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1443 Noviembre, 2018

Social and Communicative Uncertainties Around the Accidental Release of Radioactive Particles from Ascó I Nuclear Power Plant (NPP) in Tarragona, Spain

C. Oltra R. Sala S. Germán S. López-Asensio M. Montero C. Trueba



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Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

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Departamento de Medio Ambiente

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Social and Communicative Uncertainties Around the Accidental Release of Radioactive Particles from Ascó I Nuclear Power Plant (NPP) in Tarragona, Spain

Oltra, C.; Sala, R.; Germán S.; López-Asensio S.; Montero, M.; y Trueba, C. 37 pp., 13 refs., 4 figs., 4 tables

Abstract:

Introduction: The objective of the present case study was to identify and analyse the societal and communication uncertainties around a nuclear radiological event in Spain, as well as to understand public and stakeholders' response to these uncertainties.

Method: We base the study on the implementation of three data collection processes: a review of documents, a media analysis (n=275), and semi-structured interviews with the affected population (n=10) and relevant stakeholders (n=13). First, we describe the event by means of documentary review. Second, we identify five main groups of socio-technical uncertainties related to the consequences of the incident; the communication of the incident; the effects of the incident; the management of the incident and the characteristics of the incident. Finally, via in terviews with the key stakeholders, we identify and analyse a more exhaustive set of societal uncertainties around the incident, especially those linked to issues such as risk perception and communication and involvement with the local population.

Results: Communicative aspects around the emergency (such as the timing of the communication, the amount and characteristics of the information provided, the perceived transparency, the actors involved) played a critical role in the development of the emergency, together with other issues related to the characteristics of the event and the management of the incident or its consequences.

Discussion: The findings suggest that providing transparent, timely and accurate information about a radiological incident by the competent authorities may improve local trust and confidence in the case of a nuclear emergency.

Incertidumbres Sociales y Comunicativas en Torno a la Liberación Accidental de Partículas Radiactivas de la Central Nuclear Ascó I en Tarragona, España

Oltra, C.; Sala, R.; Germán S.; López-Asensio S.; Montero, M.; y Trueba, C. 37 pp., 13 refs., 4 figs., 4 tablas

Resumen:

Introducción: El objetivo del presente estudio de caso es identificar y analizar las incertidumbres sociales y de comunicación en torno a un incidente radiológico nuclear en España, así como comprender la respuesta del público y los stakeholders a la incertidumbre en incidentes y accidentes pasados.

Método: El estudio se basa en la implementación de tres técnicas de recogida de datos: revisión de documentos, análisis de prensa (n=275) y entrevistas semiestructuradas con la población afectada (n=10) y stakeholders (n=13). Primero, describimos el incidente mediante una revisión documental. En segundo lugar, mediante un análisis de prensa, identificamos cinco grupos principales de incertidumbres socio-técnicas: relacionadas con las consecuencias del incidente; la comunicación del incidente; los efectos del incidente; la gestión del incidente y las características del incidente. Finalmente, a través de entrevistas con stakeholders clave, identificamos y analizamos un conjunto más exhaustivo de incertidumbres sociales, especialmente las relacionadas con cuestiones tales como la percepción del riesgo, la comunicación y la participación de la población local.

Resultados: Los aspectos comunicativos en torno a la emergencia (como la puntualidad de la comunicación, la cantidad y las características de la información proporcionada, la transparencia percibida, los actores involucrados) desempeñaron un papel crítico en el desarrollo de la emergencia, junto con otras cuestiones relacionadas con las características del incidente y su gestión o sus consecuencias.

Discusión: Los hallazgos sugieren que el hecho de que las autoridades competentes proporcionen información transparente, oportuna y precisa sobre un incidente radiológico puede mejorar la confianza del público en el caso de una emergencia nuclear.



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Social and communicative uncertainties around the accidental release of radioactive particles from Ascó I Nuclear Power Plant (NPP) in Tarragona, Spain

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1. Introduction

The communication approach during a nuclear emergency can generate significant changes in public risk perception and behaviour, unnecessary uncertainties (Abbott, Wallace, & Beck, 2006), as well as unintended political (Wakeford, 2007) and economic effects (Covello, 2011). Therefore, poor risk communication can create stress, conflict, additional crises and undermine public trust and confidence. Good risk communication can rally support, calm a nervous public, provide needed information, encourage cooperative behaviour and potentially help save lives (Covello, 2011).

The objective of this report is to examine the socio-technical uncertainties surrounding the radiological incident occurred in November 2007 in the Ascó I Nuclear Power Plant (Spain), with a special focus on societal and communicative uncertainties. We specifically aim to elucidate, by means of a media content analysis and semi-structured interviews with key stakeholders and affected population, the existing scientific and social uncertainties during both the release and post-release phases of an emergency. The result of this study will be a close examination of the societal uncertainties that the affected population, stakeholders and emergency management actors faced during this radiological emergency in Ascó.

2. Case setting

The Ascó nuclear power plant is a second generation nuclear power station located in Ribera d'Ebre (province of Tarragona), between the towns of Ascó and Flix and on the right bank of the Ebro river. The nearest provinces' capital cities are Lleida (140.000 inhabitants), located about 62 km from the nuclear power station, and Tarragona (456.000 inhabitants) located about 71 km.



Figure 1. Photo of Ascó Nuclear Power Plant (Ascó I) and a map of the location. Source: Google Images

It is formed by two nuclear reactors: Ascó I and Ascó II. The first reactor began operating on December 10, 1984, and the second on March 8, 1986. The reactors have a power of 1,032.5 MW and 1,027.2 MW. Both are Pressurized Water Reactors (PWR). Its cooling system uses the Ebro river water and consists of natural and forced towers. The Ascó power station uses uranium 235.

2.1. A chronological recap of the accident

An event in November 2007 in Ascó I NPP (Spain) originated the release of significant amounts of radioactive particles with activated corrosion product isotopes, through the discharge stack. The detection of the release and its subsequent notification to the Spanish Nuclear Regulatory Authority (CSN-Nuclear Safety Council-), took place four months after its occurrence, on April 4th 2008, when during a periodic radiological survey within the site, discrete radioactive particles in outdoor areas of the buildings were detected.

The event was originated in an operational incident, occurred at the end of the 19th outage of Unit I (started on October 27th, 2007 and ended on December 1st, 2007). The incident occurred due to the contamination of the fuel building ventilation system with water originated from the cleaning of the fuel transfer canal, at the end of the outage of the reactor, as a result of a combination of incorrect practices and non-compliance of the operating standards (CSN, 2009).

During the refuelling operating procedure, the transfer of the irradiated fuel elements from the reactor to their storage in the fuel building is made through the refuelling canal, which crosses the containment and connects the refuelling cavity to the storage pool. The separation gate at the entrance of the storage pool is opened during this process. Once finished it is closed, being the refuelling canal and cavity emptied of water and decontaminated. The decontamination includes blasting of walls and structures and entrainment of dirt and particles to the lowest level in which a collection well is located. The remaining water of the canal is extracted from that well, by means of a portable vacuum cleaner (CSN, 2009).

The ventilation system of the fuel building has some of its grilles located in the pool wall, between its upper edge and the surface of the water. In a manoeuvre not provided in the operating procedure, the deposit of the vacuum cleaner with the water and sludge was poured manually to the storage pool, being some of the water absorbed by the grilles either by direct spillage or by splashing.

The ventilation system of the fuel building has two extraction subsystems: one for normal operations, and another for emergency operations. In the first one, the sucked air is directed to a common collector and the stack without previous filtration, whereas in the second one, the air is led to a filtration system of high efficiency before it is directed to the common collector. Both subsystems share pipes between the grilles and the entrance to the filtration system and to the collectors behind the filters.

