

Risk communication regarding NORM in building materials (May 2017)

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Abstract—This paper investigates the communication regarding NORM materials in construction. Currently there are no guidelines implemented regarding the communication about the radioactivity of these materials. The communication regarding this topic is done by three groups, governmental agencies, manufacturers of the products and non-governmental organisations. The emphasis of the communication varies wildly between these groups.

Index Terms—naturally occurring radioactive materials, risk communication, regulations.

I. INTRODUCTION

THIS THESIS is an investigation into the risk communication regarding Naturally Occurring Radioactive Materials (NORM) in buildings. Naturally Occurring Radioactive Materials are found in many industries. These materials are present in the earth's crust in low concentrations. However, due to human mining operations, these materials are brought to the surface. After the wanted product is extracted from the raw material, the leftover minerals have a higher than background radioactivity. Therefore, they present challenges for disposal. Other sources of Naturally Occurring Radioactive Materials may include the natural leakage of Radon gas through the soil of dissolution in ground water.

The use of construction materials that reuse these leftover minerals with enhanced concentrations of NORM is currently researched in the COST project "NORM4Building". These by-products such as fly ash, slags from metal production, and phosphogypsum are used among others in cements, gypsum, and ceramics. This is an efficient way to dispose and reuse these leftover minerals [1]. For example, recycled plaster reuses phosphates from the fertilizer industry and fly ashes

from coal burning applications. And is therefore more radioactive than natural gypsum.

The communication of the radiological risks related to building materials (or lack thereof) is challenging. Misinformation may cause an undue reaction. Clear and concise information may improve the awareness among consumers and support informed decision making by consumers whether to use these material or not.

Although the Basic Safety Standard [2] provided by the European Union dedicate a high attention to NORM, there is a gap related to how the radiological risks should be communicated to consumers. Communication about NORM is a responsibility of a member state, for Belgium, similarly to other countries, communication aspects of NORM for buildings is not implemented. Afterwards we explore how the radiological risks have been communicated to consumers by the authorities and industry and non-governmental organisations.

A. Risk communication

Risk Communication related to NORM used in a building material should support better informed decision-making about ionizing radiation risks by consumers. There is a great role of risk perception since is human behaviour primarily driven by perception and not by facts [3]. The main challenge in communication is that experts and the public frequently disagree when it comes to risk assessment [4]. The table below presents differences is risk perception of Belgian population related to different radiological risks. The results presented in the table below indicate that the general population has a higher risk perception of natural radioactivity than experts.

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TABLE 1

Differences in radiological risk perception between in the general population and the experts [5]

Risk perceptions	Population group	N*	Mean	Std. Deviation	Std. Error Mean	t (df=1238)	Sig. (2-tailed) $\alpha = .05$
Nuclear waste	General population	921	3,11	1,13	,038	19,32	0.00
	Experts	319	1,74	0,93	0,05		
Accident in a nuclear installation	General population	921	2,95	1,18	,039	12,45	0.00
	Experts	319	2,00	1,12	0,06		
Natural radiation	General population	921	2,54	1,02	0,03	4,06	0.00
	Experts	319	2,27	1,03	0,06		
Medical X-rays	General population	921	2,60	1,04	0,03	-3,65	0.00
	Experts	319	2,83	0,97	0,05		
The Fukushima accident	General population	921	3,30	1,21	0,04	13,50	0.00
	Experts	319	2,29	0,99	0,06		

*All respondents except those with “don’t know” answer to one or more items.

II. METHOD

The communication regarding NORM in building materials can be split in three major groups. The governmental agencies that communicate as a service to the public educating about the different kinds of radiation. Producers of products that contain NORM communicate whether their product is safe for use. Lastly non-governmental organisations (NGO) that protect and defend the interests of their backers.

A. Governmental agencies

Governments can sensitize the populace and use legislation to make a framework around the communication of NORM in buildings. We used the websites of their respective agencies. This method was chosen for its availability. The data can be found on the websites of the agencies and are a common form of communication between the government and the populace regarding information on nuclear and radioactive topics. We will investigate the European law, the Belgian Federal Agency for Nuclear Control (FANC) and that of a neighbouring country, the Netherlands. Both the European and Belgian governments are chosen due to the geographical location of the investigation. The Dutch governmental agency was chosen for its closeness to Belgium and ease of use due to language.

