European Cooperation in the field of Scientific and Technical Research - COST -

Brussels, 24 May 2013

COST 039/13

MEMORANDUM OF UNDERSTANDING

Subject : Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action TU1301: NORM for Building materials (NORM4BUILDING)

Delegations will find attached the Memorandum of Understanding for COST Action TU1301 as approved by the COST Committee of Senior Officials (CSO) at its 187th meeting on 15-16 May 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action TU1301
NORM FOR BUILDING MATERIALS (NORM4BUILDING)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to exchange multidisciplinary knowledge and experiences to stimulate the reuse of NORM residues in new tailor-made sustainable building materials while considering exposure to external gamma radiation and the resulting indoor air quality.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 80 million in 2013 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter IV of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

The depletion of energy resources and raw materials has a huge impact on the building market. In the development of new synthetic building materials the reuse of various (waste) residue streams becomes a necessity. This COST initiative stimulates the collaboration of scientists, industries and regulators to gather knowledge, experiences and technologies, to stimulate research on the reuse of residues containing enhanced concentrations of natural radionuclides, originating from NORM (naturally occurring radioactive materials) processing industries, in tailor-made building materials in the construction sector while considering the impact on both external gamma exposure of building occupants and indoor air quality. By improving radiological impact assessment models for the reuse of NORM residues in building materials the Action aims to further stimulate justified uses of NORM residues in different types of newly developed building materials. Based on these models, the Action aims at investigating realistic legislative scenarios so that the authorities concerned can allow reuse pathways for NORM that can be accepted from a radioprotection point of view in concordance with the Lead Marked Initiative (LMI) and sustainable construction.
Keywords: Validation of NORM residues, tailor-made sustainable building materials, indoor air quality, radiological impact assessment, radiation protection

B. BACKGROUND

B.1 General background

The depletion of energy resources and raw materials demands introduction of sustainability in construction sector and construction material production. In the development of new synthetic building materials the reuse of (waste) residue streams becomes a necessity. A specific class of residues, for which the use in building materials offers interesting reuse options, originate from NORM (naturally occurring radioactive materials) processing industries.

NORM residues, such as fly ash produced in large quantities from coal burning, slags from steelworks and metal recycling industries, phosphogypsum of the phosphate industry and red mud of the aluminium processing industry, are investigated for application in building materials. Using NORM residues in the production of new types of synthetic building materials for buildings raises concerns among authorities, public and scientists on the potential gamma exposure from building materials to occupants and on indoor air quality. Many NORM residues currently end up at landfills since so far no acceptable compromise is found between economical reuse options and health related legislation.

In the last decades many countries have developed methods to evaluate and classify building materials on the basis of their natural radionuclide content. It is shown by international studies of the WHO and ICRP that building materials might have a non-negligible share of radiation exposure of the public. In the European Union guideline Radiation Protection 112 (RP 112) an index of activity concentration was introduced as a tool to identify materials that need supplementary investigations. The draft of the new European Basic Safety Standards Directive (EU-BSS), released in September 2011, specifically addresses the topic of NORM in building materials. However, as these documents give basic and general directions, energy saving demands and new technologies for usage of NORM residues in construction sector may not be followed by critical legislation for indoor air radiation levels and health protection of the general public.

The developers of new building materials have to meet expected quality and performance criteria and answer legitimate legislative concerns regarding the impact of these innovations on gamma exposure of building occupants and the indoor air-quality in buildings. Introduction of the new EU-BSS introduces changes in the legislative requirements that the developers of new building materials have to meet. Large amounts of NORM residues with suitable properties are available from current or historical waste deposits and there is a lack of other options for the reuse of these residues. Therefore comprehensive investigations for the continuation and future of this practice are important. From industry there are many comments and questions on the EU-BSS and the options of recycling of NORM residues in building materials. There is especially a need for more practical/technical support and reliable research data on this topic.

This COST Action enables the collaboration of scientists to stimulate research on the responsible reuse of NORM residues in the construction sector as building materials. This Action mainly focuses on potential radiological issues related to the use of NORM residues in building materials with special attention to the impact on both external gamma radiation of building materials to occupants and indoor air quality. However this Action also takes into account existing knowledge on the chemical and physical properties of these building materials, containing toxic agents and nano particles, in order to make realistic recommendations on the potential application. The Action aims at combining research to support the construction and NORM processing industries, reference institutes, authorities and the public regarding the implementation of the ANNEX V of the new EU-

BSS draft and in this way stimulate harmonization of practices. This Action will support the development of standards and measurement protocols for the determination of indicators for the radiological impact of NORM containing building materials.

By providing more realistic radiological impact assessment models the Action aims to further stimulate the use of NORM residues in different types of newly developed building materials. Based on the models the Action aims at investigating realistic legislative scenarios so that the competent authorities can allow reuse pathways for NORM while assuring the protection of the population.

B.2 Current state of knowledge

Existing residues streams being reused or studied for reuse are (in parenthesis the codification according to the European Waste Catalogue): coal fly-ash (001 02 or 10 01 16), slag and bottom ash from a coal-fired power plant (10 01 01 or 10 01 14), phosphorous slag from thermal phosphorus production (06 09 02), phosphogypsum from phosphoric acid production, red-mud, also known as bauxite residue, from alumina production (01 03 07), unprocessed slag from primary iron production (10 02 02) as well as steel or stainless steel, lead slags (10 04 01), copper slags (10 06 01) and tin slags, from primary and secondary production. Specific residues originating from pyro- and hydro-metallurgies producing platinum group metals or rare earth elements (REE) can also have, or become tailored to have, interesting properties for use in construction materials. Attention has already been given [RP112] for a few of these secondary resources however, both a specific and wider focus is imperative.

(I) In the **cement** industry NORM residues are used or studied for use as alternative raw materials and supplementary cementitious materials. An additional path for residues with calorific value is their introduction as alternative fuels where the remaining ash is typically incorporated in the cement clinker. It is therefore clear that the cement currently produced is already a complex material, originating from a number of different materials streams. This function of cement kilns is widely acknowledged in Europe [Guidelines on Co-processing Waste Materials in Cement Production, 2006] and abroad [Hasanbeigi et al, 2012].