During all fuel-moving works, the emergency ventilation subsystem must be kept in operation, starting automatically when any of the two radiation area detectors register a pre-set dose rate value. This start-up leads to the automatic shut down of the normal ventilation subsystem, ensuring that any contamination present in the atmosphere of the fuel building is retained in the filter system and is not discharged through the stack.

The discharge of gaseous effluents through the stack is monitored continuously. These systems, on the dates when the discharge occurred, did not give rise to an alarm which might

suggest that the emission of radioactive particles was taking place, except on the 22nd December 2007. On that day a peak occurred in the particulate monitor but was not taken into account as it did not match with the development of an operative procedure at that time (CSN, 2009).

The detection of the release and its subsequent notification took place four months after the occurrence of the event, through the periodic radiological survey of the site. The available automatic radiological control systems failed mainly due to the fact that they are designed to detect homogeneous radioactive emissions and not discrete particles such as those involved in the event. On March 14th 2008, hot particles were first detected in the containment hatch area. During the following days, a further extent of the area subject to the radiological survey leads to discovering several hot points on the ground inside the double fencing the roofs of the buildings adjacent to the NPP stack (Gallego et al, 2010).

On April 4th, these findings were notified to the CSN, followed by press releases and official statements to the public, as well as a wide monitoring program to check more than 2,700 people through the whole body radiological counter, including workers and visitors. No person was found contaminated. A team of experts from the European Commission's General Directorate of Energy and Transport visited Ascó on April 29th and verified the radiation protection control methodology that confirmed the non-radiological significance of the event and endorsed the technology employed to guarantee the control measures from the operative, administrative and quality points of view (Gallego et al, 2010).

2.2. Release characteristics

A physicochemical and radiological characterization of the particles collected was carried out as well as an estimation of the source term. The particles collected in the outdoor areas correspond to activated corrosion products and have their origin in the discharge to the fuel pool of the liquid contained in the vacuum cleaner (Diego and Briceño, 2008), being the isotopic composition of the samples mainly ⁵⁸Co and ⁶⁰Co.

The estimation of the source term has been made taking into account the readings of the radiation monitors of the fuel building; the location of the vacuum cleaner during the discharge into the pool; the dimensions and materials of the vacuum cleaner; its activity once emptied; and the radioactive material collected outdoors, in the filters of the ventilation system and from the decontamination of the ventilation pipes.

The activity that accidentally passed through the ventilation system is approximately equivalent to the sum of the following (for the date 26/11/2007):

- Activity retained in the pipes of the ventilation system of the fuel building: 3,51E+04MBq
- Activity retained in the filters of the emergency ventilation subsystem: 2,46E+03MBq
- Activity retained in the outdoor areas: 4,09E+02MBq

A theoretical calculation to simulate the dispersion of the particles released the day of the incident was conducted. It took into account the physical characteristics of the stack, making possible to estimate the probability that a certain released particle, characterized by its size, could have reached a certain location. The study was developed using Computational Fluid Dynamics or CFD tools (Barbero et al, 2008).



Figure 2. "Location of the hot particles found and collected to July 2008 on an aerial view of Ascó I site". Ref: ANAV. Daily report to CSN of incident ISN-AS1-127. 28 July 2008.

The simulation took into account the orography of the NPP site, as well as significant buildings, to consider the movement of atmospheric air and particles. Due to the lack of information on the time when the particles where released, the calculations considered the atmospheric conditions on the periods where it was most likely to occur.

The results of the study (Barbero et al, 2008) show that the particulate deposition data are very similar regardless the time periods considered, with the larger diameter particles being deposited in the vicinity of the stack and moving further away as they decrease in size. The possibility of collecting large particles in regions far away would have its origin in the resuspension of particles by strong North-West winds.

An additional complementary simulation on the behaviour of smaller particles was also carried out concluding that the bulk of the small particles would be transported in the cloud, diluting the activity in the atmosphere (Montero, 2013).

2.3. Radiological consequences and protective actions applied (CSN, 2009)

2.3.1. Contamination of the ventilation system

The ventilation system of the fuel building was contaminated during the event. Cleaning and radiological control operations in different periods were carried out. The cleaning activities included vacuuming, brushing and mopping, the opening of logs as well as cuts in the pipes to facilitate the access and decontamination of their interior. The aspiration and change of the pre-filters of the two emergency units were also done.

A long-term radiological control program during the normal operation of the ventilation system (for the next two operating cycles), was established to verify the absence of particles in it. The operation of the ventilation system was kept through the emergency filtering units.

2.3.2. Contamination of the site

A radiological control of the site was carried out, to recover and analyse the particles found. In order to facilitate the identification and to be able to guarantee that the radiological survey had covered the whole site, it was divided into areas and within each, in smaller areas where the main individual structures were identified.

As a result of the radiological standardization process of the site, the surveillance program of the areas outside the controlled area already fixed, was expanded, being the survey carried out on a weekly, twice a year and yearly frequency, depending on the location.

2.3.3. Radiological survey off-site

Between 17th April and 14th May 2008, the CSN developed a special surveillance program to detect the possible radiological impact off-site the NPP at a distance of 3 km. The scope of the monitoring program was established taking into account the meteorological data and the available information related to the event.

The monitoring program included the Environmental Radiation Surveillance Program (PVRA) and its quality control, a specific surveillance control of the Ebro River and environmental gamma dose rate measurement stations. From the results obtained, it was concluded that the radiological activity off-site was not increased.

2.3.4. Radiological impact assessment

A monitoring program for the assessment of committed effective doses was established:

- Mandatory, for workers (staff and contracted personnel) and visitors, who had remained inside the double fencing, in the period between November 28th 2007 and April 8th 2008.
- Voluntarily, for those people who, during that period, had acceded to the site, remaining outside the double fencing.

Monitoring of other groups (family members of the NPP staff, inhabitants of localities close to the site) was not considered justified because of the low risk of exposure.

As a result of the application of these criteria, the monitoring program, which was originally intended to cover some 800 people, was expanded to include 2,717 people. In this context, special attention was paid to the controls carried out on different groups of schoolchildren who, during the period selected, visited the NPP.

In addition, a representative sample of workers, whose activities had a greater risk of internal contamination (for instance those involved in the location and removal of particles), was selected, in order to subject them to an additional independent control in the CIEMAT internal dosimetry service. In none of the controls performed, the results obtained were above the detection limits of the measurement equipment used.

2.4. Media coverage

The incident was covered by both national and local mass media (newspapers, TV channels and radio stations). Once the first newspaper article appeared on April 5th, 2008, the coverage about the incident remained in the media for several weeks, especially during April and May, with an important amount of news published. The information provided by the media was obtained fundamentally from the main involved actors: Ascó NPP, the regulator (CSN, *Consejo de Seguridad Nuclear*), environmental NGOs, authorities, national and local politicians and the affected population.

The information provided by both the national and the local press was very similar. There was certain unanimity in the way they dealt with the topic, although the local press provided more detailed information, probably due to the geographical proximity of the event. Initially, the incident was not excessively sensationalized by the media. We find very little evidence of amplification of negative messages or stigmatization of the nuclear technology.

During the first days after the public release of information about the incident, the media focused the attention on the detection of radioactive particles in the Ascó NPP site. The messages provided in the media often aimed at calming down the population. The mass media also highlighted the fact that the leak had occurred in November 2007.

On April the 9th, we find news articles about the complaints from local city councils showing the lack of communication channels between them, the NPP and the CSN. On April the 17th, the news covered the dismissal of the Ascó's NPP Director and the Chief of NPP's Radiological Protection Service as well as the finding of radioactive particles outside de Nuclear Power Plant facility.



