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## **Communicating nuclear and radiological emergencies to the public: how and to what extent are European countries prepared?**

### **Abstract:**

Public communication is one of the most challenging aspects of nuclear emergencies. The overall objective of this study is to analyse how and to what extent are European Member States prepared to communicate in case of nuclear or radiological emergencies. The study uses a combination of qualitative and quantitative methods: on-line surveys, round table discussion, workshop and consultations. The data for the study were collected from September 2017 to June 2018. Results show that nuclear safety authorities and other authorities or organisations responsible for defining and implementing public communication requirements during emergencies are significantly challenged as information and communication technologies continue to advance and public expectations continue to rise. While public information needs are largely met, many countries fail to respond to the demands of the current social media landscape, the level of stakeholder engagement and cross-border collaboration in the field of communication. Good practices are collected and may serve as an inspiration for authorities in their public communication plans in order to fill the communication gap in practice.

**Keywords:** communication, nuclear or radiological emergency, emergency management, Fukushima

### **Introduction**

After the Fukushima Daiichi nuclear power plant accident in Japan (2011) induced by a major earthquake and a tsunami, European Union (EU) Member States recognised that legal requirements and practical arrangements of public communication and transparency in case of a nuclear or radiological emergency in Europe should change [1]. Nuclear emergency plans in general and public communication and transparency arrangements in particular, developed after the Chernobyl accident in the 20<sup>th</sup> century, did not correspond to the new social and political environment [2]. Over this period, public information needs changed [3], the mass media landscape evolved [4-6], cross-border arrangements for public communication proved rather ineffective [7], stakeholder engagement became an important aspect of emergency management [8, 9] and higher level of transparency of nuclear safety authorities and industry was required [10-12].

Although EU Member States (MS) did not experience any direct radiological consequences, the Fukushima accident had an impact on the increased level of risk perception of nuclear installations [13], the negative perception from consumers towards food and other products from Japan [14], the adaptation of legal norms for residues of radionuclides in food and other products [15] and the nuclear energy policy changed in some EU countries [16, 17].

Several challenges regarding public communication in Europe during and after the Fukushima Daiichi accident are identified in the literature [18]. These include, among others: nuclear emergency management and nuclear safety authorities could not respond to the higher public information needs [19]; national nuclear emergency communication plans did not sufficiently consider social media, address emerging citizen journalism or citizen science initiatives [20, 21]; the (communication) response was different even in neighbouring countries despite similarities in the nuclear risks involved [22]; stakeholders were not aware of existing emergency response plans and how decisions could influence their lives [23] and different countries applied different transparency arrangements [12].

Not only the Fukushima Daiichi accident but also recent nuclear and radiological emergencies indicate the need to update public communication plans and practices in Europe. Tomkiv et al [24] recognise that one of the most significant components of uncertainties in nuclear emergency management are contradictory information and communication aspects, technical and measurement uncertainties, societal impacts and

societal framing, as well as ethical aspects. For instance, the case of Cs-137 contamination at nuclear safety authorities' premises in Finland (STUK) on 7th of March 2016 (INES 1) revealed a mismatch between public information needs and perceptions versus official communication from the nuclear safety authorities. The first communication of the nuclear safety authority in Finland caused great misunderstandings of the event, resulting in high levels of risk perception among the public (Perko and Martell, 2019).

The unusual event at the nuclear power plant Krško, Slovenia, on 4th of June 2008 showed that cross-border communication in case of a nuclear emergency should be improved [25]. One of the main communication problems was the poor translation of press releases from the original Slovenian language in different European languages (the EU has 24 official languages). For instance, the word "alert" was wrongly translated into "alarm" at the European level [26]. This caused unnecessary breaking news on different European television channels, among others, BBC in the United Kingdom and also in Norway and Luxembourg. In addition, the original public information on the emergency provided by the Slovenian Nuclear Safety Authority was presented only in 15% of the newspapers' articles in Slovenian neighbouring countries. The rest were not quoting the original source of information [26].

The successive emergency events at the Tricastin nuclear site during the period July-September 2008 triggered a new initiative from the operator and the institute for radiation protection and nuclear safety (IRSN), under the supervision of the French nuclear safety authority, as they were urged to engage with stakeholders [27]. A pluralistic committee was established in order to allow different stakeholders involved in emergency and post-emergency management to discuss research results and respond to public concerns. The pluralistic committee gathered experts from the nuclear power plant operator, the technical support organisation IRSN, institutional representatives, various local decision-makers and local stakeholders including the representative of the regional health agency, members of the Local Information Commission (with representatives of the local authority, trade unions) and a representative of an environmental non-governmental organisation.

Increased public information needs leading to high levels of pressure on nuclear safety authorities and emergency experts were demonstrated during the recent no safety significant radiological events, such as the very low concentrations of iodine-131 in air in Europe (January and February, 2017) and increased levels of the radioactive isotope ruthenium 106 detected in Russia and Europe (September and October 2017) [28]. These events triggered public concerns on social media like scepticism about no health effects or health problems due to increased ruthenium. Dissatisfaction with the "slow" reaction of authorities and scientists and low levels of transparency were voiced on social media. Nuclear safety authorities and emergency experts from different European countries were required to engage in social media discussions. For instance, scientists tried to clarify (no)risks for health and environment and to present and explain scientific calculations and related radioactive release modelling to the general public on twitter<sup>1</sup> [29, p. 28]. Despite the high public interest and the opportunity to build trust, most nuclear safety authorities in the EU did not engage in a public dialogue regarding the potential radiological or health effects of the Iodine-131 and/or Ruthenium-106 events [30].

In order to tackle reoccurring communication challenges, the European Commission (EC) enhanced the legal requirements regarding public information and transparency in the event of an emergency by revising several Directives. The revised Basic Safety Standards (BSS) Directive in 2013 (Directive 2013/59/Euratom) and the amended Nuclear Safety Directive (NSD) in 2014 (Directive 2009/71/Euratom as amended by Directive 2014/87/Euratom), involved an advanced legally binding and enforceable framework for nuclear and radiological emergencies as well as an improved framework for public information and transparency, among others. These two legal binding requirements needed to be transposed to national legislation by February 2018 and August 2017 respectively.

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<sup>1</sup> <https://twitter.com/frankdeboosere/status/943939773382774785> (last accessed on 6 May 2020)

Additionally, several research projects supported and funded by the EC focused on improving the effectiveness of public communication and increasing transparency in case of a nuclear or radiological emergency. These research and coordination projects resulted in several documents and guidelines for nuclear or radiological emergency communication to be implemented by MS as part of their preparedness, response or recovery strategy. As an example, general and practical recommendations for improved communication with media in nuclear or radiological emergencies were developed as part of the EC PREPARE project [31] and the EC CONFIDENCE project provided guidance on communicating about uncertainties in nuclear emergency management [32]

Apart from the EC, international agencies, such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (OECD/NEA), recommend to adjust existing arrangements for public communication in the event of a nuclear or radiological emergency to the new social, political and media environment after the Fukushima Daiichi accident. The IAEA, for instance, proposes a template for national and local authorities to develop a radiation emergency communication plan [33].

