



**ADVISORY REPORT OF THE SUPERIOR HEALTH COUNCIL no.
9235**

**Nuclear accidents, environment and health in the post-Fukushima era:
Emergency response**

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SUMMARY

On March 11 2011, Japan was hit by an earthquake that was followed by a tsunami, resulting in a humanitarian crisis. In the wake of this natural disaster, the Fukushima-Daiichi nuclear power plant was seriously damaged. Large quantities of radioactive substances were released into the environment and almost 200,000 people living in the vicinity of the plant had to be evacuated. As a result of these events, in Japan and around the world the safety of nuclear energy became a hot topic. In Japan itself, all nuclear power stations were shut down, and with one exception this is still the case. Furthermore, all nuclear power stations in the European Union were the European Commission to undergo "stress tests". The findings of these tests, including in Belgium, led to the implementation of a safety improvement program. However, no such critical review has as yet been carried out for the off-site emergency plans that were drawn up to reduce as much as possible the consequences of a nuclear accident on man and its environment, neither for the quality and independence of the safety supervision. Although new directives have been promulgated at the level of the European Union, the Member States still have several years to transpose the rules into their national regulation.

In the context of the fifth "anniversary" of the Fukushima-Daiichi disaster, the Belgian Superior Health Council (SHC) has carried out a review of the Belgian nuclear emergency plan. In March 2015, the Council issued a tentative opinion on thyroid protection in the event of a nuclear accident. In the present concluding opinion, the Council goes further and issues a number of recommendations concerning the measures that must be taken in the event of a nuclear accident, in the short term and in the long run. In its report, the Council draws lessons not only from nuclear accidents but also from a number of other large-scale accidents. Although the Council focuses on the process of emergency planning as such, inevitably its recommendations should be considered within the larger context of nuclear safety policy.

The Council has also drawn conclusions concerning publications analysing the (underlying) causes and consequences of these accidents and pays attention to the

¹ The Council reserves the right to make minor typographical amendments to this document at any time. On the other hand, amendments that alter its content are automatically included in an erratum. In this case, a new version of the advisory report is issued.

innovative approach to long-term management that has been developed in France. In the final chapter, the conclusions are characterised by: "awareness", "preparedness" and "completeness". Furthermore, the Council focuses in particular on the cross-border nature of any serious nuclear accident occurring in or close to Belgium. Each conclusion is followed by a recommendation concerning the need to review the Belgian nuclear and radiological emergency plan, which must be taken into account in the design and development of the nuclear safety policy. The Council's key findings are briefly summarised below.

Vulnerability: The Council calls for a review of the nuclear safety policy based, *inter alia*, on a vulnerability analysis. Such an analysis must start at local level but must also include the regional, national and international context. This vulnerability analysis, which supplements the conventional risk analysis of nuclear facilities, also includes all the factors that might play a role in any potential accident, for example the presence of other industrial activities, transport infrastructures, impact on vulnerable population groups, energy supply, etc. Furthermore, the analysis must include a study of accident scenarios that are very unlikely but might impact severely on a wide geographical area.

Scope: The idea that, thanks to the safety approach of nuclear power stations, the consequences of a serious accident would be confined to the immediate vicinity of the site is contradicted by practical experience. Even for nuclear power stations of Western design, a serious accident could have consequences for man and the environment at a considerable distance from the site of the actual accident. This means that a serious accident occurring in a power station in Belgium or close to the border would quickly affect a million people and that vast swathes of territory with important economic activities could be rendered uninhabitable. Consequently, first and foremost it is essential to implement an improved safety policy and be considered in decision making on safety and siting of nuclear power plants. Secondly, this risk must be taken into account in any decisions that are taken concerning the safety of nuclear power stations. In addition, as the Council has already recommended in its opinion on thyroid protection, the emergency plans must be revised.

Remediation: To date, the emergency plans have been limited to the accident phase, i.e. the period during which the threat remains that the affected plant might continue to emit radioactive material. It is therefore important to focus on the need to prevent or reduce to a minimum human exposure to radiation. However, if and when the plant has been brought under control, an extended phase will begin during which the most stringent remediation work possible will be carried out on the nuclear power plant. In the case of a serious accident, this phase could last several decades. Of course, within the framework of the emergency plan it is impossible to describe the remediation work in detail, but the Council recommends that an appropriate strategy be developed. Within the context of this strategy, tentative answers must be given to questions such as: Under what conditions might people be permitted to return to live and work in areas that have been contaminated by radioactive material? What should be done with the radioactive waste produced by the decontamination operations, etc.?

