Reflections on NORM III

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1. INTRODUCTION

A wide range of non-nuclear industries are processing large volumes of raw materials containing radionuclides from natural origin. During processing the concentration of these natural radionuclides may be enhanced. Most of the Naturally Occurring Radioactive Materials (NORM) is often found back in the waste streams of these industries. Many of these industries were neither aware of these problems neither about the regulatory initiatives that were being developed about this topic by international authorities. Therefore there was a great need in creating a forum for discussion between industries, scientists and regulators. This was one of the major aims of the series of three NORM-symposia that have been organized up to now.

The first edition was organized in 1997 by KEMA in Amsterdam (The Netherlands). It was entitled “International Symposium on Radiological Problems with Natural Radioactivity in the Non-Nuclear Industry”. The general conclusions state that NORM is encountered in a wide variety of industries, that there is a lack of available data and a need for international consensus on radiation protection guidelines. This conference highlighted the extent of the NORM-waste problem.

In 1998 SIEMPELKAMP organized in Krefeld (Germany) the second edition entitled “Second International Symposium on the Treatment of Naturally Occurring Radioactive Materials”. Assessment was made of public and workers exposure in different industries. This has contributed to “awareness”. Meanwhile many more data became available. The industrial experience has indicated that exposure to workers and public can be controlled to levels below 1 mSv/y. The need for practical recycling or disposal solutions was clearly put forward in waste management. Due to the worldwide trade of raw material with NORM, internationally harmonized regulation is necessary. Industry and international organizations have elaborated proposals for regulation. The European Commission in particular has progressed in developing guidance.

At the 2001 edition, organized by FANC in Brussels, the status of the implementation of the Basic Safety Standards at national level was addressed, showing a (still) high degree of variability. In a series of technical sessions the experience gained in relation to radiation protection items in different NORM-industries was presented, with special attention to waste management problems and the impact on the environment.

Numerous social and economic implications came up. As addressed in the introduction to this conference the challenge for radiation protection consists in establishing “*regulation in a reasonable and fair manner for all the industries, the workers and the public*”.

Due to the important social and economical impact, the new regulation has to looked at from a broader point of view, incorporating communication and legal and philosophical considerations.

The Social Sciences Group of the Nuclear Research Center in Mol (SCK) was asked to comment on the NORM-III symposium with particular attention to societal, institutional and communication aspects. The current paper is summarizing the major observations and reflections made by the Social Sciences Group of SCK, extended with some radiation protection and waste experts and chaired by the FANC senior officer for NORM.

2. REGULATIONS & GUIDELINES

The **International Basic Safety Standards** of the IAEA (BSS) and the Council Directive of the European Union (96/26 EURATOM) for the protection of man and environment against ionizing radiation have paid in 1996, for the first time, specific attention to the exposure to natural radiation sources. **Member states** of the European Union (EU) are required to **identify work activities** within which the presence of natural radiation sources may lead to a significant increase in exposure of workers and/or members of the public, which cannot be disregarded from the radiation protection point of view. The implementation **of corrective measures or radiation protection measures** is left to the responsibility of the member states.

The EU has established a **general framework** for ensuring compliance with Title VII of the new Basic Safety Standards and provides **guidance for the identification of workplaces and measures** to take for the protection of workers and, where appropriate, members of the public (1). Although exposure to natural radiation sources is presented within the same general framework as other exposure to ionizing radiation, no identical procedures have to be followed for natural and artificial radiation sources. This is mainly due to the fact that some approaches for controlling exposures to natural radiation sources are regarded by ICRP as **interventions rather than as practices**. It implies that the radiation exposure from natural sources should be included separately in the occupational exposure of workers and in the exposure of the public. Exposure assessment of members of the public and control of radioactive effluents and NORM-waste management is the full responsibility of the national authorities.

In order to harmonize the approach for NORM-industries in the European Union, **reference levels** were set-up for the identification of industries handling materials with enhanced levels of naturally occurring radionuclides (2). The exposure scenarios are based upon a review of the relevant industries in the EU and only the **exposure of workers** is considered.

In the EU regulatory systems for NORM are in place in only a few countries. Most member states will do so in the near future. The approaches **lack coherence**. An **overall regulatory system** should be developed. Harmonizing NORM-standards throughout the world should be set-up in a **flexible way** in order to avoid economical and social disruption.