The overall objective of this study (Research Question) is to analyse *how and to what extent are European MS prepared to communicate in case of nuclear or radiological emergencies*. For this, the study reviews existing procedures and arrangements among 28 EU MS and evaluates public communication practices in the preparedness and emergency response stages. The declared arrangements of the various public authorities and licensees, responsible for informing the public prior to and in the event of radiological or nuclear emergencies, are thoroughly reviewed. Furthermore, the viewpoints, experiences and expectations of civil society, considered an important stakeholder in the event of a nuclear or radiological emergency, are also examined.

The paper firstly discusses the theoretical and legal background for public communication in case of a nuclear or radiological emergency. It then continues to describe the methodologies applied for collecting the data. This is followed by the results section, which focuses on the main communication challenges related to nuclear or radiological emergencies: public information needs, mass media communication, cross border communication and stakeholder engagement. A dedicated section provides an overview of good practices applied in some countries. The discussion summarises the good practices resulting from the analysis which can support nuclear or radiological emergency communication practitioners, before the conclusions.

## Theoretical and legal background

Nuclear emergency management is often presented as a cycle composed of risk assessment, planning, response, recovery and evaluation [34]. Communication should be integrated into all parts of this cycle. As Perko (2011) presented in the model Risk communication in the nuclear emergency management cycle [35, p. 389], the first two stages, risk assessment and emergency planning, are associated with pre-crisis communication; the third stage, emergency response, is related to crisis communication; and the fourth and fifth stage, recovery and evaluation are part of post-crisis communication. This study focuses on the preparedness stage and plans for response stage. Thus, we refer here to “risk communication”.

Risk communication in the nuclear field may have several aims [20, 34]: 1) to warn people in case of a nuclear emergency; 2) to inform about radiation risks and protective measures [36, 37]; 3) to support stakeholders to make informed decisions related to radiation risks and 4) to establish two-way communication and joint problem solving. Since human behaviour is primarily driven by perception and not by facts [38], risk perception is a concept of great importance when developing sound and effective risk communication [39]. The main communication challenge is that the experts and the public frequently disagree when it comes to risk assessment. Several studies related to these differences demonstrate that experts have in general a lower perception of nuclear related risks compared to the general public [40]. For instance, Perko [41] finds that the general population perceives the likelihood of a nuclear accident in a nuclear installation as higher than do the experts from the nuclear research center. Lay citizens are also more concerned about Belgian nuclear installations after the Fukushima Daiichi accident than experts.

Based on the Chernobyl accident in 1986 and the public acceptability of nuclear programmes, the Social Amplification of Risk was developed as a conceptual framework [42, 43]. This framework suggests that certain elements of hazardous events are intensified or downplayed, affecting individual and social perceptions of risk. The theory explains why certain accidents are seen by experts as relatively low risk, but can still be perceived by the public as an event with catastrophic consequences (risk amplification). At the same time, accidents carrying catastrophic consequences are sometimes ignored by the public, even though experts demand attention (risk attenuation) [44]. The social amplification of risk framework (SARF) appeared in response to hypothesised imbalance between technical assessments of certain risks and the public response to them.

Taking into account the SARF and the potential high risk perception, it is important to have designed, evaluated and adapted a communication strategy before a nuclear or radiological emergency, which responds to emergency challenges, public information needs and perceptions [33, 45]. Accordingly, the BSS Directive and the NSD require changes in public information and transparency in nuclear emergency management at national level.

Table 1 provides an overview of the need for changes in the legislation across the EU MS and in case changes occur, in which domain these can be found.<sup>2</sup> Most countries (19 out of 26) indicate a change of national legislation resulting from the BSS and NSD. Out of these nineteen countries, eight indicate that changes have been made specifically concerning public information and communication. Austria makes specific mention of changes being made concerning international cooperation regarding public information. Seven countries indicate that general changes concerning radiation protection and nuclear safety will be made. Out of these seven, only three (Croatia, Germany and Slovakia) indicate that these general changes will include changes on public information and communication. The remaining four countries either mention that only general changes are made and no changes are foreseen or made concerning public information and communication as these were already foreseen in the existing national legislation, or they do not make specific mention of changes concerning public information and communication. Six countries (Croatia, Germany, Hungary, Ireland, Luxembourg and Spain) specifically mention changes being made concerning public information and communication in Emergency Preparedness and Response (EP&R) legislation.

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<sup>2</sup> The specific question asked in the survey was: "Will the new Basic Safety Standards Directive and Nuclear Safety Directive result in new national legislation regarding public information in radiological emergency?"

**Table 1 Implications of the New Basic Safety Standards Directive (BSS directive) and Nuclear Safety Directive (NSD) on national legislation**

EU Member State	Change in national legislation	Intended changes				Articles
		Radiation protection and nuclear safety	International cooperation	Public communication / information	Nuclear or radiological EP&R	
Austria	YES		✓			
Belgium	NO					
Bulgaria	YES	✓				
Croatia	YES	✓		✓	✓	<i>OG 24/18, art 15 and 38</i>
Cyprus	YES	✓				
Czech Republic	NO					
Denmark	YES			✓		<i>The law of 25 January 2018</i>
Estonia	NO					
Finland	NO					<i>New act (Public information remains unchanged)</i>
France	NO					
Germany	YES	✓		✓	✓	<i>Radiation Protection Act (§ 105 of the Radiation Protection Act and § 112 of the Radiation Protection Act)</i>
Greece	YES			✓		
Hungary	YES			✓	✓	<i>Govt. Decree 165/200 (X.8) Korm. on the rules of public communication in nuclear or radiological emergency</i>
Ireland	YES			✓	✓	<i>Q2 2018</i>
Italy	YES	✓				<i>Legislative Decree n. 137 of the 15<sup>th</sup> of September 2017 and n. 230 of the 17th of March 1995; Section II of the Title X</i>
Latvia	NO					
Lithuania	YES	✓				<i>Law on Nuclear Safety, Chapter 7 and 8</i>
Luxembourg	YES			✓	✓	<i>Art. 128, Art. 58, Art. 59</i>
Malta	YES					
Poland	YES					
Romania	YES					

Slovakia	YES	✓		✓		<i>Atomic Law Nr. 541/2004 Z. z., § 28 part 20 and 22, Decree Nr. 55/2006 §§ 11 and 20, New Act on Radiation Protection (2018)</i>
Slovenia	YES					<i>Articles 134 and 135 of the new Ionising Radiation Protection and Nuclear Safety Act</i>
Spain	YES				✓	
Sweden	NO					<i>New regulation on public information in case of emergency exposure situations</i>
The Netherlands	YES					<i>Dutch Basic Safety Standards (6/02/2018)</i>

Starting from the research question *how and to what extent are European MS prepared to communicate in case of nuclear or radiological emergencies*, this paper attempts to test the four hypothesis formulated below.