Figure 3. Evolution of the coverage of the incident in the studied newspapers

On April 14th, the press highlighted some reports by Greenpeace, pointing out that the levels of radioactivity were higher than those informed during the first days. The media started to show a critical approach towards the perceived inappropriate management of the incident and the unacceptable information omission and the lack of openness by the NPP managers.

On April the 15th, the newspapers reported that groups of students from different high schools visited the NPP after the incident. This caused a great alarm, especially within the families of the youngsters and the school personnel. Following this, the media continued to give information about this issue, including the days in which the students took the medical checks, its results, etc. The media also reported the measures that were to be adopted to determine the possible presence of radioactive contamination in other potentially affected people.

During these days, some public administrations started to take part in the possible legal consequences for the Ascó NPP. On April 17th, Catalonia's ombudsman opened an ex-officio investigation. In addition, on April 24th Tarragona's Public Prosecutor's Office opened an investigation into the incident.

During May, the information in the media about the Ascó's incident started to decline and there were less news published about the incident. The radioactive check-ups carried out among the potentially affected population confirmed the absence of contamination. However, certain collectives called into question the reliability of the test results. On May 15th, news about an alteration of the radioactive detectors made by the Ascó NPP appeared on all news-papers. At the same time, both NGOs and authorities defended a severe sanction to the NPP managers. Moreover, some political parties requested the money collected by the economic sanction should be invested in the region.

Early in June some news about the localization of new radioactive particles outside the installation still appeared. On June 10th, the Ascó NPP carried out a scheduled stop to perform the radiological cleaning of the plant and to obey the safety rules required by the CSN after the event. One month and a half after, on July 21st, Ascó NPP has connected again to the power supply. Nevertheless, no actions avoided a fine of 14.4 million Euros imposed by the Ministry of Industry for four major infractions and two minor infractions. It meant the highest economic sanction in the history of Spain's nuclear power plants.

3. Method

3.1. Media Analysis

3.1.1. Information sources and eligibility criteria

To go in depth into the socio-technical uncertainties of the event, we collected news articles that appeared in the printed mass media. We searched in an electronic media database (*My News*). We designed a three territorial category: national, regional and local. To choose a representative sample of the media, we searched the most read newspapers in the area during 2008, the year of the incident (AIMC, 2008). One of the requisites was that it should be a quality newspaper, so we excluded the yellow press. We searched for news published on the first day the public knew about the emergency until 372 days later. In our case, this period was from 05/04/2008 to 12/04/2009. We used the following keywords: *Ascó, nuclear, particles, leak* and *incident*. The word *Ascó* had to be in all results accompanied by any of the other words: *nuclear, particles, leak* or *incident*. The key words were written in the national language. We introduced it in the following way: *Ascó* AND (*nuclear, partículas, fuga, incidente*). All the news not specifically relating to the particles leak incident were excluded, despite talking about the Ascó Nuclear Power Plant. Newspapers' front pages and opinion articles were also excluded due to the few information the front pages contain and the subjectivity of the opinion articles.

| Newspapers | Number of news |
|--------------------------|-----------------|
| National | |
| El País | 51 |
| El Mundo | 34 |
| Regional | |
| La Vanguardia | 32 |
| El Periódico | 36 |
| Local | |
| Diari de Tarragona | 74 |
| Diari Més Tarragona | 48 |
| TABLE 1. A sample of new | spaper articles |

After applying these filters, we get a sample of six different newspapers (Table 1).

3.1.2. News categorization and analysis

The aim of the analysis was to identify what uncertainties were reported, how and by whom. We also tried to identify which concerns were being covered and which of them were given more or less attention. Finally, we also wanted to identify who are the main information sources during and after an emergency.

Our approach combined qualitative and quantitative analysis. For the qualitative analysis, a thematic analysis using MAXQDA was used to code the newspaper articles. For the quantitative analysis, a coding protocol was created to register all the information needed in a database. We relied on two coders. The most important codes for the analysis were the *Key sentences* and the *Uncertainties* extracted from these articles. An *Uncertainty* is defined as a

situation which involves imperfect and/or unknown information related to the investigated nuclear emergency case. Uncertainty is the lack of certainty, a state of having limited knowledge or information where it is impossible to exactly describe the existing state related to the emergency, a future outcome, or more than one possible outcome including consequences.

Two pilot tests were developed to check the coders' accuracy. For the pilot tests, we relied on four coders. The first test consisted of the coding of 10 news articles and the second one, the coding of 5 articles. After each coder completed these articles, the differences between the coders were discussed to establish a uniform coding methodology to reach a higher intercoder reliability.

3.2. Semi-structured interviews for characterization and response to uncertainty in nuclear emergencies

3.2.1. Sampling

With regards to the **affected population**, a sample of random calls to five municipalities in the range of 10 kilometres from the NPP was used (Table 2). We conducted eleven interviews giving priority to the population from Ascó, Vinebre and Flix, which are the three closest towns to the nuclear power plant. After the interview, we registered the gender and the age of the respondents as sociodemographic data.

| Interview | Gender | Age | Municipality |
|-----------|--------|-----|------------------|
| number | | | |
| 1 | М | 45 | Ascó |
| 2 | М | 70 | Ascó |
| 3 | F | 50 | Ascó |
| 4 | F | 72 | Vinebre |
| 5 | F | 49 | Vinebre |
| 6 | F | 47 | Flix |
| 7 | F | 59 | Flix |
| 8 | F | 55 | Riba-Roja d'Ebre |
| 9 | F | 80 | Riba-Roja d'Ebre |
| 10 | F | 44 | La Fatarella |
| 11 | F | 42 | La Fatarella |

Table 2: Affected population interviews

Regarding the **Key Actors**, we conducted 13 interviews from a sample of relevant actors during the emergency. We tried to collect the diversity of actors involved although some categories of actors were more difficult to reach and/or interview. They were classified into seven categories related to their role. There were politicians, authorities, industry representatives, experts or academics, journalists, environmentalists and other actors like teachers from the schools who visited the NPP during the incident.



| 1 | Expert/academic |
|----|--|
| 2 | Expert/academic |
| 3 | Expert/academic |
| 4 | Expert/academic |
| 5 | High school teacher and director |
| 6 | Journalist |
| 7 | High school teacher |
| 8 | Authorities |
| 9 | Industry representative |
| 10 | Environmentalist |
| 11 | Authorities |
| 12 | Representative of an association of municipalities |
| 13 | Politician |

TABLE 3: Key actors interviews

3.2.2. Procedure

The **interviews with the affected population** were carried out by two interviewers during a four-day span. The interviewers called to a sample of randomized landline phone numbers from a phone listing of the studied municipalities. The interviews were made during different daytimes, at morning, midday and afternoon, trying to reach the maximum different profiles of respondents. When the calls were answered, the interviewers presented themselves, the institution and the project, also indicating the confidentiality and the approximate duration of the interview. On average, the duration of the interviews was 10 minutes.

If the respondent did not want to go forward with the interview, the call was ended. Around 70% of the calls were ended before the interview started, due to the rejection of the interviewee. If the respondent was willing to answer, the interview started. The interviews were semi-structured, consisting of several key questions in order to explore the areas related to the experiences in the context of the nuclear emergency. This approach is more flexible compared to structured interviews, in the sense that it allows the discovery or elaboration of information related to the uncertainty that is important to participants but may not have previously been thought of as pertinent.

The interview started with questions about the knowledge and familiarization with nuclear power and, indeed, with the perception of the causes of the incident (see Annexe 1 (Affected population interview protocol).