B. Industry

The building material selected for the research on communication have a known presence of NORM. Of these selected building materials promotional brochures, technical

and safety data sheets where collected and their contentthe and layout analysed.

This method was chosen for its availability. The data can be found on the websites of the manufacturer and are a common form of communication between manufacturer and consumer. Gypsum was chosen due to its application in both natural and recycled state. The recycled gypsum has a higher concentration of NORM compared to the natural gypsum. To select manufacturers, the sites of three hardware stores where used to choose the most popular brands. These internet sites are easy to access and give a fast overview of the products.

C. Non-governmental organisations

There are many non-governmental organisations that inform people on the risks associated with radiation. Therefore, an investigation regarding their communication is warranted. Three types of NGO’s where selected. Alles over kanker is a cancer awareness organisation, World nuclear association a nuclear organisation and Test-aankoop, the Belgian consumers association. These organisations where selected on availability and content. The investigation into an environmental organisation did not deliver any results regarding the use of NORM in building materials.

III. MATERIALS

Of all investigated parties, electronic literature was investigated. This was due to availability and ease of use to search for certain terms in the documents.

A. Governmental agencies

We will use the websites of the nuclear authorities in Belgium and the Netherlands. For Belgium this organisation is Federaal Agentschap Nucleaire Controle, also known as FANC. In the Netherlands the Autoriteit Nucleaire Veiligheid en Stralingsbescherming, the ANVS regulates all things nuclear. Regarding the European government we will use the Basic Safety Standard recorded in council directive 2013/59/Euratom. It provides a framework for all communication regarding exposure to radiation. The following questions will be asked: what information is given about NORM? Is this information expanded regarding building materials? Are the legal thresholds regarding NORM explained? How scientific is the explanation? Is the information easily accessible?

B. Producers

Gypsum was chosen due to its application in both natural and recycled state. The recycled gypsum has a higher concentration of NORM compared to the natural gypsum. To select manufacturers, the sites of three hardware stores were used to choose the most popular brands. These sites are easy to access and give a fast overview of the products.

We have selected gypsum from Gyproc and Knauf for this. The sites of three major hardware stores were examined, Brico, Gamma and Hubo. Brico carries 4 Knauf products.[6] Gamma carries 2 Gyproc products and 13 Knauf products.[7] Hubo carries 2 Gyproc products and 17 Knauf products.[8] Gyproc is a Saint Gobain group brand. It uses natural plaster from the Parisian basin to make its products.[9] Gyproc plaster is used to finish walls, fill cracks and to join gypsum plates. Knauf is a manufacturer of gypsum and insulation materials.[10] The gypsum is made from both REA and phosphogypsum. REA gypsum is attained from the desulphurization of fly ash and smoke from thermal power plants. Phosphogypsum is a by-product of the phosphate industry.[10] The following questions will be asked when reading the brochures: how is radioactivity mentioned? How are NORM materials mentioned? What kind of imagery is used? What impression does it give? Are ecological terms used? Which colour is dominant? What labels are used?

C. Non-governmental organisations

Alles over kanker is an initiative of kom op tegen kanker and has as purpose to inform people of the causes and treatments of cancer. The world nuclear association is a non-profit organisation that supports the nuclear industry. They promote awareness and understanding regarding nuclear energy. Test-aankoop protects the interests of consumers in Belgium. They however do not have any information available regarding NORM or radioactivity in building materials. The following questions will be asked: what information is given about NORM? Is this information expanded regarding building materials? Are the legal thresholds regarding NORM explained? How scientific is the explanation? Is the information easily accessible? What impression is given?

A. Governmental agencies

Europe

Council directive 2013/59/Euratom

Article 75 mandates that radiological information is provided if requested. The article dictates the limit regarding the gamma radiation from building materials. It enforces a total external exposure limit to gamma radiation of 1 mSv for indoor exposure from building materials and outdoor exposure from other sources. The Member State shall identify building materials that are of concern, taking into account the indicative list of materials with regard to the emitted gamma radiation, that the activity concentrations of the radionuclides specified are determined and that this information is provided if requested. The types of building materials that are in accordance with this and that are liable to give doses exceeding the reference level, should be dealt with using appropriate measures such as building codes or restrictions regarding the use of such materials.