*H1: Public information needs are met by responsible nuclear emergency organisations in EU MS*

During nuclear emergencies, people experience high uncertainty [24]. Uncertainty occurs when a) details of situations are ambiguous, complex, unpredictable or probabilistic; b) information is unavailable or inconsistent; and c) people feel insecure in their own state of knowledge or the state of knowledge in general [46]. Although a possible coping strategy in case of an emergency may be information avoidance [47], communication research related to nuclear emergencies shows that most people seek information [2, 48, 49] to reduce uncertainty when uncertainty is perceived as a danger (Brashers, 2001). In this way, information helps people distinguish between options as information has a protective function to prepare people for possible risk outcomes [50, 51], to make an informed decision [52] and to build trust between the authorities and the population [53]. In this context, public information and transparency in a nuclear emergency are required by the amended legislation (BSS directive and NSD). Moreover, Article 98 of BSS directive requires EU MS to “ensure that emergency response plans are tested, reviewed and, as appropriate, revised at regular intervals, taking into account lessons learned from past emergency exposure situations and taking into account the results of the participation in emergency exercises at national and international level”. In a similar way, Article 6 of the NSD requires “licence holders [to] provide for appropriate on-site emergency procedures and arrangements, [...], for responding effectively to accidents in order to prevent or mitigate their consequences. Those shall in particular: [...] be periodically reviewed and regularly updated, taking account of experience from exercises and lessons learned from accidents” [54]. Following this, the question whether public information needs are met by responsible nuclear emergency organisations in EU MS is relevant.

*H2: Public communication arrangements address the evolving media landscape*

In times of crisis, people request timely and vetted information. Mass media communication offers great opportunities for emergency management since it is by definition capable of reaching a large number of people simultaneously [55]. Over the years, communication has evolved into a multiple-way process where information is disseminated at an, often, uncoordinated incredibly rapid pace, and is able to easily reach all kinds of audiences: affected, indirectly affected and not affected by radiological risks [21]. Media technologies including social media have the potential for increased information capacity, dependability and interactivity [56]. Social media offers communicators with a great opportunity to reach the community quickly and directly and facilitates an open dialogue [5, 57, 58] serving, therefore, the needs of providing timely, relevant and trustworthy information to the public. Research conducted few years after the Fukushima Daiichi accident showed that nuclear safety authorities and nuclear emergency management in Europe poorly adapted to the new media landscape and mostly did not utilise social media in their public information practices [19, 20]. The downside of social media, i.e. impossible to control and can easily become a source of unconfirmed information [59], as well as the lack of human resources to manage social media, were the most common reasons to avoid using it.

Communication about nuclear emergencies has nowadays become more complex, extensive and multi-directional, whilst at the same time, social media offers opportunities for moving closer to a citizen-centred ideal of risk communication [19]. One of the elements to be included in an emergency management system is the clear allocation of the responsibilities of persons and organisations having a role in preparedness and response arrangements (Annex XI of the BSS directive), including media relations and public communication [60]. The appearance of social media has challenged the traditional models of communication and has changed risk and emergency communication. There is a new demand for emergency communicators to include social media in their communication strategies. [61, 62].



Organizations like the International Atomic Energy Agency and the Belgian Superior Health Council suggest that official institutions use social media in the event of a nuclear and radiological emergency [63, 64]. Numerous recommendations have been developed to guide the appropriate use of social media in nuclear or radiological emergencies [63, 65]. These recommendations advocate for proactive use of social media by the responsible organisations, which should implement a social media strategy at the preparedness stage, setting-up own accounts on the most relevant social media platforms to reach a maximum number of users and to gain the necessary experience. Organisations should at least monitor social media platforms in which they are active to react timely to concerns, questions and rumours [20, 66]. In this study we test whether public communication arrangements address the evolving media landscape.

*H3: Arrangements for cross-border communication in case of nuclear or radiological emergency are in place*

Nuclear and radiological emergencies have a high potential to instantly become international problems due to high politicization, possible high radiation exposures and cross border effects. This is confirmed in Prezelj et al. (2016) who found that media information in the case of Fukushima Daiichi accident was dominated by external sources of information: national governments, opinion makers, secondary media sources and nuclear safety authorities from other countries [2]. The cooperation on public information during an emergency with EU MS and third countries has, after the Fukushima Daiichi accident become mandatory. The BSS Directive requires to “promptly establish contact with all other MS and with third countries which may be involved or are likely to be affected with a view to sharing the assessment of the exposure situation and coordinating protective measures and public information by using, as appropriate, bilateral or international information exchange and coordination systems” (paragraph 2 of Article 99 of the BSS Directive). In a similar vein but less explicit, the NSD states that “Member States should ensure that appropriate arrangements are in place to facilitate such cooperation on nuclear safety matters with cross-border impacts”. Also, the HERCA-WENRA approach contributes to a better cross-border coordination of protective actions during the early phase of a nuclear accident. HERCA-WENRA approach is an integrated approach, agreed by HERCA (the association of Heads of the European Radiological protection Competent Authorities) and WENRA (the Western European Nuclear Regulators Association) which aims to improve the response and cross-border coordination for all types of possible accident scenarios. It relies on the following principles: shared understanding, coordination and mutual trust between neighbouring countries or territories. Whether arrangements for cross-border communication in case of nuclear or radiological emergency are in place are investigated in this study.

*H4: Stakeholders in nuclear emergency management are regularly involved in preparedness for potential emergencies*

International guidance recognises that stakeholders should be identified already in the preparedness phase of a nuclear emergency and mechanisms should be developed for involving and consulting with relevant stakeholders to “*enhance the understanding of the complexity of the community, the recognition of the community’s capabilities and needs, the fostering of relationships with community leaders, the building and maintaining of partnerships and the empowerment of the local community*” [29]. Civil society organisations also request higher involvement in emergency planning at local and national level in European countries and signal a lack of planned involvement of citizens in the EP&R management itself [12].

The BSS Directive, in its Art. 102, requests for existing exposure situations that: “Member States shall provide as appropriate for the involvement of stakeholders in decisions regarding the implementation of strategies for managing exposure situations”. On the one hand, it is not clear whether these arrangements should be in place in the preparedness, emergency, transition or recovery phase. On the other hand, involvement of stakeholders and the transition from an emergency exposure situation to an existing

exposure situation are two of the elements of an emergency management system under the BSS. In addition, in Article 66 of BSS Directive on estimation of doses to the members of the public, the competent authority is required to keep records of radiation doses available on request, while Art. 73 establishes consultation with stakeholders regarding control of exposure in contaminated areas. Finally, Annex XI includes stakeholder involvement into the emergency management systems and emergency response plans as referred to in Articles 69, 97 and 98. The term stakeholder is also mentioned in Article 8 of the NSD and refers specifically to "stakeholders in the vicinity of a nuclear installation". More generally, paragraph 23 refers to how cooperation on nuclear safety between the 28 MS can contribute to transparency and openness towards stakeholders at the European and international level.

Stakeholder engagement in the field of nuclear or radiological emergency management is recognised to be of paramount importance [15[67]. However, it could be broadened – in terms of stakeholders and forms of engagement - and strengthened – in terms of sustainability and impact [68]. Based on a theoretical review and an analysis of practices, Turcanu et al. [69] develop recommendations for stakeholder engagement in nuclear EP&R as follows: broaden the motivation for stakeholder engagement in EP&R, in both prescriptions and practice; broaden the scope of “participation” in EP&R ; recognise the role of informal stakeholder engagement in EP&R; integrate stakeholder engagement in EP&R plans and policies; establish strategies for continuous, two-way communication about emergency and recovery planning, tailored to specific stakeholders from both local and wider areas; and elaborate a strategy to foster the development of radiological protection culture in the preparedness phase. This study investigates whether stakeholders in nuclear emergency management are regularly involved in preparedness for potential emergencies in Europe.