3. NORM-WASTE PROBLEMS IN THE CONTEXT OF RADIO-ACTIVE WASTE MANAGEMENT AND CHARACTERIZATION

The management of waste from NORM-industries is one of the most important challenges for the future. The situation in Belgium regarding the management of the waste from the phosphate industry is reviewed in the frame of the general radioactive waste management. The latter may act as guidance for the management of NORM-waste in general.

3.1 NORM-waste arising from industrial activities

In Belgium,the following types of waste arising from the phosphate industry (3) are known:

a) Gypsum dumps, generated by the sulphuric acid dissolution process.
b) Sludges, generated by the hydrochloric acid dissolution.
c) Releases from the nitric acid dissolution.

Suggested **remedies** are as follows:

- The disposal of gypsum sludges (Example a) in dumps is preferable to the discharge in marine estuaries because of the possible transfer of Ra-daughters to the marine environment such as molluscs. Capping of filled dumps is necessary to decrease the ^{222}Rn emanation into the surrounding atmosphere after closure of the dump. In the long term a hazard for the public may arise from building activities on the site and from inadvertent use of the gypsum as building material. Future habitation on these sites should be prohibited by a specific landscape classification system for this type of dumps.
- Capping of the dump should be designed to avoid as much as possible the infiltration of rainwater into the dump. But for old dumps a **groundwater-monitoring** program should be initiated in order to monitor possible groundwater contamination by the Ra-daughter nuclides in the immediate vicinity. The concentration of Bi-210/Pb-210 has to be measured. Radium-226 (as Radium-Barium-sulphate) is in principle insoluble and quite immobile.
- A specific Ra-Ba-sulphate precipitation with the production of "concentrated" sludges containing the precipitated Ra is the most recommended solution for acidulation with hydrochloric acid (Example b). The discharge of $RaCl_2$ into small rivers far from the sea is not commendable because of the long-term transfer from the riverbed contamination to the surrounding fields due to dredging operations and to the groundwater by diffusion into the underlying river bedrock. Surface contamination of large areas can occur in flooding zones.
- The increased specific activity of the "concentrated" sludges in the Ra-Ba sulphate dump resulting from the effluent treatment asks for adequate measures to minimize the leakage of the dump floor and for similar preventive measures as in example a with very impermeable capping materials e.g. silts or clays.
- For Example c, information is lacking on sludge generation and/or the possible Radium contamination in discharges. It looks as if the total

Uranium-Radium-daughter inventory remains in the final fertilizer product. This means that the U-Ra level in the upper layers of the agricultural soil will gradually be transferred from the phosphate ore layer (Morocco, Florida or Kola) to the consumer countries specifically those with intensive crop production. Use of low U-Ra containing phosphate is in this case a prerequisite for minimizing environmental contamination. The Florida phosphates are more radioactive than these of other sources.

At the European level only few nuclear waste agencies, such as COVRA in the Netherlands have developed management concepts for radium bearing waste. The agencies mainly focused in the past on nuclear fuel cycle waste management, neglecting the specificity of a diversity of small nuclear waste producers, such as biomedical and hospital waste and NORM-waste. COVRA took the lead in Europe by organising a 100y storage for the waste (with a relatively low radium content) from the Dutch phosphate industries.

3.2 Radioactive waste management & characterization in the EU; the situation in Belgium

Within the EU the management of radioactive waste in general is performed by the **nuclear waste agencies.** The **regulatory authorities** approve the **criteria** for conditioning and disposal proposed **by the agencies** and take care of **licensing and control**. These bodies have been established and are operational in most EU-countries, but are still lacking in some developing countries. The waste management agencies and regulatory authorities usually **complement** each other in the various steps of accepting the primary waste, conditioning of the waste, interim and final storage and eventual disposal. Specific institutional differences exist amongst the various EU countries, depending on historical events, national legislations, *etc*. We highlight the situation in Belgium as a particular example of institutionalised separation of nuclear and non-nuclear waste management and regulation.