In addition, the Article 74 focuses related to NORM mainly on indoor exposure to radon. It asks the Member States to establish national reference levels for the indoor radon concentrations. The level for the annual activity concentration is 300 Bq/m³. Furthermore the States shall promote action to identify dwellings that exceed the reference level and encourage the appropriate radon concentration-reducing measures. Lastly Member States must ensure that both local and national information is available regarding the risks associated with indoor radon exposure, the importance of performing measurements and on the technical solutions available for reducing existing radon concentrations

Belgium

The website of the Federaal Agentschap Nucleaire Controle has a web page dedicated to NORM. There is no specific information regarding NORM in building materials. For other NORM however extensive information is provided. It explains the main sources of this radiation are the decay chains of uranium and thorium in addition to K-40 and shows a map of Belgium showing the exposure rate in nGy/h. Furthermore it explains the difference between NORM and TENORM. With NORM being Naturally Occurring Radioactive Materials and TENORM being Technically Enhanced Naturally Occurring Radioactive Materials. It explains that in certain cases a health risk can occur and therefore appropriate measures are taken. It lists the main industries of NORM, on which the building industry is not mentioned. It mentions the two ways of exposure, the external exposure due to gamma radiation and internal exposure due to fine dust and radon. The emphasis is on radon exposure. [11]

For building materials, no information is given. This is because the issue regarding building materials is not explicitly addressed in current Belgian NORM regulations. Current studies on the natural radioactivity of building materials used in Belgium do not identify any building material of concern. Current phosphogypsum is low enough in activity to not require restriction. [12]

Netherlands

The website of Autoriteit Nucleaire Veiligheid en Stralingsbescherming contains basic information regarding the possible sources of natural radiation. It explains that building materials extracted from the earth have a natural radioactivity. And that radon exposure due to these materials can be lowered by ventilating the living area. [13]

NORM is mentioned in the web page regarding radioactive waste. It explains that due to industrial processes the activity of certain ores can be concentrated, and that this makes it a low radioactive waste. [14]

The current legislation exempts building materials from regulations. This will be changed soon to comply with the new Basic Safety Standard. The Netherlands is using cement containing materials that are included on the list of NORM materials since the 1930's. However the average indoor dose due to gamma radiation is estimated to be 0,3mSv per year, which is under the threshold in the new Basic Safety Standard. [15]

TABLE II
overview of communication from government agencies

Governmental agencies	European commission	Federaal agentschap nucleaire controle	Autoriteit Nucleaire Veiligheid en Stralingsbescherming
Mentions NORM	Y	Y	Y
Mentions radioactivity	Y	Y	Y
Mentions eco	N	N	N
Legal thresholds	Y	Y	N
Easy to understand	N	Y	Y
Accessible	Y	Y	Y

B. Industry

GYPROC

Infinito e-brochure[16]

This brochure explains the engagement Gyproc has made regarding the environment. Radioactivity is not mentioned in the brochure. The use of NORM is not communicated to the consumer. The imagery in the brochure is mostly modern infrastructure. It gives an impression of professionalism, environmental engagement and safety. The colour blue is most used throughout the folder. Blue represents trust, dependability and strength.

Product information Expresspleister[17]

This sheet gives guidelines regarding the use of Gyproc plaster. Radioactivity level is not given in the brochure. NORM is not mentioned on the data sheet. There is an image of the product included on the data sheet. The impression given is a professional, clear communication of important characteristics. The colour grey is most used throughout the folder. Grey is commonly used to indicate balance and calmness.

Label IBR[18]

This certificate of approval is awarded by the Institut für Baubiologie Rosenheim. It indicates that the product is tested. The institute checks gypsum on the following properties: radioactivity, radon, biocidal effect, heavy metals, fine dusts, electrostatic behaviour, and environmental pollution. The limit for radioactivity is the same as used in the Basic Safety Standard. The document describing the guidelines for the seal of approval links the natural radioactivity with nuclear power, Chernobyl and atomic bombs. *“In the discussion about the risks of nuclear energy, the public’s interest focuses almost exclusively on the population’s radiation exposure caused by nuclear plants.”*[19] *“Artificial radioactivity from Chernobyl or from the above-ground atomic bomb tests carried out in the 1960s could not be identified in the examined samples.”*[19] The colour of the institute is green, green gives a peaceful, healthy impression.