## Method

This study uses a combination of the following qualitative and quantitative methods: on-line surveys, round table discussion, workshop and consultations. The data for the study were collected from September 2017 to June 2018.

The on-line survey sent to nuclear safety authorities and responsible organisations for emergency management was conducted from December 2017 to May 2018. The 66 questions of the survey, most of them open questions, allowed the in-depth analysis of the following topics: public information needs, mass media communication, cross-border communication and stakeholder engagement. The survey was sent out to 28 EU MS to at least one e-mail address of the responsible emergency authority (e.g. nuclear safety authority, ministry of internal affairs, ministry of health, federal crisis centre, civil protection, etc). In some cases, the survey was sent to more than one institution since the emergency management and public communication tasks related to nuclear or radiological emergencies are shared among different organisations. Respondents were encouraged to collaborate in responding the survey and submit only one survey per MS in order to present a national response. Representatives of responsible emergency authorities from 26 MS out of 28 responded to the survey, except United Kingdom and Portugal.<sup>3</sup> Analysis of the received responses consisted of three levels: the first level was reviewing the responses at the moment of the survey reception, pointing out missing responses, inconsistencies, etc and contacting the respondent by e-mail or telephone in order to clarify and give another opportunity to complete answers on the pointed items; the second level of analysis was to collect responses on the same question from different MS and to group responses in different categories and classify categories; the last level of the analysis was to deduct relevant information and highlight pitfalls, good practices and interesting exceptions.

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<sup>3</sup> According to the UK response, the contact persons to whom we addressed the survey were no longer working in this area and the relevant contacts were “unable to respond due to other work pressures”. The contact in Portugal sent the request to the group responsible for the draft of the transposition but they did not respond although received few reminders.

The views, needs and recommendations of local communities were collected through an on-line survey sent to the Group of European Municipalities with Nuclear Facilities (GMF) via the GMF Secretariat and the national association of local information commissions in France (ANCCLI) in December 2017 and later on, in February 2018 as a reminder. Six representatives of local authorities in municipalities with nuclear facilities replied to the survey from the following EU MS: Belgium, France, Germany, Hungary, Spain and the United Kingdom. While this number is not representative of the situation at local level, it is illustrative of how public information and transparency aspects on nuclear emergencies are addressed at local level. Clarification of the survey was undertaken via personal interviews with the mayors or local councillors who responded the survey.

A regional round table discussion covering the area of France, Luxembourg, Germany and Belgium was conducted in April 2018 in Belgium in order to discuss cross-border arrangements for public communication and transparency in case of nuclear or radiological emergency. The nine participants at the round table discussion were key experts or representatives of national authorities responsible for nuclear emergency management: Karlsruhe Institute for Technology (KIT), Germany; Bundesamt für Strahlenschutz (BfS), Germany; radiation protection adviser, Germany; Ministry for Health, Luxembourg; Institute for radiation protection and nuclear safety (IRSN), France; Public Health England (PHE), United Kingdom; European platform on preparedness for nuclear or radiological response and recovery (NERIS), Belgium, the European project ENGAGE coordinator, Belgium, and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) president. The round table discussion was moderated by two social scientists. The four sets of questions related to public information needs, mass media communication, cross-border communication and stakeholder engagement were discussed. After each set of questions, there was a fifteen-minute open discussion where each one of the speakers could comment the survey results and highlight pitfalls and good practices on cross-border communication. Twenty-five experts from the Benelux region with assigned responsibility in nuclear or radiological emergency management in their countries followed the discussion in the room and expressed their views and questions at the end of the workshop. The whole workshop was recorded and analysed afterwards.

Half a day workshop with the working group on information, participation and communication of the European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery (NERIS) was conducted in April, 2018, in Ireland. It was attended by 36 participants from different European countries. The following topics were discussed in four groups, each moderated by a social scientist: public information needs, mass media communication, cross-border communication and stakeholder engagement. The discussion was recorded and analysed afterwards.

A two-day workshop entitled *“Public information and transparency in case of a radiological emergency according to new Basic Safety Standards and amended Nuclear Safety Directive: collecting good practices”* was held in June, 2018 in Belgium. The workshop was attended by 54 participants from 15 different EU countries. The participants were representatives of international organisations (e.g. IAEA representative), NGOs, (e.g. Greenpeace and International Federation of Red Cross and Red Crescent Societies representatives), local communities with nuclear facilities, nuclear safety authorities, European Commission and EU Joint Research Centre, academics and researchers, research institutes and professionals in the field of communication in nuclear and radiological emergencies. The workshop included: a) presentations from invited speakers focusing on pitfalls and good practices from communication in different countries and contexts; b) presentations from researchers based on the preliminary survey results and round table discussion; c) interactions and open discussion with the participants during and after the presentations; d) two working group sessions to facilitate the exchange of experiences. Minutes of the workshop were written and analysed afterwards.

A Reference Group was set up for this study with sixteen members representing all areas involved in the definition and implementation related to public communication arrangements dealing with national radiological or nuclear emergencies. The Reference Group members reviewed activities and preliminary results during the study duration. They met three times and interacted individually with the researchers. The Reference Group was composed of a representative from the Studie en Overleggroep Radioactief Afval STORA in Dessel (Study and Consultative Group on Radioactive Waste) in Belgium, the national association of local information commissions (ANCCLI) in France, Atomic Reporters, European Nuclear Safety Regulators Group, Federation of the European Union Fire Officer Associations, FORATOM, Greenpeace Central and Eastern Europe, Group of European Municipalities with Nuclear Facilities (GMF), International Federation of Red Cross and Red Crescent Societies, crisis communication consultant, International Radiation Protection Association, OECD/NEA (Nuclear Energy Agency), NERIS (European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery), Nuclear Transparency Watch, Radiation Protection Societies in Belgium and in the UK, University of Ljubljana (Slovenia) and the H2020 project ENGAGE.

At all events organised in the framework of this study, participants were asked to clearly identify good practices based on their own experience. The researchers collected the good practices during the analysis, before meeting and through on-going discussions and all participants were asked to validate them at the events. Finally, the Reference Group members were also requested to confirm the good practices.

During the development of the study, the data protection officer checked data collected to ensure anonymisation, particularly related to sensitive information. In order to protect the source of information, information was anonymised to avoid the identification of the specific country. Furthermore, participants in meetings and workshops had the opportunity to review the information from the study. Requested changes were mostly implemented or if not, duly justified.

## Results

The four hypotheses have been tested and reported in this section.

### **Are public information needs met by responsible nuclear emergency organisations?**

EU MS apply different methods to identify and address public information needs. In France, for instance, the Institute of radiation protection and nuclear safety, IRSN, conducts surveys to investigate public needs of information and hence, adapt the content of communication to meet these needs. Similarly, different institutions in Europe (e.g. the research institute SCK-CEN in Belgium, the Spanish research centre CIEMAT) conduct national barometers which include information on the level of knowledge of the public on protective actions, the level of information regarding emergencies, the level of trust in institutions addressing emergencies, risk perception, attitudes, etc. These national barometers are published online.