International cooperation: The consequences of a serious accident in a nuclear power station in or near Belgium will not be limited to the country in which the accident takes place. It is therefore essential to envisage international cooperation, and this applies not only to the acute phase of the accident, for example in the event of the evacuation of population groups, but also during the remediation phase. The Council notes that the emergency plans on both sides of the border are still not sufficiently coordinated and that to date too few mutual assistance agreements have been concluded. These shortcomings must be addressed without delay. To this end, the Council calls for increased coordination at the level of the European Union. Given the fact that the supervision of nuclear facilities

has a European dimension, monitoring at national level must be supplemented by European monitoring. Furthermore, European coordination must include provisions concerning the workers entrusted with the remediation work. Generally speaking, these workers do not have any training or work experience in facilities or areas that have been contaminated by radioactive substances.

Communication and participation: Decisions concerning the safety of nuclear plants are taken by a small group of nuclear experts and decision-makers. Within this context, it is still the case that public information is often unilateral. Although a change appears to be on the horizon, the Council is of the opinion that there is still much to be gained from a process of transparent communication on nuclear safety issues and on the processes of emergency planning. All the stakeholders concerned must be allowed to participate, including the people who live in areas in the vicinity of nuclear facilities. This participative approach will improve the quality of the vulnerability analyses mentioned above and will allow people to express their concerns with regard to nuclear safety. Evidently, in order to implement a participative approach there must be sufficient clarity as regards the interests of the relevant actors involved in the decision-making process concerning nuclear issues.

Precautionary strategy: The issues surrounding the development of nuclear energy, the safety of nuclear facilities and the consequences of an accident are complex and fraught with uncertainties. Inevitably, such matters raise issues that touch upon human values on which there is considerable disagreement within society. The Council advocates a precautionary approach and has framed its recommendations with this in mind. This type of approach requires a strategy that presupposes that the least likely accident strategies must be examined and that all the interested parties and the population in general must be involved as part of an open process. Furthermore, this strategy means that the bodies entrusted with the task of supervision must be genuinely and verifiably independent of the operators and of political decision-makers. To this end, the Council suggests that a European Safety Authority be set up within the European Union.

Keywords and MeSH descriptor terms²

Keywords	Mesh terms*	Sleutelwoorden	Mots clés	Stich worte
Radiation protection	Radiation protection	Stralingsbescherming	Radioprotection	
Emergency plan		Noodplanning	Plan d'urgence	

² The Council wishes to clarify that the MeSH terms and keywords are used for reference purposes and to provide a quick definition of the scope of the opinion. For further information, see the chapter on "Methodology".

Fukushima	Fukushima Nuclear Accident	Fukushima	Fukushima	
Safety	Safety	Veiligheid	Surété	
Nuclear accident		Nucleair ongeval	Accident nucléaire	
Precaution	Précaution	Voorzorg	Précaution	
Communication	Communication	Communicatie	Communication	
Participative		Participatief	Participative	
Long-term measure		Maatregel op lange termijn	Mesure à long terme	
Tsjernobyl	Chernobyl Nuclear Accident	Tsjernobyl	Tsjernobyl	

MeSH (Medical Subject Headings) is the NLM's (National Library of Medicine) controlled vocabulary thesaurus used for indexing articles for PubMed.

<http://www.ncbi.nlm.nih.gov/mesh>.

9. CONCLUSIONS AND RECOMMENDATIONS

In this opinion, the Council carried out a review of risk management in the event of a serious nuclear accident. This opinion was drawn up not only in the light of the consequences of the Fukushima accident, but also considering that if this type of accident occurred in or near Belgium the consequences would be very serious because of the concentration of nuclear facilities in highly populated areas. The key issues addressed in this opinion are the following:

*How might a process of careful preparation prevent or reduce as much as possible the detrimental effects to man and the environment in the event of a serious nuclear accident?
How can we learn lessons from past accidents to improve nuclear safety?*

The opinion discusses a number of critical remarks related to the process of emergency planning that are examined in the more general context of serious industrial accidents. Following an analysis of various accidents, not only nuclear but also non-nuclear, the Council puts forward a number of practical recommendations, identifies certain shortcomings and proposes a number of improvements, focusing in particular on vulnerability and risk communication.

In this final chapter, the Council summarises its observations. The conclusions and recommendations are categorised according to three key themes: awareness, preparedness and completeness. Given the cross-border nature of major nuclear accidents, the Council has added a number of recommendations for an international approach. Finally, the Council calls for a precautionary approach to nuclear safety, with adequate emergency planning as cornerstone.