In Belgium the central role is taken by the radioactive waste management agency NIRAS/ONDRAF (Nationale Instelling voor Radioactief Afval en Splijtbare materialen/Organisme National des Déchets Radioactifs et Matières Fissiles). NIRAS/ONDRAF submits the primary radioactive waste to acceptance criteria, one of the conditions being that a number of characteristics has to be respected by the waste producer. NIRAS/ONDRAF has the responsibility to organize the conditioning (*i.e.* immobilization by mixing with cement or bitumen, or incorporating into a glass matrix) of the radioactive waste. This is currently done by Belgoprocess (a 100% industrial daughter company of NIRAS/ONDRAF), by the nuclear power plants or Cogéma.
NIRAS/ONDRAF has established a **classification system** and rules for the acceptance of the conditioned radioactive waste. The radioactive waste packages (RWP) are subdivided in three categories (A,B,C) **depending on the radionuclide inventory** and thermal power. For instance, category A is the low-level waste, and the upper limits for the radionuclide content involve values (in Bq/m^3) for as much as 20 different radionuclides. The acceptance of the RWP by NIRAS/ONDRAF should meet the **general rules** established by the

government. NIRAS/ONDRAF has elaborated preliminary **acceptance criteria** (AC) for each kind of RWP. They have been submitted to the regulatory authorities. These AC list the requirements the RWP have to meet so that NIRAS/ONDRAF can accept the RWP produced by the operator for interim storage and subsequent final disposal. AC includes requirements on mechanical, thermal, physical, chemical, radiological properties. They take into account the specificity of the waste form (cement, bitumen, glass), of the waste package (homogeneous, heterogeneous), and of the disposal (surface, geological). This approach has not yet started for NORM-waste.

Throughout all "steps" such as generation, conditioning and disposal of the radioactive waste, **characterization** by analysis or testing is a key action. Characterization of the primary waste has to be done by the producer of the waste. The operator of the conditioning facility has to carry out characterization actions as part of his quality control plan. Finally the conformity of the waste packages with the acceptance criteria must be checked in view of the further handling of the waste packages (including disposal).
The characterization of the primary or conditioned waste can deal with different characteristics, summarized here in a non exhaustive way:

- Inventory and distribution of the radionuclides in the waste package.
- Chemical properties: leaching resistance, chemical composition, compatibility between the waste and the matrix.
- Physical properties: free liquids, porosity, homogeneity.
- Mechanical properties: compressive strength, impact resistance.
- Thermal characteristics: thermal power, conductivity, devitrification, fire resistance.
- Biological properties: biodegradation.

Full description of the technical characterization capabilities can be found in literature (4). Considerable progress has been made in many of these areas over the past years. Radionuclide analysis by destructive and non-destructive techniques should be mentioned particularly. Detailed information can be found in the reports edited by the European Network for Quality Checking Facilities for Radioactive Waste Packages (ENTRAP) (5). A round robin project organized by the European Commission that compared the non-destructive analysis on a number of 220 l low-level RWP by different laboratories with gamma spectroscopy (6) can be emphasized. The results have shown that detection limits as low as 1 kBq/kg may be achieved for most γ-emitting radionulides (Cs-137, Eu-154). Progress is still needed to identify and validate the uncertainties encountered.

3.3 Proposal of a coherent and practical approach for NORM-waste

Based on the previous information, the following **actions** are recommended:

- to establish the **inventory** of the NORM-waste (volumes, radionuclide and toxic elements, other information).
- to establish a **classification system** and **rules for acceptance**.
- to elaborate acceptance criteria for all NORM-waste fluxes.
- to **characterize** the NORM-waste (inventory and distribution of radio-nuclides, chemical and physical properties).

- to review and identify analytical **techniques** (non destructive, destructive) for determining the characteristics. As indicated above, one of the critical issues is to identify techniques with suitable detection limits and known measurement error, because the radionuclide inventory levels in NORM-waste may be challenging in this respect.
- to develop a **concept for disposal** of NORM-waste accounting for its long half-life, its radon emanation capacity and content of toxic elements, and to elaborate a system for **independent verification** of the conformity of the conditioned NORM-waste with the acceptance criteria.

Moreover it is necessary that the nuclear waste agencies and the regulatory authorities clarify their role in managing the NORM-waste issue, and launch the different actions, in particular to meet future disposal requirements.

4. DISCUSSION

4.1 The sustainability concept as an appropriate tool for societal discussion on NORM-issues

The Belgian Minister of Home Affairs, stressed that the radiation problem related to industrial processes involving natural radionuclides is a very complex problem. He pointed out that harmonization is the key issue. Therefore, intense contacts, consultations, communication between the different involved parties – as operators, regulators, labour organizations, and the public - are absolutely necessary on the various items along the line from mining to the production of the end product (7). The Minister touched here the quintessence of the societal issue. On the one hand, NORM is a technical and health problem, but on the other hand, it has a societal dimension, which raises the question why social aspects received almost no attention during the NORM-III symposium?