Occasionally, nuclear safety authorities in the Czech Republic, Finland, France and Greece use opinion surveys to test communication material. Around half of the EU MS surveyed in this study (13 out of 26) indicates that they test the communication material whilst four of them (i.e. Belgium, Hungary, Lithuania and Romania) indicate that they plan to test their communication material in a near future. Testing, evaluation and adjustment of communication materials can be undertaken in various ways. In Finland, the nuclear safety authority STUK, conducted a public opinion survey to test the public understanding of protection areas by visualising evacuation maps. The understanding of maps in Slovakia was tested by decision-makers and lay citizens. In Germany, the nuclear safety authority developed a leaflet on iodine tablets, which was tested by schoolchildren to check whether the information was clear enough and understandable. The WHO [70] indicates that one of the areas to be strengthened in Slovenia with regards to the communication engagement with affected communities is proactively testing of materials and messages in target audiences (p.52).

Table 2 presents ways of testing of communication material to inquire whether the communication material results in people understanding the emergency or the protective actions in all investigated EU MS.<sup>4</sup> Six out of 26 countries (e.g. Hungary, Ireland, Belgium) indicate that they assess public information needs in exercises. Contrary to the responses from authorities, representatives from local communities in some countries taking part in emergency management at the local level, state that the communication aspects about protective actions in exercises and drills is not regularly trained and depends on the country considered. In Spain, for instance, the last exercise involving information and communication aspects to the public was in late 2013 in Almaraz. Until then, there have not been any further exercises and it is the civil servant in charge of civil protection who updates the municipal plan for nuclear emergencies. Representatives from municipalities in France, Germany and the UK stated that they have not been personally involved in exercises where communication aspects with the local population have been tested. According to them, local authorities do not participate in this type of exercises and drills. Exceptionally, in France, a local representative declared to have been involved as an observer (not participant) in an exercise where communication between the authorities and the local community were not tested.

Other testing methodologies, like focus groups, are used in Ireland, Lithuania, Luxembourg and the Netherlands or unstructured tests are used in Germany and Croatia. The information on the internet webpages of nuclear safety authorities and emergency organisations need to be clear enough for the public to understand how to react to a nuclear or radiological emergency and how to protect themselves. For this, evaluation and adjustment of internet webpages with the emergency preparedness and response related information is, in Ireland, undertaken by external evaluators. They organise special web-user testing or stakeholder panels. In the Netherlands, an external evaluation of the nuclear safety authority website is foreseen. Nuclear safety authorities in the Czech Republic and Finland indicate that they take part in specific advisory boards dealing with citizens' needs for public participation.

Less than half of the countries (eleven out of 26 countries) indicate that they have a mechanism in place that would allow them to systematically monitor rumours during an emergency. Whilst some countries have planned to implement such a mechanism, but do not have it yet, like Cyprus and Germany, others, like France, use Radarly, a social media intelligence software to systematically monitor real-time rumours. STUK in Finland also specifies that they collect and correct rumours on the channel itself, through press releases, via their website, Frequently Asked Questions (FAQ) or interviews.

More than half of the countries (18 out of 26) indicate that they have tools for citizens to post online questions during an emergency, such as social media, contact forms, hotlines and Q&A sections. However, only five countries (the Czech Republic, France, Greece, Ireland and Italy) indicate that they use social media such as Facebook and twitter to respond on public information needs.

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<sup>4</sup> The specific question asked in the survey was: "Did you test or are you planning to test whether the communication material you normally use results in people understanding the emergency or protective actions?"

**Table 2 : Testing of communication material to inquire whether the material results in people understanding the emergency or the protective actions**

EU Member State	Testing conducted	Testing planned	Exercises	Opinion surveys	Focus groups	Other
Austria	YES		✓			
Belgium		✓				
Bulgaria	NO					
Croatia	YES					Unstructured tests/ Public meetings
Cyprus						
Czech Republic	YES		✓	✓		
Denmark	NO					
Estonia	NO					
Finland	YES			✓		
France	YES			✓		
Germany	YES					Unstructured tests
Greece	YES			✓		
Hungary		✓				
Ireland	YES				✓	Web use testing/ stakeholder panels
Italy	YES		✓			
Latvia	NO					
Lithuania		✓			✓	
Luxembourg	NO				✓	
Malta	NO					
Poland	YES		✓			
Romania		✓				
Slovakia	NO					Responsibility of license holder
Slovenia	NO					
Spain	YES		✓			Meetings
Sweden	YES		✓			
The Netherlands	YES				✓	Outsourcing

Public warning mechanisms are a relatively novel example to alert the population in case of a radiological or nuclear risk by sending a short message to their mobile phones. This system is established in a few European countries, for instance the BE-alert in Belgium, NL-alert in the Netherlands and CAT-warn in Germany. Timeliness of communication in the event of a radiological or nuclear emergency is flexible and depends on the event in many MS. When the impact of the emergency in a MS increases, the timing for communication decreases and it can go down to optimal communication within 15-30 min. Local communities participating in this study claim that it would take a maximum of 30 minutes from the moment the nuclear emergency is declared for the affected citizens to get information about protective actions.

### **Do public communication arrangements address the evolving media landscape?**

Half of the nuclear safety authorities surveyed in this study (13 out of 26) indicate that they have at least one person assigned to follow and respond to social media in case of an emergency. In only a few cases, the number of people assigned to this task raises to 2, 3 or 5, being Ireland the exception with 15 persons dedicated to this task. In some other cases, following and responding to social media is not concentrated only on one person but shared between more employees, like in the case of Finland.

Results show that most authorities in MS (19 out of 26) organise specific media training which is mainly limited to traditional media, e.g. TV, radio and newspapers. A great variety however exists on who receives this training and what this training specifically entails. In five countries, i.e. Belgium, Croatia, Hungary, Slovakia and Slovenia, management personnel receive media training. In Belgium, for instance, all directors, in addition to the communication staff at the nuclear safety authority receive media training. In other countries (Bulgaria, Denmark, Poland, Romania, Slovakia, Slovenia and Spain), only a specific spokesperson or public relations expert is trained in media communication. For instance, in Bulgaria, only public relations staff who is specifically involved in the emergency team during exercises and drills receive media training. Nine countries declare that media training is provided to either all or a specific selection of staff members. In Spain, the representative of the nuclear safety authority stated in the survey that the Nuclear Safety Council (CSN) *“train(s) employees in spoken and written communication and emergency management. All potential spokespersons receive media training and participate in nuclear emergency exercises”*. In a similar vein, in France, a large part of the staff of the nuclear safety authority is involved in communication issues and therefore communication training is adapted to the specific needs of each person and *“tailored to their various responsibilities”*. A specific section is devoted in the training *“to better answer queries from journalists and put across a message clearly”*.

Familiarisation of journalists with reporting on nuclear or radiological emergencies through participation in exercises, specific trainings and seminars is on-going in 8 out of 25 countries. In Belgium, for instance, students of journalism were once involved in a nuclear emergency exercise, whereas in France, the nuclear safety authority organises five drills a year with media pressure, involving journalists, and analysing text consistency, coordination of messages, quality of messages during speeches, etc. In Finland, special radiation protection and emergency management courses are organised on a regular basis for journalists.