Still, cement production has its own environmental footprint. Estimations suggest that cement production is responsible for 5% to 7% of the worldwide CO_2 emission. [WBCSD and IEA, 2009]

[Damtoft et al, 2010] This is predominantly the result of the fuels used to generate the required energy, estimated at 0.37kg/kg clinker, and of the decarbonation of limestone ($CaCO_3$) which takes place during cement production, estimated at 0.53kg/kg clinker CO_2. The additions of alternative raw materials with low embodied CO_2 as well as of supplementary cementitious materials (SCM) are two of the main actions reducing the CO_2/mass of cement. In terms of clinker additions, blast furnace slag, fly ash (coal ash), gypsum by-product, bauxite residue (red mud), steel slag, non-ferrous slag, coal tailings, dirt, sludge a.o. can be used. The list of alternative fuels is much more exhaustive. Examples include meat, bone meal and animal fat, tires, plastics, paper/cardboard/wood, impregnated saw dust, coal slurries/distillation residues, sludge (paper fibre, sewage), fine/anodes/chemical cokes, waste oil and oiled water, solvents and many more, including hazardous liquid fuels. Interestingly, there is no legislative framework on what can be added and it is typically availability and cost that dictate the industrial practice. On the other hand, SCMs are specifically stipulated in the EN 197-1:2000 which specifies the 27 cements in Europe. Fly ash, blast furnace slag and silica fume are some of the residues used. As a conclusion, the cement clinker is an end-product incorporating a number of residues and, unavoidably, has an enhanced concentration of radioactive elements.

(II) In the **concrete** industry, the residues are used or studied for use as SCMs (as partial cement replacement or as mineral additions in concrete) and as aggregates. The utilization of SCMs in higher volumes in concrete has not only been widely investigated but also practiced in Europe with the aim to improve workability, to increase strength and to enhance durability through an optimised packing of particles of different sizes and/or hydraulic or pozzolanic activity. [Siddique et al 2011] Among them, fly ash, silica fume and blast furnace slag are the most-commonly used residues that have established their credentials in several concrete applications in terms of physical, mechanical and durability performance as well as engineering properties. Unfortunately, the radiological point of view has not received attention.

So far, dedicated research performed in this field clearly showed that concrete strength and durability can be increased significantly not necessarily through excessive cement contents, but through the incorporation of SCMs. [Lothenbach et al 2011] Thanks to the development of effective viscosity modifying agents and superplasticizers or high-range water reducing admixtures, the amount of mineral additions that are incorporated in concrete at low water to cement ratios has increased significantly. [Khayat et al 1998] This has opened new opportunities and fields of application such as self-consolidating concrete (SCC), high strength concrete (HSC) and high performance concrete (HPC). These new materials contain high volumes of fly ash, silica fume and blast furnace slag that particularly develop improved concrete microstructure due to their fineness and pozzolanic reactivity. The European powder type SCC incorporates a total powder (cement and SCM) content of about 550–650 kg/m^3, which can contain SCM as much as cement, and mostly utilizes wastes of fly and silica fu (among limestone and quartzite powder). Moreover, high volume utilization of fly ash applies for structural fills in embankments, dams, dikes and levees, and for sub-base and base courses in road way construction. Silica fume has been diversely used in concrete applications and performs fairly well due to its high strength and low shrinkage. This residue is effectively and extensively used in the production of ultra HPC for highway bridges, parking decks, marine structures and bridge deck overlays which are subjected to constant deterioration caused by rebar corrosion current, abrasion, chemical attack (de-icing salts, seawater) and freeze/thaw cycles. Other applications are high strength concrete containing silica fume (which is often used in precast and prestressed girders allowing longer spans in structural bridge designs), silica-fume shotcrete (sprayed concrete for use in rock stabilization, mine tunnel linings and rehabilitation of deteriorating bridge and marine columns and piles), oil well grouting (for leak repairs, splits, closing of depleted zones) and repair applications of cementitious products. Blast furnace slag is commonly used in HPC and especially in blended cements in proportions of more than 50% of the cement due to its favourable impacts on concrete durability. [Siddique et al, 2011] In Europe, there is a substantial amount of residues being currently used in several concrete applications and civil engineering works . This offers not only improved material performances and engineering properties, but also great environmental gains by saving the natural resources and lowering the CO_2 footprint per ton of concrete produced. Nevertheless, this brings also along some major health concerns which have only been considered on the basis of their potential environmental impacts (hazardous elements and their leaching behaviour) but not on the basis of their natural radionuclide contents.

(III) The **ceramic industry** has been for years one of the major recipient for a plethora of residues. In particular, clay-based ceramics, such as whitewares and structural clay products (bricks, tiles etc), can accommodate various wastes either as inert or as reactive components. This relates to the vitreous bonding and the particular microstructure, often encompassing large aggregates, such as quartz or alumina. One of the great benefits of the vitreous type of bonding is that it can be derived from a number of high-volume waste products or can be used to bond a range of waste aggregate materials. [Lee et al, 2007] Much research over the past decades has examined using waste materials in clay-based ceramics either as aggregate (such as slags from various types of metal smelting or waste concrete from building demolition) or in the bond system (such as pulverised fuel ash (PFA), calcined municipal sewage sludge (MSS), quarry mud and red mud from the Bayer process and boron-containing wastes from borax mining, for example). [Pontikes et al, 2009] In some clay-based ceramics, such as brick, oil-contaminated wastes from the petrochemical industry may be added to the mix in place of water to increase fluidity and to provide internal fuel on firing. Many of these wastes may contain hazardous materials (heavy metals, dioxins) which are immobilized in a vitreous bond yielding a further benefit. Recycled selective laser sintering (SLS) glass has been examined as a partial replacement for alkali feldspar mineral fluxes in a range of clay-based ceramics, including wall and floor tile, porcelains and porcelain stonewares. [Pontikes et al, 2005] As a result, considerable expertise has been accumulated on the process of transformation of wastes into useful ceramic products. In practice, controlled additions are introduced to ensure the correct stoichiometry, phase formation and properties, whereas it is often the case that combinations of wastes are employed to form the desirable ceramics and composites. Still, as is the case of cement as well, little attention has been given to the radiological content of these materials and/or of the final products. The final materials are mostly seen from a functional viewpoint, where certain physico-thermo-mechanical properties are often required, without integrating the radiological considerations.