On the one hand, no labour, environmental neither public actor was present as speaker or as participant. Thus far, the **public opinion** does not seem to be very interested in the NORM-discussion or was not involved in due time by the organizers. Psychologically, this can be explained by a risk study of Charles Vlek and G. Keren (8). They give 11 dimensions that determine risk perception (Table 1)

Radon in houses can be taken as a first example (9,10). People feel very familiar with their homes (dimension 7), they live voluntarily in their houses (dimension 8), and living in a familiar habitat provides lots of benefits (dimension 9). Thus it becomes understandable from a psychological point of view that radiation protection experts have problems to convince people about the dangers of radon in houses.

Some NORM-industries have the same advantage. **Ceramic industry** for example has a rural, even pastoral image. Familiarity and benefits are obvious here. **Oil and gas industry** has apparent benefits as well. For laymen, radon is a natural gas and the radiation problems for sanitation, maintenance or repair workers are not their concern. However, when NORM-wastes are not treated in a sustainable manner, the consequences could affect a large number of people (dimension 3) in a large area (dimension 2) during a serious time span (dimension 4). Furthermore, many aspects of NORM-waste cause much

discussion: the uncertainties on the effects of low doses, the lack of clarity in legislation, ... Peter Sandman (11) and Ruth and William Eblen (12) showed that the endless debate of experts influences the risk perception of laymen as well. It was already argued (13) that expert dissent may increase risk perception. Therefore, it is certain that public opinion will get worried or even anxious when things go out of hand.

	Different risk dimensions
1.	Potential degree of harm or fatality
2.	Physical extent of damage (area affected)
3.	Social extent of damage (number of people involved)
4.	Time distribution of damage (immediate and/or delayed effects)
5.	Probability of undesired consequence
6.	Controllability (by self or trusted expert) of consequences
7.	Familiarity, imaginability of consequences
8.	Voluntariness of exposure (freedom of choice)
9.	Clarity, importance of expected benefits
10.	Social distribution of risks and benefits
11.	Harmful intention of agent involved

Table 1: *Different risk dimensions according to Vlek and Keren*

On the other hand, at the NORM-III symposium, **operators and regulators** did almost not discuss public concern regarding sustainable development and precaution. Because of the potential worries of the public opinion, operators and regulators have to think pro-active from now on. This is a strong plea for a profound discussion about the societal aspects of NORM. Many concepts have been used for this purpose: technology assessment, environmental impact assessment, precautionary tools such as ALARA, sustainable development, ... The concept of sustainability will be taken here as an example.

At first sight, the **sustainability concept** seems an amalgam of ideas and seems therefore useless in legislation and responsible, accountable decision-making. Some authors however see this cover-all feature of the sustainability notion as a proof that this discussion covers most societal concerns. Andrew Dobson (14) for example analyses five distinct domains of environmental sustainability: ontological, epistemological, social, economic, and institutional. Every domain entails many specific fields of tension existing within society. These different domains of environmental sustainability can easily be applied and adapted towards sustainability in the NORM-case.

The **institutional domain** of sustainability includes the discussion between the international organizations on the one hand and national or local organizations on the other hand. As a matter of fact, this problem was the one the Minister of Home Affairs brought forward in his inaugural speech and was a major concern of the NORM-III symposium.

In the **economic domain** protectionism is opposed to trade, and unpriced ecological services to marketised environment (14). It is not at all sure that

concerned local actors will have the same opinion as NORM-experts in these discussions.
At the **social level** there is the discussion between poverty on the one hand and equity or wealth on the other. The concept of western technology dissents with the concept of appropriate technology. Even the discussion between debt repayment and debt remission and welfare compared to aesthetics can be applied to NORM.
On the **epistemological level**, ignorance can be ignored or can be treated by means of the precautionary principle. At the most abstract level – according to Andrew Dobson– questions can be put at the appropriateness of western science. Peter Sandman (15) mentions a cluster of four major errors that could happen in "sound science":

- Pretending that scientific support is stronger than it is.
- Pretending that scientist's actions are grounded in science when they are grounded largely in other considerations.
- Pretending scientist's disputes with critics are about science when they are mostly about trans-scientific issues.
- Scientists who believe their own pretences.