The majority of countries (24 out of 26) indicate that they have a specific policy regarding staff speaking to media in the event of an emergency. Italy and Malta indicated that they do not have such a policy. Only one country, Sweden, claims to have a *“freedom to supply information”* policy for all staff. Similarly, the Finnish nuclear safety authority developed a social media policy through which all 340 employees are encouraged to use social media in their relations with journalists and the public. On the contrary, sixteen countries state that only a specific spokesperson is appointed to communicate with the media. In Austria, Finland, Poland and Slovenia, the division head or his/her deputy is appointed to address the media. Whilst in Hungary and Poland the General Director or his/her deputy are allotted to communicate to the media, in Slovenia this responsibility is given to the emergency director. In 17 out of 24 countries, a

dedicated and trained spokesperson(s) is available to speak to media. The policy itself emphasises that communication with the media needs to be transparent, timely and accurate, and brought across in plain (understandable) language.

Media is often the first partner to cooperate with nuclear safety authorities in public communication, according to the results of the survey, beyond official collaborations. Based on the results from the survey, traditional media is the most often used channel for the provision of information for the general protection measures to be applied and steps to be taken in the event of a nuclear emergency. The second most used channel is the internet including authority websites, online newspapers and social media. Early warning systems are the third most often used channel of communication. From the point of view of local representatives of the Group of European Municipalities with Nuclear Facilities consulted as part of this study through the survey and based on personal interviews, social media is one of the main concerns in emergency communication. Representatives of municipalities raise doubts on how to address social media during emergencies as it is likely to spread ungrounded rumours. They also claim that social media is the least trusted source of useful information, whilst the level of trust in traditional media is usually higher.

Atomic Reporters in collaboration with Stanley Foundation published one page on “*Recommendations for improving communication with journalists to enhance public safety in the event of a nuclear or radiological emergency*” [71]. These recommendations could be used by different organisations to improve their relationship with media and ensure quality reporting about nuclear or radiological emergencies.<sup>5</sup> Emergency organisations involved in this study were not aware of these recommendations presented by a journalist at the study workshop.

### **Are arrangements for cross-border communication in case of nuclear or radiological emergency in place?**

Half of the MS surveyed in this study indicate that they collaborate with public communication officers from other countries involved in emergency management. Collaboration occurs either directly or indirectly (e.g. e-mail exchange, bilateral meetings, working group, regional exercises, etc). Several countries also indicate that they plan to either set up collaboration or expand upon existing collaborative practices with other MS. However, six out of 24 countries (i.e. Croatia, Hungary, Italy, Luxembourg, Malta and Slovakia) indicate that they do not have specific arrangements in place to collaborate with public communication officers from other countries indicating room for improvement in the cross-border collaboration involving emergency management.

Most MS are aware of the “HERCA-WENRA approach for better cross-border coordination of protective actions during the early phase of a nuclear accident”. During the round table discussion on cross-border arrangements held in April 2018 as part of this study, the participants recognised that the HERCA-WENRA guidance for bilateral arrangements can improve exchange of information among countries which may be affected by a nuclear or radiological accident. Although it is not a guarantee for success, it is a starting point as it may allow countries to send out the same message despite the massive problems with different European languages.

Only Finland, Ireland and Poland declare, in the survey, that they publish information on a nuclear or radiological emergency in the official language of neighbouring countries. On the contrary, the majority of MS, 19 out of 22, indicate that they do not publish public information in the official language of neighbouring countries in the event of an emergency. The most common language used by nuclear safety

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<sup>5</sup> <http://www.atomicreporters.com> and <http://www.atomicreporters.com/wp-content/uploads/2016/06/RotterdamJournalistsRecommendations616LR2.pdf> (last accessed on 5 May 2020)



authorities to publish any news on emergencies, after their own, is English. Estonia uses Russian as a second language and Finland uses Swedish. Almost all countries except four (Croatia, Estonia, Greece and Luxembourg) indicate that they would refer to the website of the nuclear safety authority (or crisis centre) of the Member State in which the emergency takes place.

In Germany, decisions on emergencies are published in German, English and French and messages are translated in-house as it helps to ensure that the message conveyed is the correct one. In some cases, professional translation tools or embassies are used to publish swift information in other languages. Due to language barriers, TRADOS, a professional translation software used by the IAEA, is also used by the nuclear safety authority and the technical support organisation in France for swift scientific and technical translations. In Luxembourg, different embassies contacted the nuclear safety authority to request press releases regarding emergencies before they are made public in order to be able to translate these themselves and convey the correct information. Representatives of Luxembourg, France, Germany and Slovenia state that, in some cases, agreement is sought with neighbouring countries on predefined statements and press releases during peaceful times. For instance, during the ruthenium event described above, the technical support organization IRSN in France and the nuclear safety authority in Germany BfS exchanged information before they sent a public press release.

Experts at the cross-border round table emphasised the need for stakeholders in the field of nuclear or radiological emergencies to gain practice to respond to potential emergencies through regular exercises. In this regard, they advised to include cross-border aspects in exercises, particularly in Eastern European countries.

### **Are stakeholders in nuclear emergency management regularly involved in preparedness for potential emergencies?**

To engage with stakeholders in emergency preparedness, most MS (17 out of 26) use formal consultations. Other approaches may include public meetings organised and hosted by local authorities (16 out of 26), by nuclear safety authorities (12 out of 26), by radiological installations (12 out of 26), etc. In addition, written inquiry points (e.g. emails and letters) may also be used as tools for public engagement( 15 out of 26) or telephone enquiry points (15 out of 26), among others. Local information committees (11 out of 26), regional information committees (11 out of 26), experiences of public participation in emergency exercises (11 out of 26), informal or drop-in meetings in the vicinity of the site (9 out of 26) can be also considered as examples of approaches for stakeholder engagement. In the case of Belgium, the local partnership STORA, which includes representatives of local politicians, businesses, representatives of local associations, etc., follows up all nuclear activities in the municipality. STORA launched a campaign for the people from the municipalities of Dessel and Mol to reinforce at the local level a national campaign launched in March 2018 to inform the Belgian population on nuclear risks and safety measures. In this case, the local campaign enabled residents to make informed decisions in case of a nuclear or radiological emergency in their local community, as reported by the STORA representative in the Reference Group of this study.

Besides these engagement methods, several interactive online tools are applied, including twitter, a dedicated page on the nuclear safety authority website, Facebook, other software or apps, etc. As mentioned above, STUK in Finland supports an in-house communication culture that encourages all employees to engage in dialogue with stakeholders via different tools, like social media. This way, they reinforce the institutional message, allowing people to have a more personal perspective and thus, moving from “institutional trust to peer trust”, as reported by the communication representative at the study workshop.