(IV) An emerging field in the building industry is the development of **Alkali-Activated Materials** (AAMs). AAMs is the broadest classification, encompassing also materials known as inorganic polymers and geopolymers. These AAMs binder systems derive by the reaction of an alkali metal source (solid or dissolved) with a solid silicate powder. This solid can be a calcium silicate or a more aluminosilicate-rich precursor such as a metallurgical slag, natural pozzolan, fly ash or bottom ash. The alkali sources used can include alkali hydroxides, silicates, carbonates, sulfates, aluminates or oxides – essentially any soluble substance which can supply alkali metal cations, raise the pH of the reaction mixture and accelerate the dissolution of the solid precursor. [Shi et al, 2006] These materials are being considered very promising for replacing traditional structural materials (based on cement) and offer a possible solution to the immobilisation of toxic and radioactive wastes as well as the treatment of industrial residues. [Comrie et al, 1988] Indeed, it is most often the case that industrial residues are used as raw materials. [Shi et al, 2006] Research on the synthesis of geopolymers has been greatly accelerated that past years; some examples from vitreous blast furnace slags, fly ashes and other by-products are cited herein. [Shi et al, 2011] The target is to design typically castable mixtures, either monoliths of flowable “concrete” and products are already available in the market. In comparison to ordinary Portland cement, geopolymer concrete has better resistance to corrosion [Miranda, et al, 2005] and fire (up to approx. 1300°C) [Davidovits et al, 1991], high compressive and tensile strengths, a rapid strength gain, lower shrinkage [Sofi et al, 2007]and longer durability. [Bakharev et al, 2005] Moreover, the carbon footprint of geopolymer concrete is significantly lower than that of similar products from Portland cement. [Duxson et al, 2007] As a result, the use of geopolymer concrete has a large greenhouse gas reduction potential in comparison to Portland cement.

Several exposure pathways must be investigated to assess the impact of natural radionuclides in buildings on residents. In addition to direct gamma radiation an important pathway of radiation exposure comes from radon, originating from building materials or the soil. Results of different epidemiological studies indicate that there exists a linear dose-effect relationship with no threshold (LNT hypothesis) between exposure due to radon and lung cancer. It is shown by international studies, of the WHO [WHO, 2009] and ICRP [ICRP, 2007], that building materials have a non-negligible share of radiation exposure of the public due to radon.

During the last few decades, the interest in the radiological and health related impact of building material aroused and stimulated the research activities. Initial investigations were focused on developing computational methodologies: room models [Markkanen, 1995]. In a later stage based on *in situ* techniques [Nuccetelli et al, 2001; Bochicchio et al, 2004], the evaluation and prediction of the indoor gamma dose rate and the radon and thoron indoor concentration on the basis of the radioactivity content and other characteristics of building materials was performed. The comparison of several room models had shown their substantial equivalence [Risica et al, 2001]. In the last 10 years a database of activity concentration measurements of natural radionuclides (^{226}Ra, ^{232}Th and ^{40}K) in building material was established. It regards, about 10,000 samples of materials used in the construction industry in 26 of 27 European Member States [Trevisi et al, 2012]. Part of bulk materials (bricks, concrete, cement, natural- and phosphogypsum, sedimentary bulk stones and tuff) and superficial materials (plutonic, volcanic and metamorphic stones**)** considered contain residues of NORM industry (coal fired power plants, aluminum production from bauxite, phosphoric acid and phosphate industry, steelworks and metal recycling industries, etc.).

Current European recommendation concerning natural radioactivity in building materials is based on RP 112. RP 112 uses a model for building materials including the effects related to the presence of all natural radionuclides from radium and thorium series and potassium forty. In the model secular equilibrium among all radionuclides constituting decay series is assumed. This assumption is more or less valid in case of construction material of natural origin. However when NORMs are considered quite opposite assumption should be made. Lack of equilibrium impacts the model of risk scenario and implies application of more accurate measurement methods.

B.3 Reasons for the Action

The depletion of energy resources and raw materials leads to the search for alternative pathways to gain valuable materials. Waste to materials research is a challenging topic which needs to involve experts on all (chemical, physical, ecological, economical and radiological) aspects of materials. One important aspect, that is the focus of this Action, is that future building development needs to limit the gamma exposure of building materials to occupants and to meet air quality requirements taking into account radiological and chemical noxes.

This COST Action brings together the necessary variety of experts with different backgrounds in order to achieve efficient discussions towards optimal solutions and articulation of future challenges related to above mentioned problems. This Action will promote the exchange of knowledge and experiences between experts, each with a specific view of interest (radiological, economical, ecological,…) and stimulate future joint research on the reuse of NORM residues in new tailor-made sustainable building materials in the construction sector. This research will consider the impact of NORM containing building materials on both external gamma exposure to occupants and on indoor air quality.

A fast dissemination of the results to industry and regulators is pursued in the present economic climate. Indeed, factsheets delivered by this project will provide information for factories that produce NORM to reuse their rest stream to new feedstock's instead of waste. In addition, for factories that use NORM, it will give insight how to explore the best feedstock's for their application.

Furthermore, if the waste to material conversion encounters risks related to the gamma exposure and indoor air quality of its application to the building occupants, this Action will provide recommendations for optimization of the building material production processes.

The reuse of NORM residues can also decrease an environmental detriment related to its accumulation at landfills.

B.4 Complementarity with other research programmes

This COST Action stimulates the responsible reuse of NORM residues in building materials by combining research on alternative, new tailor-made building materials specifically developed to allow the incorporation of NORM residues.

The Action will be complementary to:
-EUREKA! 5415 NEWCOMAT ("New generation of constructive materials based on industrial waste in the concept of sustainable development."; 2010-2014), a project without radiological focus;
-FP 7 SUSCON ("SUStainable, innovative and energy-efficient CONcrete, based on the integration of all-waste materials"; 2012-2015), a project without focus on radiological aspects;
-FP 7 LEEMA (Low Embodied Energy Advanced (Novel) Insulation Materials and Insulating Masonry Components for Energy Efficient Buildings; 2012-2015) , a project without radiological focus;
-FP 7 EASEE (Envelope Approach to improve Sustainability and Energy efficiency in Existing multi-storey multi-owner residential buildings; 2012-2015) , a project without radiological focus;
-Joint Research Project IND57 MetroNORM ("Metrology for processing materials with high natural radioactivity"; 2013 – 2016) EMRP – European Metrology Research Programme). The MetroNORM project primarily focuses on the standardization of the radiological measurement protocol for NORM residues. Standardization issues regarding measurement procedures for NORM in building materials, that are part of the scientific program of this Action, will be dealt with in close collaboration to the MetroNORM project.