He finishes with:

> The damage companies do themselves by mishandling “sound science” isn’t limited to those occasions when they turn out wrong about the risk ... and end up wishing we had stopped them in time. A better measure of the damage they do themselves is the frequency with which they lose — we do stop them — even though they are probably right about the risk. And perhaps the best measure of the damage they do themselves is our society’s ever-declining confidence in science as a guide to decision-making about risky technologies. A less arrogant approach to “sound science” would facilitate greater public confidence in sound science.

A discussion on **health** as part of the social problem remains the quintessence in the debate on NORM-issues. How is health balanced to financial interests? And who is considered? Present generations, future human beings, and non-human beings? How many generations does present-day industry take responsibility for? What does responsibility mean over a period of several hundreds or thousands of years? Quality Assurance and Quality Control will have to determine how controllable and extensive the NORM-challenges are.

These domains show the **usefulness of the sustainability concept** as a mediator for the societal debate. Precaution and technology assessment are in our opinion elements of the sustainability concept and as such useful as well to contribute to institutional trustworthiness.
Ortwin Renn (16) gives four components of **institutional trustworthiness**: competence, openness, fairness and empathy.

- Having competence means that institutions need technical knowledge, experiences with professional risk management practices, and that these institutions have to take care for congruity between institutional mandate and actual as well as perceived performances.
- The institutions' openness consists of honesty, disclosure of one's own interests, the willingness to take up new topics and issues, fast responses to

public inquiries, willingness to respond to public concerns and anxieties, the willingness to disclose trade-offs with respect to the underlying attributes of the decision-making process.

- An institution is fair when it includes all relevant viewpoints, when it provides equal opportunities for all adversaries, when it is willing to interact with adversaries and to process their arguments, and if it willing to respect other viewpoints, lifestyles and values.
- Empathy is accomplished when people are taken seriously, when there is a willingness apologize for mismanagement, and –last but not least- when an institute is willing to be overprotective rather than always showing a rationalisation of dangers.

In many aspects of public life, from town and country planning to high level waste treatment, gaining confidence or being trustworthy through involvement of the public and/or labour organizations can be very useful in developing a economic and efficient decision-making process (17). The earlier the public discussion is implemented in the decision-making process, the more useful it is. Therefore societal aspects of NORM should be treated as an important issue in the coming symposia, legislation, and decision-making processes according to the well-developed schemes of sustainability, precaution, etc.

4.2 Risk - Safety

For material flows in the nuclear industry, risk related to radioactivity seems dominant. In most cases it is not necessary to bother about the presence of toxic chemicals. NORM-industry on the contrary gives rise to (huge amounts of) **mixed waste**, containing a cocktail of long-lived radioactive and chemical pollutants. Therefore, the risk estimate as well as the management strategy for such type of material should be based on a combined **radioactive-chemical risk analysis**. There is currently no much experience in this field. Moreover in most countries authorities at different levels and different institutions are responsible for the management of respectively radioactive and chemical waste. This makes the realization of such a combined approach even more difficult.

Although the technical aspects related to waste as described in 3.3 are challenging, attention has to be paid to the problem of **risk perception**. **Information** of the workers and public and active **communication** should be focused on. Political, ethical and institutional aspects will probably be the dominant influencing factors in NORM-waste management.

4.3 Transparency and harmonization of the regulation on NORM-activities

4.3.1 The scope of implementation of the regulation

Although natural radiation sources were not included in the early regulation on radiation protection, significant steps towards harmonization of the approach towards natural sources were made with the publication of the volume ICRP-60 in 1991. The European Basic Safety Standards Directive of 1996 now explicitly includes natural radiation sources.

It is not easy to adopt a similar approach for the different activities linked to ionizing radiation (medical field, nuclear sector and non-nuclear industry, radon

in houses...). It is even more difficult to adopt an integrated approach, i.e. a completely holistic approach taking into consideration each risk associated with an activity (environmental, toxic, carcinogenic) and its ethical concern. It is however **necessary to clarify the relation between the specific regulation on radiation protection and the general legislation on safety at work**. A combined risk of asbestos and ionizing radiation can make it for example difficult for companies to respect both regulations, since the radiological risk has not been referred to in the hierarchy of risks comprised in the legislation on safety at work.

There is a clear need for a methodology acknowledging the principles of BATNEEC (Best Available Techniques not Entailing Excessive Costs), ALARA (As Low as Reasonably Achievable), ALARP (As Low as Reasonably Practicable - used in the UK for safety at work in general), BPM (Best practicable Means). All these principles that do imply safety in relation to multiple risk factors.

