in Radiation Protection in actual problems about peaceful uses of nuclear energy (nuclear energetic, nuclear medicine, etc.) was achieved and possible risks in case of non-use of all recommended radiation protection were presented.

The RSRP specialists published a lot of articles in the central or local news press on the radiation protection subjects and are involved in the on going events treating population radiation issues.

The point of view of the RSRP regarding the peaceful uses of nuclear energy as well as the improvement of the citizens capabilities to take decisions regarding the nuclear activities in Romania is presented at different conferences and symposiums organized in Romania and abroad

The presence of the professional women, organized into associations like Women in Nuclear (WIN) could bring an important added value to the pro-nuclear 'civil society' contribution for better informing the public. They may act under the umbrella of the nuclear professional society, or could be set-up as independent organizations.

The goal of the group is to inform the public objectively on the use of nuclear energy and application on national and international level and to develop dialog with the public

Another goal is to emphasize and support the role that women can and do have in addressing the public's concerns about nuclear energy, nuclear application and nuclear technology

- The target audience of this organization is:

Public, Female leaders
Local policy makers
Health professionals
Academic's and women's associations

CONCLUSION

- All target audience is important in building the confidence, but some categories deserve special attention, considering the today priorities of the company:
    - Local public, including local authorities – as far the anti-nuclear NGOs started a strong campaign against Cernavoda 2 and further development of the site
    - Mass-media representatives, increasing the co-operation with local newspapers, as well as with the national ones
    - Politicians, considering this year elections, and the re-drafting process of the political strategies of different parties
    - Improving the internal communication developing INTRANET and EXTRANET channels, and extending social events inside the company
- A better social acceptability of nuclear energy may be obtained through a sustained effort to improve the public trust, using tools as diversified as possible;

- The public information and public participation are the two main components of the communication process, the accent following to be changed from information to participation;

- Public communication must be professionalized and planned so that each target group be treated in a specific manner;

- According to our experience, at this moment the target groups are local communities, mass media representatives and decision makers, but we can not neglect the internal communication which is important for local public involvement;

- Company has enough flexibility to re-define the target audience, considering possible future reallocation of priorities