The Action has links to:
-STAR (Strategy for Allied Radioecology; 2011-2015), an EC-funded (FP7) Network of Excellence that assesses the impacts of radioactive substances on man and the environment and focuses on a long-term vision on radioecology research within Europe. Star does not deal with occupational exposure;
-International Radon Project (IRP) of WHO (launched in 2005) which collects and analyses information on radon risk, radon policies, radon mitigation and prevention as well as radon risk communication.

To our best knowledge, there is no other programme in the EU, or a comparable joint interdisciplinary action to cover the approach described in this Action.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The main objective of the COST Action is the exchange of multidisciplinary knowledge and experiences (radiological, technical, economical, legislative, ecological) to stimulate the reuse of NORM residues in new tailor-made sustainable building materials in the construction sector while considering exposure to external gamma radiation and the resulting indoor air quality.

C.2 Objectives

1. To deliver a practical evaluation of develop options for new tailor-made types of building materials to reuse NORM residues.
2. To develop a data base with best practices for reuse of NORM residues in building materials.
3. To evaluate and develop practical measurement protocols, if possible *in situ* measurement methods, to determine the indicators for the verification of the radiological impact of newly developed building materials containing NORM. A complementary secondary objective is to support standardization efforts of measurement protocols which is especially needed for *in situ* measurement methods.
4. To develop realistic radiological impact assessment models for the reuse of NORM residues in building materials.
5. To evaluate the concordance and applicability of current radioprotection legislations with usage of NORM residues in building materials and the related impact on both gamma radiation exposure and indoor air quality.
6. To disseminate this knowledge to construction and NORM processing industry, consumers, national governments as well as to international agencies such as WHO and IAEA.
7. To develop a practical guidance for industry to address questions and comments regarding the EU-BSS linked to the processing of NORM in building materials. This Action aims at providing answers, double checked with the European Commission.

C.3 How networking within the Action will yield the objectives?

An interdisciplinary team of scientist with top expertise's in radiological characterization of NORM and building materials, dose modelling, chemical and technical characterization and development of building materials, radiation protection and related economical and legislative aspects is being gathered. These experts have the right equipment and infrastructure (among others specific instruments for radiological characterization of NORM and building materials) to achieve the research goals set in this COST Action. Several companies and regulators have expressed interest to support the Action in the Advisory Board.

C.4 Potential impact of the Action

Next to the networking benefits, the knowledge and results that will be obtained in the course of the COST Action is expected to provide innovative ideas to validate NORM residues that currently end up at land fill disposals. Added value will be also reflected in reduction of costs related with NORM residues disposal and encouraging of technologies which enable NORM residues to be used as free building material. At the same time the protection of the population is assured since the COST Action will gather information on external gamma radiation exposure sources and the indoor air quality when using NORM residues in tailor-made building materials. In particular the COST Action will have the following benefits:

- The Action will develop and validate (*in situ*) measurement methods/protocols for the characterization of NORM containing building materials.
- The Action will aim at standardization and the development of standards for the (*in situ*) measurement methods/protocols.
- The Action will inform European researchers, legislators and industry about possibilities and the radiological impact of the reuse of NORM residues in building materials.
- The Action will contribute to the development of radiological impact assessment models for the reuse of NORM residues in specific types of building materials.
- The Action will provide feedback to industry to address questions and comments regarding the EU-BSS linked to the processing of NORM in building materials.
- The Action will provide feedback to legislators on the impact of different legislative radioprotection scenarios on the use of NORM residues in building materials.
- A further research-related benefit will be the creation of a training and exchange program for graduate students, postdoctoral fellow, and young researchers focused on using NORM residues in building materials and the related concerns towards exposure of occupants to external gamma exposure and the indoor air quality.

C.5 Target groups/end users

The results obtained from the COST Action will be targeted to NORM processing companies, the building material industry, local and national legislators, institutes of standardization, European Council of Engineers Chambers, relevant Working Groups of the European Commission and the IAEA, and the public.

Representatives from NORM processing companies and the building materials industry were consulted in the preparation of the Action. Discussion with and input from national legislators, representatives from the European Commission and the IAEA further contributed to the construction of this Action.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

This COST initiative encourages the collaboration of scientists, industries and regulators to gather knowledge, experiences and technologies, to stimulate research on the reuse of NORM residues in tailor-made building materials while considering the impact on gamma exposure of building occupants and the indoor air quality.

The program is divided into four Working Groups (WG) as follows:
WG 1: Studying the state of the art in the reuse of NORM residues in building materials and development of a data base with best practices for reuse of NORM residues;
WG 2: Developing new options for tailor-made building materials to incorporate NORM residues;
WG 3: Improving the measurement capacity to verify that existing and newly developed (WG 2) NORM containing building materials are in accordance to European legislative requirements. A secondary objective of WG 3 is supporting standardization efforts of measurement protocols and the development of standards;
WG 4: Improving radiological impact assessment models for the reuse of NORM residues in building materials. Investigating the influence of different legislative radioprotection scenarios on the use of NORM residues in building materials and the related impact on both gamma exposure and indoor air quality.

D.2 Scientific work plan methods and means

WG 1: Studying the state of the art in the reuse of NORM residues in building materials and development of a data base with best practices for reuse of NORM residues.

Sub-task 1.1: To set criteria for the evaluation of practices incorporating NORM in building materials and define relevant information to be incorporated in the database.

The realization of a European database will reinforce the technological and industrial impact of this Action allowing making a transparent evaluation of the potentialities of NORM residues for use in building materials. Main focus of the database is the potential application of NORM residues in building materials for buildings but alternative options (e.g. road construction) will also be considered if applicable.

Deliverables: A documented list of criteria for the evaluation of practices incorporating NORM in building materials.

Sub-task 1.2: Characterize NORM residues currently used and investigated for possible use in the synthesis of building materials. Compile the relevant databases per material, ensuring statistical accuracy. Group materials per process that generates them but also per application where they are employed.

Selection of NORM residue streams must be based on the compliance of the residues as building material additives. As an example, the building industry needs a continuous raw material supply with a rather well controlled (minor) fluctuation in chemistry and mineralogy. In this context, the selection of the residues streams will be based on the current state of art and only materials produced in high quantities will be considered.