From the lawyers' perspective **the technocratic society**, in which Soft Law regulations are dominating, engenders that the law-making is mainly left over to the "executive state-powers", instead of being the result of democratic decision making in Parliament.

Soft Law can be defined as "regulation without a distinct legal sanction or consequence", while Positive Law results from a process, laid down in the Constitution, guaranteeing the democratic choice of priorities amongst the economic, environmental and ethical values involved.

Positive Law is nowadays often made by the judges, confronted with technocratic and scattered rules. The judges must rely the more and more on the general principles of law, such as the principle of proportionality, the principle of non-discrimination and the principle of equality, because this gives the flexibility needed to interpret the rules of the fast changing society.

4.3.2 The identification of NORM-activities and the duty of notification

According to the Basic Safety Standards Directive, member states have **to ensure the identification of the activities which may be of concern** by means of surveys or by any other appropriate means (art. 40 Directive 96/29/EURATOM).

In Belgium, professional activities involving significant increased levels of exposure for workers or members of the public to natural radiation sources are subject to a **duty of notification** (art. 9.1 Royal Decree of July 20, 2001 on radiation protection). These activities involve a risk from ionizing radiation emanating from a natural radiation source in cases where natural radionuclides are **not** processed in view of their radioactive, fissile or fertile properties. Since no sanction has been linked to a violation of this duty, this passive regulatory approach cannot be considered sufficient to identify the concerned activities.

4.3.3 Difficulties to harmonize the regulation on NORM-activities

In Belgium, the application of radiation protection measures to reduce exposure pursuant to all or part of the regulation for practices can be considered necessary by the Federal Agency of Nuclear Control (FANC) - for these activities - if certain levels of exposure have been exceeded (art. 9.3 juncto art. 20.3 Royal Decree of July 20, 2001 on radiological protection, art. 41 Basic Safety Standards Directive). The violation of these levels can give rise to

several corrective measures (art. 9.3 of the Royal Decree on radiation protection). Except for the protection of aircrew (art. 42 Basic Safety Standards Directive), the Basic Safety Standards Directive does not clarify these levels.
Therefore, **these "action-levels" can be different from country to country** (see for Belgium: art. 20.3 of the Royal Decree on radiation protection).
To improve harmonization the European Commission provided some recommendations for the member states (1). **The European harmonization effort in this field is hindered by the difficulties the member states are facing when identifying or measuring the concerned activities.**
At the moment scientific certainty on the application of the regulation is lacking in several countries. By creating the new category “work activities”, in addition to “practices” and “interventions”, each NORM-activity is now (temporarily) outside the scope of application of the exemption limits. In the past high exemption limits were of application on natural materials. Significant quantities of occurring radioactive material originating from the NORM-industry are staying outside the scope of the regulation, except if they are delivered to the nuclear industry. This is a clear example of the inconsistency of the nuclear sector versus the NORM-industry. For these reasons it can be recommended that the (draft) proposal for guidance of the European Commission on exemption and clearance for NORM-materials will soon be applied in the national regulations (18).
Despite this lack of harmonization the principles of law, mentioned above – and in particular the duty of care and **the precautionary principle can urge decision makers to a more common approach**. As an example the verdict of 18.10.2001 by the Administrative Court of Appeal in Marseille, France, in the ASBESTOS case, can be referred to. In this case the government has been condemned for not having set lower dose limits for workers at the time when it was scientifically proven that health effects were occurring. In the same sense, the Belgian government has recently been held liable for its lax attitude towards safety measures in trucks. If safety regulations are delayed because of the influence of the industry, government risks to be held liable in case of accidents.
This may illustrate that in spite of different applications of dose levels in the EU member States, a judge might use the general principles of due care (to be taken by the government, but also by the industry) **to intervene "ex post".**
At the same time this is a plea for a more "ex ante" approach which can be implemented via the ALARA Principle or "reflexive regulation", i.e. regulation based on a combination of performance and system-specifications which implies that one can reflect on how to achieve compliance with performance standards (19).

4.4 Communication

Due to increased awareness of industry and research, national regulatory authorities have started in the late nineties to take initiatives in order to control the NORM-problem.
But only few nuclear waste agencies, such as COVRA in the Netherlands have developed management concepts for radium bearing waste. With this initiative

COVRA arrived at illustrating a broader problem solving capacity than usual for a nuclear actor while improving communication with the industry.