Then, respondents were asked about the communication and the information received during the emergency, for instance: if they were in the town when the news disclosed, how they heard from the incident or if the information received was complete and clear. There were also questions about the implication and engagement related issues, such as if there were meetings between the authorities and the population to inform about the incident or if the population had to be taken into account more seriously in a future emergency.

The questions about risk perception included the first thoughts of the population just after the incident was disclosed, their worries, or their perception of the neighbours' worries.

Regarding the information appeared in the media regarding a lack of transparency of the authorities and the NPP managers, the respondents were asked about their trust in the first information received after the incident, trust in the management of the incident or in the management of future incidents.

In terms of emergency response, the respondents were asked about the medical checks to find radioactive particles, the guidelines to follow in case of emergency or the knowledge about the effects and distribution of iodine tablets.

In the case of the **interviews with the key actors**, the interviews were made during a fourthmonth span. The interviewees were previously contacted by e-mail to invite them to participate in the study and to schedule a date to do a phone interview in the case they were interested in. The contacts were obtained through the media analysis and by snowball sampling. On average, these interviews had a duration of 35 minutes.

The interviews were also semi-structured, consisting of several key questions regarding their role and experience in the nuclear emergency. The interview started with questions about the role of the interviewee during and after the incident (see

Annexe 2 (Key actors interview protocol).

Next, they were asked about the uncertainties appeared and the management of the event, asking about the things that were made in a correct way and the things that have been done following incorrect or negligent procedures.

Finally, there were questions about communication with the authorities and with the public, and on the role of the public during the incident.

3.2.3. Analysis

Both *Key Actors* and *Affected population* interviews were transcribed and coded with MAXQDA with the same categories we did in the media analysis: *Technical uncertainties after the incident, Uncertainties related to the effects of the incident, Uncertainties in the management of the incident, Uncertainties related to communication aspects, Consequences of the incident.*

Once the interviews were coded, thematic analysis of the extracts was performed.

4. Results

Technical uncertainties after the incident

A first technical uncertainty reported both in the newspapers and in the interviews was related to the **range of the leak (affected area)**. The exact perimeter affected by the escape was not clear, probably because of the late detection of the leak (for instance, the wind and the rain during the weeks after the leak could have influenced the path and deposition of the particles). Early after the event, it was transmitted that the particles have not left the nuclear facility but then many news articles appeared announcing the finding of particles outside the NPP area.

At first, it was stated that only the area of the NPP facility had been affected by the leak. The following extracts show these messages:

"No mechanical sensor or manual operator has located contamination beyond the limits of plant property" [Press]

"The deputy director of Radiation Protection of the CSN, said yesterday that he had a 'reasonable certainty' that nothing contaminating has come out..." [Press]

During the following days, some news came out regarding the detection of particles outside the NPP facility:

"The surrounding area of the Ascó nuclear power plant has also been contaminated by the leakage of radioactive particles" [Press]

Even in June, new particles outside the initial range were found. In the end, it was clearly recognized by representatives from CSN that they were not sure about the exact diffusion of the radioactive particles. The following extracts, from the Spanish Regulator (CSN), clearly transmitted this uncertainty:

"It will be impossible to find out if there have been radioactive particles that have travelled a few kilometres" [Press]

"The CSN trusts that the direction of the dominant wind in the area has transported the particles in the opposite direction of the town" [Press]

"CSN recognize that it is more than probable that some particle has gone further pushed by the wind" [*Press*]

In addition, the various actors involved (NPP managers, regulatory body, environmental NGOs) in the incident were in disagreement regarding the range of the leak:

"According to the plant, the particles, [...], have been deposited on the ground, although Greenpeace says they have also appeared on roofs, fences and other areas of the atomic complex" [Press]

As stated by one of the interviewed experts, the company managers established the perimeter of measurement at the beginning, without taking into account scientific arguments.

"No modelling of the dispersion of particles was made because the company said that particles had not gone beyond 1 km. However, cobalt particles could have travelled hundreds of kilometres; they are very small particles, such as the sand of the Sahara" [KA-4, expert]

Other expert affirmed that although the main plume of the particles stayed in the perimeter of the nuclear power facility, the number of particles that could be out was uncertain.

"Because we were looking for... you could always find especially at the beginning... but that was already mostly inside the plant, because let's say the incident, the plume that could be formed with the particles... that is, the largest amount, fell in the plant" [KA-3, expert]

Although all the affected population interviewed remember the incident, they neither know if the incident was serious. They nor can specify how far the escape arrived.

"There was a leakage... they were checking, if not all the town, all the lower part, the part of the river, to see if they found particles..." [AP-3]

A second technical uncertainty found in the articles is the **magnitude of the leak**. A disagreement on the exact magnitude of the leakage was transmitted in the news. While environmental NGOs qualified the incident as important:

> "Greenpeace yesterday raised the figure to 5 Curies, which is qualified as 'important level' of radioactivity" [Press]

> "Greenpeace adds that the contamination emitted outside greatly exceeds the levels announced by the plant owners" [Press]

Other actors clearly stated, "The radiation levels have been insignificant" [Press] or:

"The director of Radiological Protection of the CSN sent a reassuring message to the population, assuring that although new contaminated particles are being found outside the plant, they have very low levels of radioactivity" [Press]

This seems to be related to the difficulties with the measurement because the particles are only detected at a very close distance (20 centimetres).

As stated by one of the journalists interviewed, there was a great disparity between sources: "And... there was a great disparity between what some sources said to me. I had sources in... I'd rather keep it reserved" [KA-6, journalist].

One of the experts said the leak of hot particles was true but the characteristics itself of these particles does not let to easily identify and quantify the activity.

"It was proved that there was a leakage of radioactive material outside, and in the form of what is known as hot particles, which means that it is very concentrated and in this concentration, there is a lot of activity but for its own characteristics... The identification of where it is and its quantification is difficult, it is not easy" [KA-2, expert]

In that sense, contradictory messages related to the **severity of the incident** were transmitted. While managers from the NPP first considered it as a minor incident, the regulatory authority (CSN) decided at the beginning of April that the incident was one of the four most serious incidents in the history of nuclear energy in Spain. CSN admitted that the leakage had been between 100 and 400 times greater than the stated at the beginning of the incident:

"The amount of radioactivity collected outside the NPP is 19.5 million Becquerel, while until the last weekend only 235,000 Becquerel was admitted by the NPP managers" [Press]

In mid-April, Ascó managers acknowledged having underestimated the seriousness of the event, and the CSN raised the magnitude of the incident from level one to level two.

One of the interviewed key actors considered that the CSN tried to defend the nuclear power plant after the incident, while they maintained that the levels of radioactivity were below the limits.

"That they are capable of doing this type of calculations and at that moment they came out saying that the radioactivity was below the limits, which was a minimal fraction of the permissible. Then, after the months they were rising it and every time it was more and more and there were thousands of particles and clearly what the CSN did was trying to defend the interests of the company" [KA-10, environmentalist]

Uncertainties related to the effects of the incident: Health risks

Similarly, divergent messages regarding the **health effects** of the leakage appeared in the newspapers. Managers at the NPP clearly transmitted that the incident posed no risk for the health of the local population:

"If only one person had ingested all the radioactive particles found, would not have exceeded the legal limits for the general public, which are lower than the levels that are requested for employees" [Press]

"The radioactivity of the 150 particles found so far represents a null impact in the health of the people and for the environment" [Press]

"Even if a person incorporates all the particles found, their effect would be much lower than that of an X-ray" [Press]

Nuclear authorities conveyed a similar message:

"According to the Deputy Director of CSN, the event did not pose a risk to the environment and if a person had ingested the particle with the highest activity he would have received 0.8 milliSievert, 80% of the maximum allowed for one year" [Press] "We want to reassure the population by stating that the radiation of the particles emitted in November poses no risk to people" [Press]

One of the interviewed experts also sent a reassuring message on the health implications of the leak: "We have to be calm, this is less serious than it seemed. It is important but in terms of the health risk it is less serious than we thought." [KA-12, Representative of an association of municipalities]

Divergent messages regarding health concerns of the incident appeared among the affected population. While some of the interviewees felt worried when the incident happened, other interviewees did not feel worried about it. One of the reasons they argue is that they have lived near the NPP for many years and they cannot be continuously worried. Other people consider there are other things that are equally dangerous in which people are constantly exposed, such as air pollution.