WG 1 will start to list and discuss existing practices and practices that are still under research on the use of these residues in building materials. As a starting point, information is used from established industrial sectors, namely: (a) the cement industry, where the residues are used as alternative raw materials, alternative fuels and supplementary cementitious materials, (b) the concrete industry, where the residues are used as supplementary cementitious materials and as aggregates and (c) the ceramic industry, where the residues are used as alternative raw materials. Emerging practices as the use of NORM residues in geopolymers/inorganic polymers, where the residues are used as raw materials, are addressed in more detail by WG 2. Information in the database will be updated in close collaboration between WG 1 and 2.

Deliverables: Database where each residue stream is listed and sorted per process that generates it but also per application where they are employed. This database will be enriched over the years with measurements of residue streams, also per country, and a substantial wealth of data with statistical gravity will become available.

Sub-task 1.3: To investigate and use the newly obtained information regarding the activity concentration index to improve the existing EU activity concentration index database with particular attention to materials containing NORM residues.
Deliverables: Newly obtained information regarding the activity concentration index will be used to improve the existing EU activity concentration index database [Trevisi et al, 2012] in order to increase the total number of samples, with particular attention to materials containing NORM residues.

Sub-task 1.4: To obtain and investigate the information from representative national surveys in order to obtain a more significant EU view regarding the use of NORM in building materials.
Deliverables: Information of representative national surveys that will be added to the new database with best practices for reuse of NORM residues in building materials.

Sub-task 1.5: To perform a cost-benefit analysis and a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis on the practices considered in the database.
The new database will combine research information towards industrial practices incorporating NORM residues in building materials. For the considered practices a cost-benefit analysis and a SWOT analysis will be included if sufficient information is available.
Deliverables: Cost-benefit analysis and a SWOT analysis on practices considered in the database.

Sub-task 1.6: To provide input for the European Waste Catalogue.
Among individual waste already classified in European Waste Catalogue, EWC, more than 200 may be at least suspected as containing enhanced concentration of natural radionuclides [Michalik et al. 2011]. The information in the database will be used to provide input for the European Waste Catalogue. By supporting this initiative the acceptance level of this Action within the EU will increase.
Deliverables: Updated information for the European Waste Catalogue.

WG 2: Develop new options for tailor-made building materials to incorporate NORM residues.

Sub-task 2.1: Studying the developed options for building materials to incorporate residues investigated for possible use in the near future for (a) the cement, (b) the concrete and (c) the ceramic industry. Information in the database will be updated in close collaboration with WG 1. Deliverables: Updating the database with relevant information regarding new developed options.

Sub-task 2.2: Analyse the effect of higher substitution rates of virgin raw materials in terms of radiological content, for NORM residues currently used and possibly used in the future in the synthesis of building materials.

Considering a number of EU policy documents (as listed in the State-of-the-Art) promoting higher substitution rates of virgin raw materials, models need to be developed where the effect of this trend in terms of radiological content, per building materials, is analysed. This work is approached by a breakdown analysis per material, listing all material streams used in its synthesis. For example, in the case of cement clinker, higher alternative fuels will lead to an increased level of residual ash incorporated in the clinker. Similarly, use of non-ferrous slags may become more widespread in the future but this might have an adverse effect on the radiological content. To this extend, a holistic analysis is envisaged.

Deliverables: Analytical model per type/family of building materials where the % of virgin raw materials substituted is related to the radiological content.

Sub-task 2.3: Analyse the radiological content of emerging building materials, in particular geopolymers/inorganic polymers. Detect which materials are used and which can be used. Give recommendations on the raw materials used.

Geopolymers/inorganic polymers are very promising as they can be synthesized primarily by secondary resources. This fact, corroborated by life-cycle assessments (LCA analyses), has provided convincing data that these materials are more sustainable and “green”. Still, no information is available on how the selection of raw materials affects the radiological content and performance in a real-life scenario. This sub-task aims to address this and deliver insight also in these aspects.

Deliverables: List of possible raw materials to be used in the synthesis of geopolymers/inorganic polymers and recommendations on the raw materials used with respect their radiological content.

Sub-task 2.4: Develop and recommend methodologies and materials to reduce the radiological impact of building materials. In particular, techniques related to: (i) the pretreatment of the raw materials (for the separation of the radiologically enhanced fraction), (ii) the development and

application of the building material, (iii) the effect of its inherent and engineered properties by application of coatings, laminates or other treatment (density, X-ray shielding, radon barriers etc). It is often the case that a pre-treatment of a raw material may result to its beneficiation in terms of a specific chemistry or mineralogy. For example, particle size separation by sieving or other means may result to a fine fraction with particular characteristics, possibly lower/higher radiological content. These opportunities will be analysed in the first part of this sub-task. In the second part, the development of the materials as a research question is addressed. Existing models make assumptions based on data derived from concrete. However, surface materials (e.g. tiles) should be considered as such and their radiological effect should be quantified in a more realistic manner. Finally, in the last part, the inherent properties as well as the engineering properties, each building material bears, are taken into consideration. For example, many building materials are quite sophisticated and surface coatings could reduce gas (radon) permeability. Similarly, materials with controlled porosity (low density) are expected to become more widespread in the future in view of their enhanced heat (and sound) insulation capacity. In both cases, the effect of these properties needs to be understood and, in a reverse engineering approach, to be used to the benefit of producing safe building materials with NORM residues.
Deliverables: report on the effects of techniques related (i) to the pretreatment of the raw materials, (ii) the development and application of the building material, and (iii) the effect of the inherent and engineered properties of the building material, to the radiological content of building materials itself and the exposure a dweller experiences in a building.

WG 3: Objective is to improve the measurement capacity to verify that existing and newly developed (WG 2) NORM containing building materials are in accordance to European legislative requirements.

Subtask 3.1: Optimization and initiatives towards standardization of the determination protocol for indicators related to the external exposure to gamma radiation.
The scientific focus of task 3.1 lays on the investigation and application of industrially useful methodology/protocols for measurement of the activity concentration index (Annex VII of the EU-BSS) to assess the applicability of newly developed building materials for the European building market. Specifically to further aid industry in the search for cost-efficient measurement solutions the applicability of *in situ* measurement methodology will be investigated. An important aspect is the validation of the developed methods which is even more important in case of *in situ* measurements [Stals et al, 2011, Schroeyers et al, 2010].
Deliverable: Publications regarding optimized (*in situ* if possible) measurement protocols and the

validation of these protocols for the determination of the activity concentration index for NORM containing building materials.

Sub-task 3.2: Optimization and initiatives towards standardization of the determination protocol for indicators related to exposure to radon isotopes (Rn-222 and Rn-220) and radon progeny (PAEC - potential alpha energy concentration).