KNAUF

Ecogypsum inside brochure[20]

This brochure highlights the low environmental impact of the Knauf production process. The main goal is to convince the user of the ecological engagement of the manufacturer. Radioactivity is not mentioned in the brochure. The use of NORM materials is not communicated to the consumer. The imagery in the brochure is divisible in three categories: imagery of plants, imagery of a modern factory, and lifestyle. It gives an impression of environmental friendliness, increased living standards, and safety. The colour green is most used throughout the folder. Green represents peaceful, health and growth. The folder mentions all Knauf products are ATG certified.

Safety guidelines Knauf gypsum[21]

This datasheet encompasses all guidelines regarding the safe use of Knauf gypsum products. It informs the consumer of the precautions and first aid measures that should be taken. Radioactivity is not mentioned in the brochure. The use of NORM materials is not communicated to the consumer. The data sheet uses a hazard symbol to inform the user of the severe eye irritation the product can bring. The data sheet gives a complete and professional impression. No colours are used to give an impression.

TABLE III
overview of communication from the industry

Producers	Knauf	Gyproc
Mentions NORM	N	N
Mentions radioactivity	N	Y
Mentions eco	Y	Y
Legal thresholds	N	N
Easy to understand	Y	Y
Accessible	Y	Y
Healthy impression	Y	Y

C. Non-governmental agencies

Alles over kanker

Alles over kanker has a web page dedicated to inform people with everything in connection with radiation. They have a small paragraph explaining that many building materials contain radioactivity, and that radon can cause lung cancer. They explain that these building materials can exhale radon gas which is a source of radiation. They give tips to combat this by well ventilating your home and refer to the site of FANC.[22]

World Nuclear Association

World Nuclear Association provides a paragraph explaining the radioactivity in building materials the prevalence of the most common NORM nuclides in these materials. It gives an explanation of the levels of radioactivity allowed, explaining the thresholds for certain sectors in building. "Activity concentration guidelines for the use of NORM residues in building construction have been developed using the ACI approach and material has been classified into three categories, depending on whether the dose is below 0.5 mSv/yr (unrestricted use), between 0.5 and 1 mSv/yr (use restricted to roads, bridges, dams or, with dilution, low occupancy buildings) or above 1 mSv/yr (prohibited use)."[23] Furthermore they give a comparison with granite. "Granite, widely used as a cladding on city buildings and also architecturally in homes, contains an average of 3 ppm (40 Bq/kg) uranium and 17 ppm (70 Bq/kg) thorium."[23] Furthermore it provides a table with many types of building materials and their ranges of activity. Using this table, consumers can get an idea of the activity of certain materials.

TABLE IV
overview of communication from non-governmental organisations

Producers	Alles over kanker	World Nuclear Association	Test-aankoop
Mentions NORM	N	Y	N
Mentions radioactivity	Y	Y	N
Legal thresholds	N	Y	N
Easy to understand	Y	Y	N
Accessible	Y	Y	N

V. DISCUSSION

In this research many forms of communication where seen. In general, results show that radioactivity in building material is not communicated to the consumers. The information is rather omitted or accessibility is limited for consumers. Although the legal framework indicates that information should be delivered when requested, The communication regarding risk is different nowadays. Societies request an open and

transparent communication in order to empower consumer's decision making on whether or not using NORM in buildings.

In particular, results show that the emphasis of communication is different for each type of group. Governmental agencies want to inform within the legal framework, while producers want to show their product is safe for everyone. Non-governmental organisations have different motivations which depend on what type or organisation they are. As alles over kanker informs about cancer risk while World Nuclear Association informs about the legal limit and its safety.

It is important that the communication with consumers is clear, however the information given has to be understandable, as to not overwhelm them with it. A balance must be found.

Differences between consumers, industry, non-governmental organisations and authorities in their motivation, values, goals, level of knowledge, interests, their perceptions, beliefs are often taken as an excuse for avoiding communicating about NORM used in buildings. Also arguments over the objectivity, validity, and relevance of scientific findings are common in debates related to possible health effects of radiation, especially related to scientific uncertainty and effects of low doses. These differences should be seen as a drawing factor for intense communication and not as caveats. The clear communication should lead to informed consumers and empower consumers to make decisions related to NORM used for buildings.