"Well, it is something that is there, but at the moment there hasn't been an accident, so you do not have to think about it because in this case, you can't live" [AP-10]

"For my health, I am concerned every time I go to Barcelona, for the emissions and the pollution there. For my health, I care every time I use the microwave and I am exposed..." [AP-3]

However, environmental NGOs such as Greenpeace questioned these statements.

Concern about the health effects of the incident was spread among the workers at the plant; some of them even voluntarily used a radioactive scanner in the double fenced area. Concern also spread among the families of those students who visited the plant before the notification of the leakage. Concerns from potentially affected people are poorly covered in the media. Only one press article clearly pointed out some of the concerns from the public:

"All citizens ask themselves how it is possible that something like this has happened? Since when do they know and since when the Nuclear Safety Council know? How is it possible that all surveillance plans have failed? How far has radioactivity spread? What measures will the Nuclear Safety Council take in this regard?" [Press]

One of the interviewed environmentalists said the risk was that some people could have inhaled or incorporated these particles in their organism with the serious health concerns it could have.

> "But the risk was not so much for a gigantic radioactive cloud but for the particles that could have affected certain people who had the bad luck to incorporate them by inhalation or by contact with the skin" [KA-10, environmentalist]

Most of the affected population interviewed are unaware of the **health effects** of the incident although part of them believes that there was no risk to the people's health.

"The consequences [of the incident] are unknown" [AP-1]

To assess the effects of radiation on exposed people, **health exams** were initiated. Initially, only 800 medical checks were planned, but they were extended to 1,600. No radioactive contamination was found:

"The check-up of some 1,550 workers of the plant and subcontractors is planned. So far, 900 have been analysed and in all cases, the absence of contamination has been verified" [Press]

High school students who visited the NPP were also examined and no radiation was found: "The totality of the radiological controls, carried out by a mobile unit (truck) displaced by the Ascó nuclear plant to the schoolyard, was negative" [Press]. The measurements were supervised by, inspector of the Nuclear Safety Council (CSN), expressly displaced to verify the process.

One of the interviewed teachers said that the regional Health Department and the parents of the school made some pressure to guarantee the possibility of health checks and to be reassured that there was no risk.

> "Yes, what happened is that the Health Department put pressure, then the Parents' Associations of the schools, the parents involved, to avoid any suspicion, health checks were made" [KA-5, High school teacher]

Some actors declared that despite health checks for people not working in the plant were not required there was a need to reassuring them. In the same way, inhabitants from the closest town were also invited to pass medical checks.

"The mayor of Ascó said yesterday that any person in the population that wishes may undergo radiological checks within the municipality" [Press]

Finally, it was transmitted that "the analyses to 2,116 people (workers and visitors) have not detected anyone contaminated" [Press]. One of the key actors said that more health checks than needed were made to reassure the population: "I would say that more than needed to reassure people was done" [KA-2, expert]. Anyway, some political parties stated, "Although the measurements made to 2,116 people did not show significant doses, the leak was enough to produce a dose higher than that allowed for the public" [Press].

Regarding health exams, affected actors express that do not remember if medical checks were done to the potentially affected citizens. However, some respondents declared that if they had been invited to pass a medical check they were gone.

"I do not remember anyone being checked for radioactive contamination" [AP-4]

"I would say that the population was not checked. If there were health checks for the population I had volunteered to pass it" [AP-7]

Besides, an important concern in the neighbouring area was related to the **effects on the tourism**: *"it can affect the image of the region as a tourist destination, agriculture and recreational activities that are developed around the Ebro River"* [*Press*].

One of the key actors said the region nowadays do not have any alternative economic sector. Neither a certificate of origin of any product.

"Not fear, but you must know the economic reality of that area, there is not too much choice either. For example, the Ribera d'Ebre did not have any certificate of origin of anything" [KA-6, journalist]

Some interviewed affected actors affirm that the presence of the NPP affects agricultural activities of the region.

> "As immediate consequences... there is a handicap that we have to pay all the people who live in the area. Ascó apart from nuclear energy cannot do anything else [...] Ascó cannot live on its agricultural brand because it already has a hallmark, we are marked" [AP-1]

Uncertainties in the management of the incident

One important uncertainty related to the management of the incident is the **cause** of it. It is worth to take into account that the incident was informed a few months after it had happened. In May the 9^{th,} it was published in the media that the causes of the incident were still to be determined. In the next days, and again in the media, different parties pointed out different causes: a failure in the surveillance systems, a low safety culture, economic interests (above safety), etc. CSN accused the plant of *"inadequate control of radioactive material"* [Press]. The association of affected towns by nuclear power plants (AMAC) accused the owners of the plant of prioritizing *"benefits before safety"* [Press]. Some statements in the media articles clearly exposed that *"the most serious thing at the moment is not the radiation but "the deficiencies in the safety culture" of the NPP"* [Press].

One of the key actors said the series of errors related to the lack of safety culture could not be allowed.

"I think that at the end of everything, when we found out how it had happened... that is, because a number of radioactive particles had escaped outside, we learned a number of errors that cannot be allowed, right? It was pretty ridiculous all this" [KA-6, journalist]

One of the interviewed key actors considers that the CSN attitude was secretive and vulnerable to the NPP interest.

"But the attitude of the CSN has not changed much; it remains a very secretive attitude, of protection of the interests of the nuclear power plants, in contrast of the protection of public safety in the case of radiological risk. That should be the first and fundamental objective of the CSN but it is often clearly subordinated, placed in second place because it is subordinated to the interests of the plants" [KA-10, environmentalist]

Some of the affected population interviewed remember that the incident was due to a human error.

"There was a leak because there was some mistake" [AP-5]

"I remember hearing that a person who worked at the plant without knowing what he was manipulating threw a product or thrown contaminated water or I do not know, threw a product out of the plant" [AP-7]

As portrayed by the media, other relevant actors exposed additional aspects related to the management of the incident, such as **signs of a possible deficiency or negligence in the management procedure**. For instance, the party that governed in Spain (PSOE) pointed out that three days after the incident, the NPP deactivated the alarm that prevents the radioactive particles from reaching the outside. Errors in the cleaning process were also pointed out:

"CSN sources lashed out yesterday against Ascó's management for having half-cleaned the ventilation system" [Press]

"Other sources of the regulatory body (CSN) attacked the "apathy and neglect" of the management of the power station" [Press]

This kind of headlines appeared in the national newspaper between the seventh and the 8th of April.

Some of the affected population do not know if the incident occurred in 2008 was correctly managed, but even though they believe that if there were an incident, the NPP would know how to manage it properly.