WG 3 works on the standardization of experimental methods to evaluate radon (possibly thoron) emanation and exhalation rate of building materials. In houses it is not straightforward to distinguish between radon emanation from soil and building materials and therefore specific parts of the new EC-BSS are dealing with radon issues separately from exposure related to gamma exposure of occupants. In Funke et. al [2007] and Schulz et. al [2008 and 2010] it is shown that the assessment of the radon situation in dwellings is a multidimensional question to solve. The contribution of radon to the radiation exposure is not (fully) incorporated in the activity concentration index used in the BSS. The EU-BSS uses a separated indicator for radon and the current version of the draft fixes the maximum national reference level at 300 Bq m^{-3} for dwellings although this is still under discussion. Another reason why Radon is treated separately in the EC-BSS is that Radon can be remediated (ventilation) unlike the gamma dose and that in many regions the main fraction of the radon exposure in buildings originates from soil. However, it is shown by international studies of the WHO and ICRP, that building materials might have a non-negligible share of radiation exposure of the public due to radon. Therefore radon emanation assessment and exhalation rates of newly developed building materials needs to be researched.

Deliverable: Publications regarding optimized (*in situ* if possible) measurement protocols to evaluate radon (possibly thoron) emanation and exhalation rate for NORM containing construction materials.

Subtask 3.3: An important research objective is to establish a calibration procedure for measurement methods of the activity concentration index and the radon emanation and exhalation rate towards traceable metrological reference materials and standard sources.

This Action aims at investigating potential radiological reference materials and standards for the determination of the activity concentration index of NORM containing building materials. This task will be performed in close collaboration with the above mentioned Metro-NORM project in a joint venture with several reference institutes. The focus of the Metro-NORM project is on NORM residues with high natural radioactivity concentration while sub-task 3.3 will focus on research towards standards when these NORM residues are incorporated in building materials.

Deliverables: Proposal for a calibration procedure and development of standard materials for the calibration of measurement procedures to determine the (i) activity concentration index and (ii) radon emanation and exhalation rate of NORM containing building materials.

Sub-task 3.4: Comparing the newly proposed measurement protocols for the activity concentration index and emanation assessment and exhalation rate with existing measurement protocols.
The standard materials developed in sub-task 3.3 will be used for intercomparisons between institutes using several measurement protocols and instruments.
Deliverables: WG 3 will organize intercomparisons between institutes using several measurements protocols and instruments for (i) activity concentration measurements but also (ii) emanation assessment and exhalation rate measurements in close collaboration with reference institutes and the Metro-NORM project. A report of the result of the intercomparisons will be provided.

Sub-task 3.5: Preparation of a unified certification procedure of construction materials and subsequent legislation proposal.
Finally a unified measurement protocol and requirements for the certification of testing laboratories involved in building material certification process will be proposed.
WG 3 aims at establishing a uniform procedure for testing building materials (including measurement methods, quality assurance, quality management and sampling) for getting a certificate related to the radiological content of the building materials. Such approach must be grounded on relevant legislation, so a proposal of new regulation or changes in an existing legislation will be developed by WG 4.
Deliverables: Factsheet for unified certification procedure of construction materials. The subsequent legislation proposal will be dealt with in WG 4.

WG 4: Improving radiological impact assessment models for the reuse of NORM residues in building materials. Investigating the influence of different legislative radioprotection scenarios on the use of NORM residues in building materials and the related impact on both gamma exposure and indoor air quality.
Sub-task 4.1 To investigate available impact assessment models for the use of NORM in building materials specifically for the cement, concrete and ceramics industries.
Various factors complicate the radiological impact assessment of building materials containing NORM residues: (1) Lack of secular equilibrium among natural radionuclides from decay series or state of transient equilibrium only is very common among NORM residues originating from

different industrial processes. Therefore additional information is required on the changes of natural radionuclides composition and activity concentration in building materials made from NORM residues in the course of time and their effect on usefulness of particular NORM residues. (2) Radon exhalation is a key process influencing quality of the construction materials. (3) The radiation attenuation factor for different kind of construction materials is a key parameter for modelling of exposure to external radiation inside. In addition when modelling the indoor air quality the co-existence of radiological and toxic substances, such as by example heavy metals, needs to be considered.

WG 4 will target challenges in modelling and modelling tools specifically for scenarios using the newly developed construction materials containing NORM residues. Research on several computational methodologies - room models [Markkanen, 1995] - and *in situ* techniques [Nuccetelli et al., 2001; Bochicchio et al., 2004; Risica et al, 2001] is available to evaluate and predict the indoor gamma dose rate and the radon and thoron indoor concentration on the basis of the radioactivity content and other characteristics of newly developed building materials. It was found that modelling of doses due to natural radionuclides in building materials is an effective tool for optimization of radiation protection. Such modelling cannot be done for each building material, however in case the activity index is higher than 1, the modelling might be helpful in deciding if the construction materials under consideration might be used.

Deliverables: improved radiological impact models based on optimized scenarios for the use of NORM in building materials specifically for the (i) cement, (ii) concrete and (iii) ceramics industries and (iv) specifically for the use of geopolymers.

Sub-task 4.2 End-of-life considerations for building materials with NORM.

Building materials can be recycled in other applications or building materials. It is the scope of this sub-task to investigate if the building materials with NORM lead in the long-run to un-safe building materials. The work performed herein will analyse the different scenarios and in collaboration with WG 1 and WG 2 define the recycling potential. Dilling et. al [2009] investigate the release of natural radionuclides, the leach ability, from NORM residues caused by sewage basing. The leach ability of building materials containing NORM residueswill be as well in the focus of WG 4. This topic will be discussed in close cooperation of WG 1 and WG 2.

Deliverables: Report on End-of-Life considerations for building materials with a particular focus on the leach ability of “NORM-building materials”. Information on the leach ability will be included in the database.

Sub-task 4.3: In close collaboration with legislative experts, researchers and experts from industry the possibilities and the practical implementation of the newly developed building materials to the market will be evaluated.
WG 4 will organize open discussions with all stakeholders in order to establish their interest on this matter and in order to understand existing practical problems that the implementation of the newly developed building materials will effectively face. In this step of the evaluation the Advisory Board will be involved. Evaluation of practices will take into account the radiological impact models, input from WG 1,2 and 3, current European legislation, the new EU-BSS and experiences from current practices.
Deliverables: (i) Round table discussions with all stakeholders and (ii) reports on the evaluation of the practical implementation of the newly developed building materials on the market.