1. More Awareness

1 A serious nuclear accident could also occur in Belgium, and requires a rapid review of emergency planning

Conclusion: Although they are a rare occurrence, serious accidents involving industrial facilities, including nuclear power plants, could also occur in Belgium. In such eventualities, the accident scenario is often unexpected and unpredictable and the social consequences have often been considerable. The Fukushima accident is a case in point. An accident involving a faulty nuclear plant occurring in Belgium or in a neighbouring country could have very serious consequences for the health and well-being of the entire population, as well as for the economy of Belgium and even of Europe as a whole. The European nuclear safety authorities have also drawn attention to the necessity of an improved approach for severe consequences (HERCA/WENRA).

Adequate nuclear emergency planning is therefore essential. An emergency plan must be flexible because the outcome of any accident will be largely unpredictable. It is therefore essential to envisage a range of scenarios during the preparatory phase and during exercises of emergency plans, including beyond-design accident scenarios. The

emergency plans must also address the long-term consequences of a nuclear accident.

Recommendation: The CSS recommends that the Belgian nuclear and radiological emergency plan be adapted as promptly as possible in 2016, not only because 2016 marks the fifth anniversary of the Fukushima accident but also because the previous plan, which dates back to 2003, has not yet been revised. Among the issues discussed in the present opinion, particular attention must be given to the possibility of interaction with other at-risk activities, and special emphasis must be given to the cross-border nature of accidents and the long-term consequences of practically any serious nuclear accident. As emergency planning is the pivotal element of nuclear safety policy, these adaptations may have an impact on the decision-making process concerning the use of nuclear energy for electricity production.

2 Identify the underlying causes of accidents and prevent conflicts of interest

Conclusion: Nuclear and other industrial accidents show striking similarities in terms of their causes. In this opinion, the Council looked at fundamental risk factors that highlight the underlying causes such as design flaws, communication problems, lack of training and defective or non-existent safety procedures and measures. The Fukushima accident is also a telling example of this phenomenon. In order to focus on the so called general failure types, as is right and proper in the context of an adequate safety culture, the authorities must exercise independent control over the operation of nuclear power plants. In Japan, the lack of independent control contributed to the Fukushima accident, in particular because of the lack of precaution against tsunamis. The risk of an accident increases when the agencies responsible for monitoring are not free of short-term political or commercial interests.

Recommendation: During the periodic assessment (or reassessment) of the safety of nuclear facilities, the supervisory authorities must demand that the underlying causes of accidents be adequately addressed.

The CSS recommends that the independence of Belgian control of nuclear facilities be guaranteed in practice, in particular by establishing procedures to prevent conflicts of interest.

3 It is essential to carry out vulnerability analyses of complex technologies while giving attention to human interaction, in particular in the context of emergency planning

Conclusion: The unpredictability of accident scenarios is inherent to complex industrial plants. One aspect of this systemic uncertainty is the so called common mode failure. As the Fukushima accident showed, a problem occurring in one nuclear reactor can also affect the operation of other reactors in the plant and question the integrity of the fuel

storage pools. This type of failure is bound to exacerbate the accident and its consequences.

A vulnerability analysis helps identify the sources of systemic uncertainty and should therefore be an integral part of the processes of authorisation and emergency planning. Furthermore, it helps improve the effectiveness of intervention measures and can shed light not only on the public opinion on nuclear safety but also on how people view possible shortcomings and threats.

Recommendation: The CSS recommends the systematic implementation of vulnerability analyses as a basis for emergency planning in complex and nuclear industrial facilities. Such an analysis must be geared towards identifying possible accident scenarios. Even accidents that are highly unlikely but might have considerable consequences must be given the necessary attention. This analysis must also focus on the vulnerability of the local population and their resilience in the face of the individual and collective consequences for health and well-being in the short and long term.

4 The social fabric of the affected regions may be disrupted for some considerable time

Conclusion: Given that it is difficult to predict accident scenarios and possible unexpected interactions between a faulty nuclear reactor and other facilities, the possibility cannot be ruled out that part of the radioactive materials in the nuclear power plant might be released into the environment. Despite the presence of many different safety measures such as containment systems, the Fukushima accident showed the possibility of a significant release of radioactivity into the environment even with reactors of Western design. Despite the relatively low probability involved, the consequences of such beyond-design accidents can be very serious and might last for many years and make certain areas uninhabitable for several generations.