The communication on the NORM-problem in Belgium was improved by the yearly environmental reporting procedure of the Flemish government for all compartments of the environment, including nuclear activities (20). This reporting of activities, emissions, immissions and effects is based on the OCDE pressure state-response approach. It allowed to identify for the public, the industry and the authorities the extent and complexity of the NORM-problem.

The visual demonstration of siting of Ra- and Th-bearing waste through aeroplane monitoring using γ-spectroscopy (21) had a particular communication effect. As a consequence initiatives could be taken to clarify the source terms and to argue and start remediation actions.

Institutional segregation of nuclear and non-nuclear regulation and waste management in Belgium are however delaying solutions.

NORM-waste clearly has mixed waste characteristics with for instance similar risk levels for Cd as for Ra in phosphate plants producing gypsum . Only few integrated assessments of nuclear and non-nuclear risks related to NORM-waste were presented.

The forced implementation from 2000 on in national regulations of EU-countries of the Council Directive 96/26 EURATOM has accelerated information and communication. Manipulation of information by interest groups or their client consultants was however dominating the scene.

The debate has concentrated on clearance and exemption values, which are determining as well the cost of regulation as the future acceptance of increased environmental releases.

The elaboration of international criteria and derived reference levels by IAEA and EC were dominated by the economic challenges of different industrial sectors. They were confronted with the attempts of an apparent coherent regulatory system, established for nuclear activities to face the paradox of radon exposure and NORM (13).

Future modifications of the radiation protection system will be a choice of either flexibility offered by optimisation opportunities or the cognitive attempt to make a general increase of exposure to a carcinogen acceptable to the public. Communication will be crucial for the outcome.

Considerable and unique progress was made at political level in Europe through the acceptance of exemption and clearance by the European Parliament. This compromise edited in guidance for the BSS implementation has left the application and interpretation of radiological criteria and more particular of radon exposure scenarios to national authorities. Harmonization impact will have to be followed-up.

The attempt to level clearance and exemption levels as proposed by companies, consultants and as defended by the Dutch regulators seems to contain a hidden agenda:

- Differences in NORM-quantities used for risk assessment.
- The not taking into account of Rn scenarios for housing on NORM-waste.

Up to now the public opinion, the unions and the media have shown poor interest for the subject. NORM is no strategic issue for NGO's as Greenpeace,

while unions confronted with the paradigm change in society were not able to give expert priority to new long-term risk challenges.
It was most striking during this symposium that those actors and their expert institutions were not able to participate in such debate while invited by the organizers as relevant concerned stakeholders.
No opinion was expressed on future exposure of numerous workers, the public and the environment by those actors. A poor coverage by media of the NORM-problem also reflects this phenomenon. It creates some uncertainties on the outcome of the regulatory approach in future, since cheap and easy accessible detection capacity is available to illustrate in due time NORM-releases to the public domain.
In a problem of such extent as NORM a lack of awareness of relevant actors should be corrected by adapted information campaigns in order to anticipate later policy complications.
The sustainability of NORM-practices and policies was not discussed during this conference, contrasting with other conferences the same period in Europe, where public involvement (22) and sustainability (23) of nuclear waste management came on the foreground.

5. CONCLUSIONS

The reflections have shown that radiation protection for NORM is a very complex and challenging matter as well from technical point as from societal, institutional and communication point of view.

The set-up of a general harmonized approach, with the involvement of operators, regulators, labour organizations, NGO's and the public is without any doubt the only feasible one to gain acceptability in the long run.

The technical aspects related to NORM-waste management are most challenging, needing the establishment of a classification system, the set-up of acceptance and characterization criteria as well as the development of a general disposal concept.

For addressing the societal discussion on NORM-issues the sustainability concept is an appropriate tool.

The general principles of law of due care and precaution can urge decision makers to a more common approach.

Great attention has to be given to active communication with and information of the workers and the public. It was striking that those actors and/or their expert institutions haven't participated in NORM-III. This lack of awareness should be corrected by adapted information campaigns in order to anticipate later policy complications.

All members of the working group experienced the discussions made in preparing the present manuscript as extremely useful and necessary. They all recommend firmly to include transdisciplinary considerations in future meetings or discussions about NORM.

6. REFERENCES

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