"I cannot tell you if it was managed correctly" [AP-7]

"In case of an incident, I trust in the management of the emergency" [AP-6]



Figure 4. Uncertainties around the incident. Source: Own elaboration based on content analysis

Communication aspects

Much news referred to uncertainties in the communication process of the incident. Newspapers clearly highlight that there was an important **delay in the communication** of the incident. Ascó NPP managers informed late the CSN. The next quotes illustrate how this delay appeared in the news:

"The management of Ascó nuclear power plant was aware of the leakage of radioactive particles on March 14, in the middle of Easter, and did not notify it to the Nuclear Safety Council (CSN) until Thursday" [Press]

"Dominguez admits that there has been a communication problem. The leak occurred on November 26 and was only notified on April 4" [Press]

Besides, an environmental NGO informed the public about the leakage earlier than the nuclear authorities (CSN) did. The notification of the event by the CSN came an hour after the Greenpeace announcement and the ANAV (Ascó NPP managers) declaration came two hours later.

One of the interviewed key actors expressed that if the CSN was a real independent organism they had to start the protection measures when they know about the leak:

"Obviously, if the CSN had been a clearly independent body, it would give priority to the protection of the public against radioactive and radiological risks... when they knew it in October or November, what they would have had to do was to start the application of these measures to the public" [KA-10, environmentalist] Regarding the affected population interviewees, much of them knew about the leak due to the information appeared in the press, especially in the newspapers. This can reflect the delay in the information because the population living near the nuclear power plant know neither about the incident nor about the leak: *"I do not remember how I found out, maybe by the me-dia" [AP-3]*. Other affected people who had family or close friends working in the NPP affirm they received more information than the one that appeared in the media: *"My husband works at the nuclear power plant. Maybe we could learn a bit more about what happened than if we get informed by the media" [AP-6]*.

In addition to the delay in communication, a **lack of information** from the NPP managers to the other actors is also transmitted in the news. The NPP did not communicate the leakage to the CSN; in fact, they hid the leak to the CSN resident inspector. The CSN accused the plant of providing "incomplete and deficient information" [*Press*]. The Deputy Director of Radiological Protection of the Council, explained: "We are disappointed. We have given inadequate information because we relied on incorrect information from the NPP" [*Press*]. The CSN opened an investigation to the plant for hiding information.

Regional and local authorities were not informed. Mayors of the surrounding towns claimed this lack of information. For instance, one of the articles quotes a local politician from a small town surrounding the NPP regarding the lack of information: *"If they had warned us before, we would be talking about the management of the crisis and not about the hiding of information"* [Press].

NPP managers did not communicate the leakage either to the workers or to the schools that have visited the plant days after the incident:

"The director of the school declared to feel 'hurt' by the lack of information" [Press]

"Students from the high-schools that visited the plant were informed about the leakage in the news. Yet NPP workers learned about the leakage when it leaked to the press" [Press]

One key actor claimed that although the press mentioned one of the schools who visited the NPP, they omitted his own school.

"Nothing. And then when it already come out in the press, then they get in touch with us, eh... afterwards in the press it came out a lot about the Marists of Girona, and they omitted us" [KA-5, High school teacher]

Environmental NGOs consider insufficient the information provided on how the release of radioactivity occurred. Around fifteen members of the environmental NGO Ecologists in Action had planned to visit the nuclear plant one month after the incident, but the visit was cancelled arguing construction and maintenance works. At the same time, environmentalists were accused of causing alarm among the population.

Many of the affected population interviewed consider that they did not receive enough information about the incident. For instance, none of the interviewees remembers that informative meetings were held between the authorities and the population to explain the incident. Nobody remembers either receiving clear guidelines on what to do in case of an incident.

"We did not receive any information about whether particles had been found when they came to measure here" [AP-7]

"The City Council did not give any information to the population about the incident" [AP-7]

"I do not remember if there were informative meetings with the population. I do not think so" [AP-2]

The communication channels between local authorities and the NPP are questioned by some of the actors in the news articles. This **problem with communication channels** is another source of uncertainty. Flix is located 3 km from the NPP but no one called the mayor to inform or warn him about the leakage:

"The Mayor of Flix, yesterday regretted the few communication channels that exist between the town hall, the nuclear power plant and the Nuclear Safety Council" [Press]

"The mayors of the villages near the nuclear power plant heard about the leak of radioactive particles by the press" [Press]

An interviewed journalist said he had to inform the mayor of Flix about the leak because the mayor did not know anything about the incident: "And I informed the mayor of Flix that this had happened" [KA-6, journalist].

Therefore, the association of municipalities affected by nuclear power plants (AMAC) expressed their anger and demanded a revision and improvement of the communication channels. In the end, the NPP promised to improve its information policy to the 13 mayors of the area of influence of the plant.

In contrast, one interviewed local politician reveals that in his case the communication with the NPP managers and the CSN was perfect, on time and cordial.

"It is essential in every way because, on one hand, it is very important to thank them for it, but on the other hand, it is very important that they fulfil the commitments of the relationship, that the management of the nuclear power plant calls the mayor through his chief of communication and tells him what happens" [KA-13, politician]

Regarding the communication channels, some of the affected population interviewees missed more information from the City Council through all the stages of the incident, from the start of the leak until the clean-up and the detection of particles.

"You should always be more aware of the population. We have to know what we have and what we do not have next to our house" [AP-8]

"We did not receive any information about whether particles had been found when they came to measure around" [AP-7]

Communication about the incident is frequently portrayed as **not transparent enough** in the news articles. Representatives from Greenpeace, for instance, said they had serious doubts about the data provided by the plant to the CSN and described the explanations as "incomplete". In fact, Greenpeace declared *"to have proven that Ascó tried to hide the escape to the detriment of public health"* [*Press*].

As indicated by the Greenpeace spokesperson "The plant lowered the sensitivity of radiation detectors to avoid notifying alarms to the organism" [Press]. The national nuclear authority (CSN) concluded that there were eight "deviations, breaches and bad practices" [Press]. At the same time, an employee of the NPP declared, "the management of the plant has 'fulfilled' with the procedure, giving information about the radioactive leak" [Press]. Besides, people from the nearest town declared that it is difficult to criticize the NPP because it is the main employer in the town: "A thousand inhabitants do not matter anything in the interests of a nuclear? They exploit us" [Press].

Some of the interviewed key actors also shared this opinion about the lack of transparency and the hiding of information: "yes, yes, yes. Eh... the whole feeling was that... that they were not explaining everything" [KA-5, High school teacher]. One of them even says the regulator wanted to protect the NPP management company.

"The initial reaction was that, to protect the management of the company, to minimize the importance of the incident, minimizing it but in a totally unfortunate way in the sense that it was deception after deception. And then they gradually recognizing it" [KA-10, environmentalist]

On the other hand, technicians at the plant explained that the CSN has decided not to tolerate more "own interpretations" by the Ascó management because of the numerous irregularities in the communication of the radioactive leakage and its importance.

The following message appeared repeatedly in the press: "What is relevant in this case is the lack of transparency rather than the scope of the event" [Press].

Some interviewees from the nearby towns consider that the NPP always gives the minimum information. In their view, the information received was not completely clear. Even, some of them think that the NPP hides information to the population. In fact, there are different interviewees who believe that they do not know many of the things that really happen at Ascó NPP.

"There is always something hidden, whatever it is" [AP-5]

"The information I received was neither complete nor clear because they said nothing had happened, that it was not important and then Greenpeace came and they looked at it and found more areas with radiation" [AP-7] Another concern related to the communication of the incident was that the communication was **excessively technical** and difficult to understand by the reader.

There is also some evidence of **contradictions in messages** between different actors but also from the same actor: *"The CSN confirms the irrelevance of the incident but states that a more detailed exploration is necessary"* and *"Ascó NPP and CSN claim that there has been no risk to people while Greenpeace puts in doubt"* [Press].

One of the interviewed actors also remembers disparity between figures given by different sources: "And... there was a great disparity between what some sources said to me and the others" [KA-6, journalist].