Recommendation: The CSS draws attention to the possible long-term consequences of serious nuclear accidents. The Council therefore recommends that emergency planning include an approach for long-term remediation, i.e. during the phases occurring after the actual accident has been brought under control. The process of emergency planning must include a long-term strategy aimed at ensuring that social life is restored as far as possible, even if this may be difficult in a densely populated country.

5 A multidisciplinary and participatory learning process is needed for emergency planning

Conclusion: It is difficult for society to draw lessons from real accidents. This applies not only to political decision-makers, but also to experts. The reason for this is that when accidents occur there is a shift in political priorities. This shift is caused by other shocking

events and is influenced by the media and pressure groups. For example, during the Katrina disaster, the shortcomings were also the result of the fact that priority was given in the US before to antiterrorism measures, resulting in a situation where less effort was made to provide protection against hurricanes. There is a similar phenomenon among experts, as the culture of a specific group can unconsciously divert attention from the above-mentioned systemic uncertainties.

In order to be able to implement efficient emergency planning measures to reduce the consequences as much as possible, the personnel concerned and the local population must be aware not only of the risks but also of the possible protective measures. The vulnerability analysis recommended in this document is one way in which the local population can be involved in the authorisation and emergency planning processes. Furthermore, it also provides a means of obtaining information on the challenges, obstacles and opportunities in the way of intervention measures and the possibilities of such measures.

Participation inevitably raises issues of an ethical nature concerning the pros and cons of nuclear energy production. These issues must be addressed in a transparent manner in order to ensure a proper examination of the conditions in which it is acceptable to generate nuclear energy. This opens up possibilities for fostering trust for the different authorities among the local population, including the authority responsible for monitoring nuclear activities.

Recommendation: The CSS recommends a process of permanent interactive learning based on near-accidents and exercises. It is essential to devise a structure that permits the open exchange of experiences and knowledge and fosters cooperation focusing on the possible problems among different disciplines and different levels of authority. Such a network approach to accident management encourages personal contacts between the key stakeholders. This approach could also include measures to encourage closer cooperation with neighbouring countries.

The CSS also recommends authorities to set up experiments with social learning processes that involve the population concerned, the agency that operates the reactor, the FACN and the local authorities along with their respective experts. These processes can be useful in providing input to the management of nuclear accidents and accidents in general. Participatory projects require clear and transparent procedures in order to limit conflicts of interest and lobbying.

Nuclear engineers are not the only experts who should be involved in the process of drawing lessons from accidents. The Council recommends that this process should also involve sociologists, communication experts, experts in ethics, insurance experts, specialists in the health sciences and psychologists.

6 The need for transparent and interactive communication concerning risks

Conclusion: Communication concerning nuclear accidents and emergency planning must be an integral part of a transparent communication process on issues surrounding nuclear energy. Balanced information concerning the risks and uncertainties is crucial, but the emphasis should not only be on this information or the measures taken to limit the consequences. The experience of Chernobyl and Fukushima showed that the impact on health and well-being can be larger. The fear of delayed health problems, temporary or permanent expulsion from home, miscellaneous dilemmas and social stigma are some of the challenges that might arise in terms of communication, both in "peace time" and during an accident. People react differently after accidents, and an accident can radically change their living environment and their concerns. After an accident or an increased threat is announced, people do not systematically panic but they try to find a reliable source of information.

Differences in perception concerning nuclear risks and the effectiveness of emergency measures must not be permitted to impede the task of addressing the concerns of the population, even if such concerns call into question the results of the risk analyses and the options taken in decision making. Trust can also be won by taking into account radically different points of view. We can improve the effectiveness of the measures implemented in the event of an accident by creating sustained trust.

Recommendation: The Council recommends that a more broad-based approach be adopted to communication within the framework of the emergency planning process and that this process be made more transparent. Communication is a two-way process which, alongside more balanced technical information as regards the risk of exposure to radiation and its uncertainties, must also take into account the concerns of the population. It is essential to take people's emotions, values and social opposition into consideration. In the opinion of the SHC, communication concerning accidents according to the participatory approach outlined means more than simply issuing instructions in a unilateral fashion and answering questions about the risks involved. A lot of attention must be given to the task of ensuring respect for people's concerns, in particular as regards the well-being of the family and of animals, income and fair compensation for losses incurred and the prospects of a return to a more or less normal life.

What is required is an appropriate communication structure that is satisfactorily transparent and is distinct from the direct management of the crisis. The RISCOS model, that was developed in Sweden and tested in Belgium, provides a means of ensuring a separation between, on the one hand, communication and, on the other hand, exercising influence over the population.