Sub-task 4.4: The goal is to investigate and propose alternative legislative scenarios that can potentially stimulate the use of NORM residues in European cement, concrete and ceramics industry while assuring protecting of the population.
Deliverables: Reports for the (i) European cement, (ii) concrete and (iii) ceramics industry and (iv) on the use of geopolymers. with the comparison and evaluation of alternative legislative scenarios that can potentially stimulate the use of NORM residues while limiting the radiological impact. The output of WG 4 can lead to a reassessment and readjustment of the criteria used for the critical evaluation of existing and emerging residues in building materials (WG 1).

E. ORGANISATION

E.1 Coordination and organisation

The **Management Committee** (MC) of the COST Action, with representatives of the participating countries, supervises and coordinates the activities of the Action. With the exception of the start-up meeting, meetings of the Management Committee will be organized in connection to workshops / seminars. A core group from the Management Committee will form the Steering Group and meet more regularly to verify the status and progress of the Action between Management Committees (at least 2 meetings between Management Committees are scheduled).

An **Advisory Board** consisting mainly from NORM processing and construction industries and relevant associations and regulators will work in close collaboration with the MC and the WGs. Setting up the Advisory Board will be the task of the MC. WG members can suggest relevant members for the Advisory Board and this Action aims at continuously expanding the board. The Advisory Board will meet in the form of round tables organized in connection to workshops / seminars to ensure an efficient transfer of information between the participants of the Advisory Board and the MC and WG members. Members of the Advisory Board will get access to and the opportunity to give feedback on the reports generated by MC and the WGs.

The functions of the **Management Committee** are:
*To Appoint the Chair, Vice-Chair and Working Group (WG) coordinators for the Action;
*To plan seminars / workshops and the next MC meetings;
*To ensure that WG are proceeding according to the objectives and focus of the Action by procuring and assessing the progress reports prepared by the WGs;
*The critical appraisal of activities (previous, ongoing and planned) such as WG meetings, Short-Term Scientific Missions (STSMs), publications, exchanges between laboratories, training schools, … in order to maintain the objectives and focus of the Action to the promotion and the use of NORM residues in tailor-made building materials while meeting health related concerns;
*To promote the integration and information exchange among WGs;
*The promotion and approval of STMS and to encourage the involvement of young scientist;
*To prepare annual reports;
*The establishment and maintenance of the website ‘NORM4Building’ to ensure up to date communication and dissemination of results;
*To set up the Advisory Board;
*To create and maintain contacts with other linked (COST) Actions and relevant technologic and scientific platforms for organizing common seminars/workshops on topics of common interest;
*To organize, in the course of workshops, feedback moments, round tables involving the Advisory Board. Care will be taken to structure the discussion on the progress and future of the Action;
*The report of the feedback will be distributed to the WGs and the Advisory Board.

A **Scientific Committee** will coordinate the construction of the Scientific Program for the first two years. The Scientific Committee will be embedded in the Steering Group (as proposed by the DC Hearing). All recently available research projects existing in this area will be merged and coordinated via technical meetings, workshops and working visits during the 4 years of the project.

Major Milestones will include:

1. The plenary start-up meeting where the Management Committee, Steering Group (with embedded Scientific Committee), Working Group Coordinators, as well as the implementation of the work plan and the distribution of tasks will be defined.

2. To provide a detailed scientific program for the COST Action for the first two years.

3. To get companies and legislators involved in the Advisory Board of this COST Action by means of structured round table discussions.

4. WG annual meetings and additional WG meetings that can take place in the framework of the annual workshops. The WG meetings function as scientific key moments for the combination of research information. During the WG meetings an evaluation of activities carried out by participating members is provided. Recent research and reviews will be presented and new initiatives for the transfer of knowledge are made.

5. Publications: databases; a book and an electronic handbook will present the major achievements of the Action to interested stake holders and the general public.

6. By means of the Action website networking between participants and ensuring the dissemination or exploitation of the results of the Action will occur. On the site activities will be announced (e.g. workshops and conferences, training schools, WG meetings, conferences). The site will facilitate communication between the participants (e.g. blogs, transfer of files and documents) and disseminate results (e.g. public reports, databases, links to publications).

7. Final conference: a comprehensive state-of-the-art and dissemination of the results of the Action will be provided.

E.2 Working Groups

Different expert will set-up 4 open Working Groups as discussed in the scientific work plan.
The appointed WG coordinators will be responsible for:
*Organizing the scientific WG meetings
*Reporting to the MC: keeping the Management Committee updated on the progress of their WG.
*Overall coordination of the activities within their WG as laid down in the framework of the Action

*Initiating the set-up of joint research (through intergovernmental or EU) and preparing research and publications
* The WG coordinators will form the backbone of the Scientific Committee that can be expanded to include an additional member for each Working Group and that will be embedded in the Steering Group.

Short-Term Scientific Missions:
The **exchange of young scientists** between the different organizations from the participating countries will strengthen and intensify the corporation in the conducted research.

WG Scientific Meetings:
Different WGs will plan and organize separately scientific meetings to enhance the exchange of information and ideas, to stimulate the synergy among scientists, institutions and countries, to address specific topics and to plan joint experimental work. In association with other WGs, joint meetings and scientific workshops will be organized to enhance integration of activities. In the initial phase of the projects WG 1 and WG 2 will organize joint meetings since the first sub-tasks overlap. Exchange of information between the Working Groups is vital to ensure the progress of the Action: WG 2 needs strong input regarding the progress of the developed data base with best practices for the reuse of NORM residues (WG 1) and regarding the determination of indicators (WG 3) for and the modelling (WG 4) of the radiological impact of the studied building materials. At the same time input for modelling and in order to develop legislative options (WG 4) is required regarding the processing and properties of the building materials (WG 1 and 2) and the measurement protocol used to determine the radiological properties of building materials (WG 3). Joint meetings between the different WGs will be organized.

E.3 Liaison and interaction with other research programmes

The MetroNORM project primarily focuses on the standardization of the radiological measurement protocol for NORM residues. Standardization issues regarding measurement procedures for NORM in building materials that are part of the scientific program of this Action will be dealt with in collaboration to the MetroNORM project. Representatives of the MetroNORM project will be invited to discuss standardization of measurements at the organized workshops, conferences and to the WG 3 meetings. The possibility to organize joint seminars, topical days at workshops, conferences will be explored.