VI. CONCLUSION

We can conclude that the communication regarding NORM in building materials is lacking. This has as an effect that the awareness about radioactivity in these materials is low. Research shows that communication about radioactivity in building materials is rather as a form of technical communication and education whereby the public is informed about radiological risk estimates. Furthermore risk communication regarding radiation is rather seen as a marketing practice that aims to persuade people that NORM in building materials are safe. There are discrepancies between the recommended practices and the actual practices regarding communication .

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REFERENCES

- [1] W. Schroeyers and A. Janssens, "How can NORM4BUILDINGS support the management of NORM residues?."
- [2] E. council, "council directive 2013/59/Euroatom," 2014.
- [3] O. Renn, *Risk Governance; Coping with Uncertainty in a Complex World* (Earthscan Risk in Society Series). London: Earthscan, 2008.
- [4] T. Perko, B. Adam, and K. R. Stassen, "The differences in perception of radiological risks: lay people versus new and experienced employees in the nuclear sector," *Journal of Risk Research*, vol. 18, no. 1 pp. 40-54, 2015.
- [5] T. Perko, "Radiation risk perception: a discrepancy between the experts and the general population," 2013.
- [6] Brico. (2017, 5/5/2017). Available: https://www.brico.be/search?q=fh_location%3D%2F%2Fcatalog01%2Fnl_BE%2Fitem_type%3E%7Bproduct%7D%2F%24s%3Dpleister%2Fcategories%3C%7Bcatalog01_b1%7D
- [7] Gamma. (2017, 5/5/2017). Available: https://www.gamma.be/nl/assortiment/bouwmateriale/pleisterwerken/gips/c/bouwmaterialen_pleisterwerken_gips
- [8] Hubo. (2017, 5/5/2017). Available: <https://www.hubo.be/nl/a/bouwmaterialen/gipsplaten-pleisters/pleisters.html>
- [9] Gyproc. (2017, 5/5/2017). *Waarom gyproc pleister*. Available: <http://www.gyproc.be/gyproc-pleisters/producten/bouwpleisters/nl>
- [10] Knauf. (2017, 5/5/2017). *producten*. Available: <http://www.knauf.be/nl/producten>
- [11] FANC. (2017, 14/05). *NORM*. Available: <http://www.fanc.fgov.be/nl/page/%C2%AB-norm-%C2%BB-problematiek-naturally-occurring-radioactive-material/363.aspx>
- [12] S. B. Pepin, G. Dehandschutter, B. Sonck, M., "How will Belgium implement the european directive with regard to NORM?," *annalen van de Belgische Vereniging voor Stralingsbescherming*, vol. 41, no. 3, 2016.
- [13] ANVS. (2017, 14/05). *ioniserende straling: bronnen en effecten*. Available: <https://www.autoriteitnvs.nl/onderwerpen/straling/inhoud/ioniserende-straling-bronnen-en-effecten>
- [14] ANVS. (2017, 14/05). *Radioactief afval*. Available: <https://www.autoriteitnvs.nl/onderwerpen/radioactief-afval>
- [15] R. Wiegers, "How will the netherlands (try to) implement the new BSS in the NORM and building industry," *annalen van de Belgische Vereniging voor Stralingsbescherming*, vol. 41, no. 3, 2016.
- [16] Gyproc. (2017, 5/5/2017). *infinito*. Available: <http://www.gyproc.be/infinito/nl>
- [17] gyproc, "Product informatie blad express pleister "
- [18] gyproc, "Oorkonde IBR," 2015.
- [19] IBR, "Seal of approval guidelines," 2014.
- [20] Knauf, "ECOGypsum inside."
- [21] knauf, "Safety guidelines knauf gypsum."
- [22] A. o. kanker. (2017, 15/05). *radioactieve straling*. Available: <http://www.allesoverkanker.be/radioactieve-straling-ioniserende-straling>
- [23] W. n. association. (2017, 15/05/2017). *NORM*. Available: <http://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/naturally-occurring-radioactive-materials-norm.aspx>