Consequences of the incident

An important debate regarding the need of **sanctioning** the NPP was reported in the media. *"The event will most likely motivate a sanction from the Nuclear Safety Council"* [Press]. They were sanctioned especially for the delay and the deficiency of the information granted by the NPP: *"but they were fired with a powerful sanction especially because they had not warned at the time"* [Press]. The possibility to reinvest the fine in aid to the affected region was suggested by some parties:

"The group of CiU in the Congress has presented a motion so that the Government allocate the sanction that is imposed to Endesa to reactivate the region" [Press]

From another point of view, one of the key actors thinks the economic sanction was exaggeratedly high.

> "My impression is that the financial sanction was exaggerated considering the real risk but there were people who did not think so and the evidence is that a judge accepted..." [KA-2, expert]

Finally, the NPP faced a million dollar fine and a mandatory shut down of electricity-producing. Many voices declared in the media that the shutdown of the activity supposes a great economic loss for ANAV and Endesa: *"the real economic damage for Endesa and Iberdrola"* [*Press*] or *"Stopping the NPP is economically worse than a fine"* [*Press*]. Some parties requested **more severe punishments**:

> "ICV requests prison sentences of up to 20 years and the disqualification by many others, according to the articles of the Penal Code on crimes related to nuclear energy" [Press]

Some of the interviewed key actors also think this incident needs to be clarified and to get criminal proceedings: "Obviously this was a subject that demanded or should demand responsibilities from a criminal point of view" [KA-10, environmentalist].

Apart from the **clean-up work**, ANAV admitted that the shut down would be used to review the nuclear procedures. The CSN clarified that the shutdown of the plant had been a decision

of the owner of the nuclear, not from the CSN, and had done so to decontaminate the areas that are not accessible with the plant in operation.

Cessations were requested to avoid the policy of concealment of information. Finally, the Director of the NPP and the chief of radiation protection were dismissed. Anyway, the media reported some complaints because the dismissed directors continue to hold management positions in the company.

Different parties also requested **changes in the safety protocols**. For instance, the regional government declared, *"they were negotiating with the Nuclear Safety Council (CSN) the creation of a 'stable protocol' for action in the event of incidents" [Press*]. Nevertheless, Endesa and Iberdrola, owners of the NPP, refused to increase investments in nuclear maintenance and safety.

One of the key actors affirms that a new protocol was created consisting of the communication of every incident to the mayors by SMS.

"Thereafter, the plant itself launched a new protocol to inform the mayors about any notifiable incident that happens by SMS" [KA-6, jour-nalist]

The affected population interviewed from the closest towns generally know the safety protocols to be followed in an emergency.

"There are paths, gathering points. Depending on the direction of the wind you have to go always to the opposite side. Keep everything closed and follow the instructions given at the meeting point" [AP-2]

On the other hand, some people from towns farther but still in the 30 km radius do not know the procedures to follow in an emergency case:

"I would not know what to do in case of an emergency. I suppose they would explain it to us, some sirens would sound and they would not let us move from here, we are wall to wall with the power station" [AP-4]

Other representatives of the affected populations believe the emergency protocols should be updated and improved after the incident.

"There is a Plan. It depends on the area where you live. You know the meeting point where you should go. I understand that it should be strengthened. [...] I think the City Council, the nuclear power plant and all the organisms involved should meet and reinforce it. It is always good to emphasize it and have it clearer. People know it but not enough, people should have it clearer" [AP-1]

According to some of the actors' statements in the articles, the incident and its management produced a **lack of trust in the management of nuclear energy** in Spain.

One of the key actors thinks that the effect of the NPP not informing transparently enough about the incidents combined with a time where some conflicts erupted in the plant, reduced the trust of the public in the management of nuclear energy.

"This is a matter that scares people a lot, there were several conflicts in the nuclear power plant in that period, and... with this not informing attitude by the NPP, suspicions about nuclear energy increased a lot... from the parents and from ourselves" [KA-5, High school teacher]

Nevertheless, some of the people living nearby the NPP declare they trust in the management of nuclear energy, both in managers of the plant and in authorities. They say they have to trust them because they live near the plant and there is not an alternative:

"Yes, I trust in the management of emergencies. If after 20 years we do not trust them..." [AP-2]

"Let's say I should trust. I should trust. Every time I trust less the actions of the human being but I should trust it clearly, otherwise, we would not live calm either... I think it is a very serious thing and that therefore must be treated in a very serious way. I should trust, clearly" [AP-3]

Results from the quantitative content analysis

Additionally, we carried out a quantitative analysis of the socio-technical uncertainties that appeared in the news articles from the studied six newspapers. It consisted mainly in counting the number of times an uncertainty appeared in the articles. In this section, we present these quantitative results classified in the inductively generated subcategories (from the qualitative analysis).

| Uncertainty type | Number of articles |
|---|-----------------------|
| Consequences of the incident | 279 |
| (Lack of) trust in nuclear management | 97 |
| Complaints / Fines / Economic costs | 90 |
| Changes in safety protocols and emergency response | 50 |
| Clean up works | 22 |
| Cessations | 20 |
| Communication aspects | 266 |
| (Lack of) transparency | 110 |
| (Lack of) information | 76 |
| Delay in communication | 32 |
| Contradictions between the messages of the different stakeholders | 25 |
| (Problems with) communication channels | 21 |
| Excessively technical information | 2 |
| Uncertainties related to the effects of the incident | 241 |
| Health risk and effects | 113 |
| Health exams | 82 |
| Environmental risk and effects | 33 |

| Impacts in the region / Stigmatization | 13 |
|---|-----|
| Uncertainties in the management of the incident | 200 |
| Deficiencies in the management procedures / Negligence | 105 |
| Causes of the incident: Safety culture / Human error | 64 |
| Response time | 11 |
| Causes of the incident: Functioning of the surveillance systems | 10 |
| Causes of the incident: Economic interests | 10 |
| Technical uncertainties | 169 |
| Magnitude/Severity of the leak | 84 |
| The range of the leak | 79 |
| Difficulties in the measurement | 6 |

TABLE 4. Number of times an uncertainty has appeared in the news articles

The more frequently thematic category in the articles relates to the *Consequences of the incident*, with 279 mentions. Looking at the subcategories we can observe that the *Potential loss or lack of trust in nuclear management* was the more cited with 97 hits, followed by *Complaints / Fines / Economic costs* (90 times); the *Changes in safety protocols and emergency response* (50 times); the *Clean-up works* (22 times) and the *Cessations* (20 times).

The second most mentioned category, very close to the first one, relates to the *Communication aspects* involved in the incident, mentioned a total of 266 times. The two most cited subcategories, with a great difference, are *(Lack of) transparency* (110 times) and *(Lack of) information* (76 times). At a far distance, we can find the *Delay in communication* (32 times); the *Contradictions between the messages of the different stakeholders* (25 times); the *(Problems with) communication channels* (21 times) and the *Excessively technical information*, with only two mentions.

Regarding the Uncertainties related to the effects of the incident, with a total of 241, the *Health risk and effects* is the most mentioned subcategory with 113 hits and followed closely by the *Health exams* (82 times). At a distance, we can find the *Environmental risk and effects* (33 times) and the *Impacts in the region and/or Stigmatization* (13 times).

Regarding the Uncertainties in the management of the incident, the topic received 200 mentions, including 105 about Deficiencies in the management procedures and/or Negligence. The others are the Safety culture with 64 mentions, the Response time with 11 hits, and both Functioning of the surveillance systems and Economic interests with 10 mentions.