Examples of the way citizens may be engaged, discuss or participate in communication aspects related to preparedness plans for nuclear or radiological emergencies is through their involvement in exercises and drills. Nearly all countries (24 out of 26) indicate that they include communication aspects with the public in nuclear or radiological emergency exercises/drills. The frequency by which aspects of communication

in exercises or drills are included varies from once every five years to several times a year. In countries like Hungary, Belgium or the UK, exercises and drills are regularly conducted. In Hungary, there are exercises every two years involving the nuclear safety authority, first responders, the operator and civil protection. The municipality leaders are invited to participate in the drills organised by Paks Nuclear Power plant and the National Disaster Management Directorate. In Belgium, there are exercises once a year and these involve the nuclear safety authority, first responders (medical services, firefighters, police), the operator and hospitals. However, the WHO [72, p. 62] indicates the need to address “mass casualty evacuation preparedness through exercises, particularly in densely populated areas around nuclear plants”. In the UK, exercises involve regulatory authorities, first responders, operator, schools, civil protection, national representatives from the parliament and senate and the military-navy. In the case of Spain, according to responses from local level representatives, citizens were involved during the Cáceres Urgent Response International Exercise (Curiex) in Almaraz (Spain) in late 2013. The exercise involved the nuclear safety authority, first responders, local citizens, schools, NGOs, civil protection, national and international representatives and media and aimed to test the effectiveness of information provided to the affected population and local media involvement. In Slovenia, the WHO [70, p. 60] highlights the need to conduct “simulation exercises for scenarios occurring outside the immediate vicinity of the nuclear power plant”. Similarly, for Lithuania, the WHO [73] recommends to strengthen multi-selectorial EP&R to a nuclear power plant in a neighbouring country, through regular exercise regime and systematic training programmes (p.63) and to conduct “regular exercises which include verification of preparedness and response for radiological emergencies” in Latvia [74, p. 58].

Various methods are applied for the inclusion of communication aspects, such as table top exercises, frequently asked questions, mock conferences, etc. Nuclear safety authorities were asked about the most important lessons learned regarding communication with the public from exercises and drills. Four categories of lessons learned can be identified: those related to the preparedness stage, those related to the use of language, those related to time needed for communication and those linked to the need to improve certain aspects. Table 3 summarises the lessons learned for the 26 countries which responded the questionnaire.<sup>6</sup> Concerning preparedness, several countries, like Austria, Estonia or Germany, indicate that they have learned that the use of templates is important but need to be adjusted to the specific context of the emergency. Concerning language, the most often expressed lesson learned is the use of simple, plain and understandable language. Providing immediate information proves challenging as it is time consuming, despite having prepared and translated templates. The need to improve collaboration and coordination of messages among the different emergency management actors (e.g. authorities, first responders, platforms and organisations) is mentioned by the majority of MS as a lesson learned from the exercises and drills.

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<sup>6</sup> The specific question asked in the survey was “what are the most important lessons learned regarding communication with the public from these exercises/drills that you would like to share?”

**Table 3. Lessons learned regarding communication with the public from exercises / drills \***

<b>EU Member State</b>	<b>Preparedness stage</b>	<b>Use of language</b>	<b>Time for communication</b>	<b>Other (Need for...)</b>
<b>Austria</b>	Need to be proactive and prepare templates			
<b>Bulgaria</b>		Use plain language		
<b>Croatia</b>	Prepare preapproved messages to be used		The approval procedure by responsible authorities for communicating is too long	Use templates for the first public information
<b>Cyprus</b>		Investigate the differences in risk perception and understanding of concepts in public announcements		Need to improve trust in governmental bodies' communication, as the public understand public announcements in a different way than foreseen.
<b>Czech Republic</b>	Assess FAQs for high information need			Need to enhance consistency, openness and transparency
<b>Denmark</b>				First communication needs to be made both via traditional media and social media
<b>Estonia</b>		Use simple and understandable language	Regular communication is time consuming	Use templates with caution and adjust them to the emergency context
<b>Finland</b>				Coordination communication with different authorities should be enhanced
<b>France</b>	Importance to build trust at this stage			A citizen centric approach should be applied
<b>Germany</b>	Improve radiation risk communication		Public media can be faster than authorities	Information exchange between emergency management and communication experts is needed
<b>Greece</b>	Templates and other communication material needs to be prepared			
<b>Hungary</b>			Regular communication is time consuming	Public communication officers and nuclear experts need to collaborate to provide factual and publicly understandable information

<b>Ireland</b>	National emergency coordination group needs to agree on and test relevant messages			Engage with media as early as possible Coordination between all ministries and agencies (radiological and non-radiological) is essential Limit to 3 key messages Political and expert spokespersons should attend the same media conferences There is a need for consistent and coordinated communication
<b>Italy</b>			Give immediate information	Direct public to follow official information sources
<b>Latvia</b>				Aspects of communication are not included in nuclear or radiological emergency exercises / drills
<b>Lithuania</b>		Ensure communication in foreign languages (minorities and tourists) Need to use easy and understandable language		Provide regular information to the public Templates need to be adjusted to the context Need to coordinate messages and channels of communication of the different authorities
<b>Luxembourg</b>		Use of different languages		Improve coordination between neighbouring countries
<b>Poland</b>		Avoid technical language		Need to increase trust of the public in institutions
<b>Romania</b>	Use different tools for different information needs			
<b>Slovakia</b>	Need to prepare FAQs	Use easy, understandable communication and simple instructions		Monitoring social media to avoid rumours
<b>Slovenia</b>				Openness, transparency and intensive communication is needed Provide relevant information Include communication in regular drills and exercises
<b>Spain</b>		Be empathic		Transparency, clear information, correction of mistakes and rumours, information increase, train in media skills, monitoring media and the coordination in information sharing between organisations
<b>Sweden</b>				It is important that decision-makers work in close liaison.
<b>The Netherlands</b>				Ensure consistency in the messages by different involved parties.

\*Malta and Belgium are excluded from the table above for the following reasons: in the case of Malta, communication aspects are not part of the exercises whilst in Belgium representatives did not respond to this specific question.

## Good practices in public communication related to nuclear emergencies

During this study, good practices regarding timely, clear and understandable public information were identified in some EU MS. Rumours that appear during a nuclear or radiological accident are systematically collected in real-time and are also responded by using the same communication channel that published the rumour in a few countries. In case of a nuclear or radiological emergency, a specific website that becomes active in the event is developed in a limited number of EU MS. A call center is planned and tested in advance in some countries.

The following good practices regarding public information needs, understanding and evaluation of effectiveness were found in some EU MS: Online querying tools (e.g. social media, hotlines and Q&A) are used for posting online questions and answers during an emergency; Public communication and information material on emergencies and/or protective actions is tested in a few MS to see whether it is sufficiently clear and understandable. Verification of these materials is undertaken by using different and complementary methods and approaches (e.g. focus groups, public opinion surveys, meetings, etc). Few nuclear safety authorities encourage emergency management to communicate also about uncertainties in emergency management. The EC and several national authorities invest in research related to communication before, during and after nuclear or radiological emergencies. In some EU MS, evaluation and adjustment of the internet webpage of the nuclear safety authority with the emergency preparedness and response related information is conducted by external evaluators, stakeholder panels or through public opinion surveys.