For the EUREKA! 5415 NEWCOMAT and the FP 7 SUSCON, LEEMA and EASEE projects exchange of information will be organized by WG 1 and WG 2. Also in this case the possibility to organize joint seminars and topical days will be explored.

To further promote the interaction with these project from other programmes the possibility to organize Short-Term Scientific Missions and joint training initiatives for young scientists will be explored.

The possibility of organizing Inter-COST workshops with appropriate other ongoing COST Actions will also be explored by the WGs to address topics of common interest.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

A specific coordinator will be appointed in the MC who will develop and coordinate new initiatives to stimulate the further involvement of female scientists in the activities of the COST Action between MCs and report the status of these initiatives during the MCs.
Specific training for young scientists, technicians and specialist in relevant fields regarding the incorporation of NORM residues in building materials for construction will be initiated and established by the WGs in a coordinated attempt to increase the involvement of early-stage researcher. Specialized seminars, practical training courses will be organized by the different Working Groups and the goal is to also organize this training in field facilities of selected partners to further ensure the training of young researchers. Young researchers of partner institutes will be informed about and stimulated to attend the training courses by the different institutes involved in the COST Action. The exchange of expertise between institutes will be further promoted by giving young researchers the possibility of undertaking short term visits to partners with specific field of interest. This Action will stimulate the mobility of researchers to provide research seminars in partner institutes especially for the training of young researchers.

F. TIMETABLE

The total duration of the Action is estimated to take four years. To appoint the Management and Scientific Committee (after the approval of the Action) a start-up meeting will be organized. For the first two years of the Action a detailed “Scientific Program” will be established by the Scientific Committee (SC), representing all Working Groups, and approved by the Management Committee within 2 months after the start-up meeting.

In the table below, the outline of the main milestones and deliverables of the Action is given. Training and exchange visits, scientific seminars, workshop and conference attendance, paper/poster presentations, journal and non-technical publications, networking, and outreach events will occur on a regular basis for the whole duration of the Action.

Year 1 of the Action	**Month due**	**Deliverable**
Nomination of the MC (and Steering Committee)	M1	
Appointment of the SC (that will be embedded in the Steering Committee)	M1	
Plenary start-up meeting	M2	Yes
Scientific Program	M3	Yes
Set-up electronic communication network	M3	Yes
Set-up of (internal and public) website “NORM4Building”	M3	Yes
First meeting of Working Groups	M3-M6	Yes
Set up of Advisory Board	M10	Yes
1e annual workshop, General Meeting, and MC Meeting, Round table discussion involving Advisory Board, Approval of first-year report	M12	Yes

Year 2 of the Action	**Month due**	**Deliverable**
Separate or combined meetings of WGs and STSM	M13-20	Yes
2e annual workshop, Round table discussion involving Advisory Board, and MC Meeting, Approval of second-year report	M24	Yes

Year 3 of the Action	Month due	Deliverable
Separate or combined meetings of WGs and STSM	M25-34	Yes
3e annual workshop, Round table discussion involving Advisory Board, and MC Meeting Approval of second-year report	M36	Yes

Year 4 of the Action	Month due	Deliverable
Separate or combined meetings of WGs and STSM	M37-46	Yes
4th annual workshop Round table discussion involving Advisory Board, and finals plenary meeting, MC Meeting; Approval of the final results and reports of the Action	M48	Yes

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CY, CZ, DE, EL, ES, FR, HR, HU, IL, IT, LT, MK, NL, PL, PT, RO, SI, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 80 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The results of this COST Action will be disseminated to the following target audiences:
A. Different scientists and scientific communities working on NORM residues and the reuse of (waste) residues in building materials;
B. Industries processing NORM, producing and reusing (NORM) residues, industries producing building materials and industries working on the radiological characterization of (NORM containing) building materials. European Council of Engineers Chambers and national Engineers

Chambers;
C. Standard Bodies working on standardization of measurement of natural radioactivity in NORM and building materials and certification institutions of building products and (waste) residues;
D. European level policy makers, European ALARA Networks and Working Groups related to the European Commission working on the new EU-BSS.E. National government policy makers: specifically governmental institutes involved in radiation protection, health care and waste / residues management. All competent authorities, as defined by Regulation (EU) No.305/2011, laying down harmonized conditions for the marketing of construction products and the reuse of residues form the target audience for this Action;
F. National Health Institutes and institutes/bodies working on radiation protection;
G. General public.

H.2 What?

An **Advisory Board** consisting mainly from NORM processing and construction industries, relevant associations and regulators will not only lead to an optimisation of the dissimilation of the results towards industry and the relevant regulators but will assure discussion between the researchers of this COST Action, relevant industry and regulators.
The tools used for the dissemination plan of the Action for various audiences are shown in the table below.

Dissemination Tools	**Target audiences**
Posting of general information on a public website	**B, F, G**
Posting of working documents and interim reports on the internal website	**A +** ‘Advisory Board of industry and regulators’ + ‘involved participants from relevant standard bodies’
Electronic communication network	**A; F;** relevant standard bodies of ‘**C**’ are involved in close collaboration with the MetroNORM project; + ‘Advisory Board of industry and regulators’
Workshops and conferences organized by MC and WGs	**A; B; C; D; E; F**
Round table discussion organized	**A; B; C; D; E;F**

during the workshops and conferences (organized by MC and WGs)	Representatives of the 'Advisory Board of industry and regulators' will be specifically encouraged to participate in the round table discussion
Contributions to other national and international conferences and symposia (e.g. conferences of Construction sector…)	**A; B; C**
Publications	**A; B; C; D; E; F**
Non-technical publication	**B; F; G**

H.3 How?

Proceedings and reports will be produced as a synthesis of the results discussed in workshops, conferences and the round tables. Special care shall be taken to organize and structure the round table discussions (involving the Advisory Board) during the workshops and the conferences. A round table can start from panel discussion and in a next step involve the rest of the round table. Round tables can be spit according to the topics dealt in the various Working Groups.

This COST Action aims at interesting editors and publishers of well-known journals for the Action's work and try to publish thematic series in selected (specialized and non-technical) journals aiming at specific target groups.

Database information will be made available gradually during the progress of the Action. Evaluation and updating of the database information will occur in close collaboration with the Advisory Board. Database information will be made available by means of (specialized and non-technical) publications, via presentations on workshops and conferences and via the website.