Finally, *Technical uncertainties* regarding the incident were mentioned 169 times in the news articles. The *Magnitude/severity of the leak* was mentioned 84 times and the *Range of the leak* 79. Followed at a great distance by the *Difficulties in the measurement,* with only six hits.

5. Conclusions

The present report has explored the socio-technical uncertainties originated by a nuclear radiological incident in a Spanish nuclear power plant. We aimed also at understanding the needs and concerns of people living in the area and stakeholders.

First, a documentary analysis was carried out to describe the case, its context, the chronology of the incident and the communication process involved. After it, empirical work was carried out to identify and understand the public and stakeholders' response to the incident. This work consisted in a content and thematic analysis of the two most read national, regional and local newspapers during the first 372 days after the incident; semi-structured interviews with a sample of key informants (N=13); and semi-structured interviews with members of the local population (N=11).

The media content analysis allowed us identifying five main groups of socio-technical uncertainties: Uncertainties related to the *consequences of the incident;* the *communication of the incident; the effects of the incident; the uncertainties in the management of the incident* and *the uncertainties about technical characteristics of the incident*.

The qualitative analysis allowed us to explore further these five groups of uncertainties. Regarding the technical issues around the accident, interviewees reported doubts about the real range of the leak, due to the impossibility of determining if the particles had leaked outside the perimeter of the nuclear power plant or not. Disagreements about the magnitude of the incident also appeared in the form of a disparity between sources, with the environmental NGOs alerting about the importance of the incident and the national regulatory body attenuating the magnitude of the event.

Different and contradictory messages about the health effects of the leak were also a source of uncertainty. This uncertainty was amplified by the fact that there was a visit of high school students to the plant after the leak. The students visited the plant before the incident was made public, triggering some doubts about the management of the nuclear power plants and the management of possible incidents. When the leak was disclosed and it was known that the incident had taken place five months ago, not only it produced an alarm for the fear of contamination of the students and teachers but also a sense of lack of transparency.

Regarding the management of the incident, a debate emerged about the causes of the incident and the actions taken by the nuclear power plant to solve the situation. The media and some of the interviewed stakeholders referred to failures in the surveillance systems, a low safety culture, a prioritization of the economic benefits above safety and, in general, to a negligence in the management of the initial leak as the main causes of the incident.

Regarding the communication aspects of the incident, stakeholders and the media referred, first, to a delay in communicating the incident to the stakeholders and the public. Greenpeace informed about the incident before the official sources did. The residents of the towns close to the NPP complained about a lack of information from the official channels and the fact that they were only informed by the local press. This lack of early information was also mentioned by some local authorities, who complained about the lack of communication between them

and the managers of the NPP. The lack of a proactive communication by the nuclear power plant with the public and stakeholders was generally perceived as a main source of uncertainty.

Finally, another relevant topic of discussion around the incident was related to the consequences of the incident: the fines and sanctions the NPP received and the cessation of the managers responsible for the errors occurred. Some stakeholders perceived the sanctions as exaggeratedly high while others thought they were insufficient. This issue also created some debate about the possible reinvestment of the money to the region. Some local people also think that all of these can affect tourism in a region with a bad reputation about the quality of its alimentary products due to the proximity of the nuclear power plant.

Other consequences of the incident covered in the media were related to changes in the safety protocols, like introducing a better communication via SMS between the NPP managers and the local mayors of the area, and to a decrease in the level of public trust in the management of nuclear energy in Spain.

Implications

We identified five issues regarding the accidental release of radioactive particles from Ascó I Nuclear Power Plant in 2008 that where a source of uncertainty from a socio-technical, political and ethical perspective: the characteristics of the incident, its health effects, the communication around the incident, the management and the consequences of the incident. The uncertainties identified in the study provide a realistic picture of the complexity of any radiological incident, while at the same time argue against complacency about the future.

From an engagement perspective, part of the controversy around the episode had to do with the communication approach during the emergency. As Abbott, Wallace, & Beck (2006) have shown, the communication approach during a nuclear emergency can produce significant changes in risk perceptions and reactions. Our study of the incident in Ascó shows that some of the stakeholders were outraged by the perceived lack of transparency by the NPP and the perception that public safety was not a priority for the NPP.

The findings of the study suggest that providing transparent, timely and accurate information about a radiological incident by the competent authorities may improve local trust and confidence in the case of a nuclear emergency. The need to improve the communication channels between the NPP and the national and local authorities seems to be also a critical issue.

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Annexe 1 (Affected population interview protocol)

PRESENTATION. We are researchers from CIEMAT, which is a Public Research Organization. We are working on a European project on radiation protection and we are conducting interviews with people living near nuclear power plants.

Would you be so kind as to answer some questions?

It will be 5 minutes.

FILTER QUESTIONS: Did you live in Ascó in 2008?

DESCRIPTION. We do not know if you remember that at the Ascó nuclear power plant there was an incident in 2008 where radioactive particles were released. We would like you to think about this incident and how you experienced it.

QUESTIONS

Knowledge. Familiarization

Can you explain to us what happened? Do you know what consequences this incident could have?

Communication. Information received. Implication

C2 Were you (in your town) at the time the news was made public?C1 How did you hear about the incident?C8 Do you think the information you received was complete and clear?What information did you miss?

C11 Do you remember if there were meetings to inform the population about the incident?

In case of a negative answer...

Do you think that the NPP or some authority should have explained to the population what happened?

In general, are radiological protection information meetings held?

In case of affirmative answer...

C12 Did you attend these meetings? What information was provided? C17 Do you think you were informed enough to protect your health? What other information would you like to have received at that time?

In general, are radiological protection information meetings held? Who organizes them? Do you think that the population should be taken more into account when incidents such as the 2008 incident occur?

Risk perception

RP 1 What was your initial concern after this incident? Do you remember if you commented your concerns with other neighbours? How did they feel? What uncertainties did you have to face? Those things that generated doubts when you had to act...

In the weeks following the incident, it was said in the media that the leak was much higher than the one initially recognized...

Were you afraid?

Trust

Sometimes the media talked about the lack of transparency and hiding information...

T1 Do you trust in the information that was given at the time of the incident?T8 Do you think the incident was handled correctly? Why?T9 Do you think the authorities responded adequately? Why?What things do you think were done right or wrong in the management of this incident?

T11 Do you trust in the management that can be done in the event of an incident?

Emergency response

We do not know if you will remember that contamination tests were carried out... RP3 Have you or any member of your family been tested for contamination? If you had knowledge of the existence of these controls and had been taken on a volunteer basis, would you have carried out the contamination tests?

Do you remember if other types of measurements were made in addition to the contamination tests? In the environment, food, water...

Did they give clear guidelines on how to act once the incident was known? In general, would you know how to act in the event of a nuclear accident? What should you do?

Do you know what iodine tablets are? Do you know what they are for? Do you know where to get them?

End. Thanks.

Is there something you would like to add?

Socio-demographic data

- Gender
- Age

Annexe 2 (Key actors interview protocol)

Role of the interviewee

- Description of the position/activity/responsibility that the interviewee had during the emergency:
 - What was your role or your relationship to the incident of the particle leak?
 - What was the role of this person in the decision-making process related to the management of the emergency in general and of the protection actions in particular?

Map of actors

- Who did you have a relationship with? Who do you think that played a leading role?

Uncertainties

- What uncertainties did you have to face?

Evaluation of event management

- What things surprised you or do you think they did wrong?

Communication

- How was the public informed and/or the potentially affected population (workers, schools, nearby population)?
- Was there a lack of transparency?

The role of the public

- How was the public considered during the crisis?
- And the city council?
- Were they taken into account?
- Do you think that the population has confidence in the management of the incident and of the NPPs in general?