The following good practices regarding media communication were identified: In various MS, professionals of nuclear safety authorities who may appear in media as spokespersons during a potential nuclear or radiological emergency receive media training on a regular basis. Some nuclear safety authorities ensure that personnel within the organisation is trained to use social media for public information in nuclear or radiological emergencies. This task is in a few authorities shared among different employees and is not limited to the communication personnel only. The use of social media (e.g. twitter, Facebook and blogs) is done in conjunction with traditional media (e.g. journals, TV, radio, sirens, warning systems) during an emergency in order to reach all audiences. Relationships of authorities with journalists are in some EU MS developed and maintained before a potential emergency by involving them in exercises, specific trainings and seminars where they can be familiarised with reporting on nuclear or radiological emergencies. Some nuclear safety authorities release public information in more than only official national language. In several EU MS the policy for staff concerning media communication, including the definition of rules, roles and responsibilities, is developed and the elements of media communication are tested and trained in advance. Finally, it is worth mentioning the work of Atomic Reporters in collaboration with Stanley Foundation which published one page "Recommendations for improving communication with journalists to enhance public safety in the event of a nuclear or radiological emergency" which could be used by different organisations to improve their relationship with media and ensure quality reporting.

The following good practices regarding exercises were identified in the study: Evaluation and adjustment of the communication material after exercises is undertaken in order to improve the communication strategy for the response to future emergencies in most of the EU MS. Public information and communication aspects with the public are tested in regular exercises and drills to review the effectiveness of public information, identify challenges and pitfalls, not only on paper but also in practice in the majority of EU MS. Local communities and other stakeholders (first responders, schools, hospitals, journalists, students of journalism) are included in exercises in several countries.

The following good practices in cross-border collaboration the field of public information and transparency were recognized: Communication personnel is included in cross-border and regional exercises. Information on the emergency is published in English in most countries while information in the official languages of neighbouring countries is done in a few MS. Public information officers collaborate cross-border with officers from other countries either via email or through more formal ways of communication (e.g. working group, regular meetings) in several EU MS.

The following good practices in the field of communication and stakeholder engagement were identified: Communication strategy for nuclear or radiological emergency is designed, evaluated and adjusted in order to respond to emergency challenges and public information needs in case of an emergency in most EU MS. The communication cell is in direct contact with the decision-makers on emergencies and the communication officer or liaison are present in the incident command centre during an emergency in the majority of EU MS. Nuclear safety authorities in most MS establish a specific position or function in the organisation with responsibility for public information and communication both during the preparedness stage and in case of a nuclear or radiological emergency. Citizen science initiatives for radiation measurements (e.g. SAFECAST) are encouraged by authorities as useful communication and engagement tools between experts, policy-makers and the public in some countries during the preparedness, response and recovery phases.

## Discussion and conclusions

Public communication is one of the most challenging aspects of nuclear emergencies [18, 58]. The overall objective of this study was to analyse how and to what extent are EU MS prepared to communicate in case of nuclear or radiological emergencies. The study findings show that current arrangements and procedures for information and transparency regarding nuclear and radiological emergencies in EU MS appear, on paper, to be broadly compliant with EU legislative requirements based on the responses provided by the nuclear safety authorities. However, these results need to be carefully assessed, since lessons learned from recent nuclear and radiological events in Europe and neighbouring countries point out different gaps in public communication. Also civil society representatives in this study identified gaps in public communication practice. These findings confirm the study from the Nuclear Transparency Watch [12] which already demonstrated the existence of large gaps between the announced provisions and the reality and/or the absence or poor implementation of planned activities in practice.

Results of this study show that public information needs are met by responsible nuclear emergency organisations in most EU MS (H1). Emergency management organisations assess and respond to citizens' information needs differently in different countries. In particular, eight countries out of 25 consulted in the survey declare to conduct public opinion surveys to assess public information needs and eleven countries systematically monitor rumours during an emergency. Five countries analyse lessons learned from past events whilst only three countries use social media to identify citizen's needs and respond to them accordingly. Few countries declare to use other mechanisms to assess information needs: some test communication material, six countries assess information needs during exercises, four organise focus groups discussions with citizens, internet pages are seldom evaluated by external evaluators or citizen panels and two MS take part in specific advisory boards. One country declares to use a hotline and another one applies a contact form.

The hypothesis the public communication arrangements address the evolving media landscape (H2) can be accepted only partially. The results of this study indicate that traditional media is still the most often used channel for the provision of information for the general protection measures to be applied and steps to be taken in the event of a nuclear or radiological emergency. It is worth mentioning that experts are often not allowed to speak publicly as they are bind to a specific policy regarding the staff speaking to the media or in public. An exception is Finland, where STUK, the nuclear safety authority, has developed a social media policy through which all 340 employees are encouraged to use social media in their relations with journalists and the public. In all other countries, the utilisation of social media is poor and mainly limited to one social media account and few human resources. This practice does not positively contribute to address social amplification or attenuation of risk [75].

The hypothesis (H3) that arrangements for cross-border communication in case of nuclear or radiological emergency are in place can be rejected. Only approximately half of the countries surveyed in this study collaborate with public information officers from other countries involved in emergency management. In addition, 19 out of 22 countries, indicate that they will not publish public information in the official language of neighbouring countries in the event of an emergency. However, most countries will publish the information in English. This may help to reach out to international newswires and correspondents identified at the preparedness stage to ensure that international media use the primary source. This practice may address a problem of secondary information source as the main information in a nuclear emergency, as it was demonstrated in Europe

during the Fukushima Daiichi accident [2]. Some countries stated that the translation of press releases and any documents for public information is undertaken by embassies or using professional translation tools in order to publish swift information. Although this practice may be time demanding, it may address the problem of possible miscommunication as shown in the Krsko case [26].

Stakeholder engagement is an evolving principle in nuclear emergency preparedness, response and recovery [69]. The hypothesis (H4) that stakeholders in nuclear emergency management are regularly involved in preparedness for potential emergencies in EU MS can be accepted only partially. While some EU MS use different tools to engage with stakeholders, such as consultations, public meetings by local authorities, written inquiry points and telephone enquiry points, representatives of civil society claim that citizens are insufficiently involved. For instance, in most countries, civil society organisations can neither participate nor observe emergency exercises. In addition, recent nuclear and radiological events in Europe and neighbouring countries pointed out to the need of nuclear safety authorities to engage early enough in a two-way communication, rather than only providing one-way information. The study has shown that there are citizen science initiatives for on-line radiation measurements which prove to be useful communication and engagement tools between experts, policy-makers and the public, during preparedness, response and recovery phases. Authorities could be more responsive to them, engage and support them with information, material resources, public-interest partnerships and events. This study shows that this kind of engagement is still a missed opportunity for authorities to further engage with the public.

This study provides useful insights into gaps in public communication in case of a nuclear or radiological emergency. It also examines the common and often innovative public information practices in place to ensure informed decision-making, public response, openness and transparency and highlights good practices. It shows that nuclear safety authorities and other authorities or organisations responsible for defining and implementing public communication requirements are significantly challenged as information-communication technology continues to advance and as public expectations continue to rise. The Euratom BSS Directive and NSD provide minimum requirements for public communication which have to be applied more ambitiously in order to be prepared for communicating potential nuclear and radiological emergencies timely, clearly and openly and enable citizens to make informed decisions in case of an emergency.

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