7 Be aware of the possible role of the social media in crisis management

Conclusion: Today's communication landscape is very different from the environment that existed ten or twenty years ago. The internet and the social networks permit the instant exchange of information among many different actors, and the new media can be used to disseminate information quickly in the event of an accident. However, such networks can also be a source of confusion and error. At the same time, the mainstream media (newspapers, radio and television) still have a part to play in the reporting of risks and accidents.

Recommendation: Nowadays the authorities use the social networks primarily to monitor the reactions of the public, but a change may be on the horizon. The SHC recommends that the social networks be used actively and bilaterally as a means of exchanging information on the measures to be implemented in the event of an accident and on the concerns of the population with regard to the accident. This recommendation is all the more important as the social networks provide a means of gathering unique information about the local situation in the event of an accident.

2. Better preparedness

8 Adequate emergency measures - the cornerstone of the nuclear safety policy

Conclusion: The "stress tests" of nuclear facilities were based on the reaction of the countries of the European Union to the Fukushima accident. This self-assessment of operators, which was coordinated by the authorities, resulted in a number of programs aimed at upgrading power plants. These programs, which have been assessed at European level, are unquestionably a move in the right direction, but they are not enough to ensure nuclear safety completeness in Europe. In fact, the stress tests took into account the internal emergency plans for nuclear facilities but not the quality of the external emergency plans that are the subject of the present report or for that matter the need for a review of these plans. Even after these programs have been implemented, there is still work to be done. The Council wishes to draw attention to the fact that the situation is not clear as regards the vulnerability of the physical protection of nuclear facilities. Furthermore, the threat of terrorism calls for a measure of restraint when it comes to disclosing information about any weaknesses and additional reinforcement measures. However, this does not mean that we cannot openly discuss the issue of security and take it into account among the imponderables surrounding emergency planning.

No independent assessment has been carried out of the actions taken by the different national authorities that were involved in crisis planning in the wake of the Fukushima disaster. A European study conducted in several countries involved carrying out a critical review of the preparations made in the emergency plans on a participatory basis and

concluded that there is still considerable room for improvement.

The SHC welcomes the draft document drawn up with a view to taking nuclear safety into account in the new European regulations and the idea of extending emergency planning to include the long-term consequences.

Recommendation: The Council recommends that the long-term process of harmonisation of the nuclear safety criteria and of the requirements for emergency planning in Europe be pursued and that monitoring be organised at European level. A study requested by the European Commission has failed to shed light on the quality of the specific safety conditions prevailing in the Member States. The Council calls for Belgian participation in a inquiry of actors on preparedness to nuclear crisis situations, along the lines of the arrangements made by France concerning the facilities close to the border.

The Council proposes that appropriate arrangements be made to integrate in off-site emergency planning provisions relating to security (especially sabotage).

9 Complex measures in densely populated areas must also be prepared for longer periods and larger distances

Conclusion: The Belgian nuclear emergency plan focuses mainly on the threat of exposure to radioactive materials during the initial days and weeks following an accident. The measures described are sheltering, the distribution of stable iodine tablets, evacuation and the limitation of local food production. The emergency plan proposes that such measures be implemented within a radius of 5 to 20 kilometres around the areas covered by the plan.

The short-term measures will be counterproductive if they are maintained over a long period with no clear outcome in view. The organisation of society can be disrupted by measures sheltering, population evacuation in particular and, albeit to a lesser extent, the limitation of locally grown food. Furthermore, the experience of Chernobyl and Fukushima showed that the distances envisaged by the plan are too small. Interventions at distances of up to 100 kilometres or more from the site may be necessary and require sufficient preparedness.

The emergency plan does not address the measures relating to the transition period that starts when the risk of radioactive emissions has disappeared and for arrangements for what may turn out to be a long period of recovery afterwards.

Recommendation: The SHC recommends that, based on the experience of past accidents, the areas covered by the plan for sheltering, the distribution of stable iodine and

evacuation be extended to cover realistic distances. In accordance with a recommendation of the European safety authorities (HERCA and WENRA), the Council has already recommended in a previous report that the stable iodine distribution strategy be extended to an area covering 100 kilometres. This distance should also apply to the provision of sheltering. Evacuation is an extreme measure that may result in casualties, but it cannot be ruled out and must be envisaged strategically and selectively within a radius of at least 20 kilometres based on radiological and non-radiological criteria.

The SHC recommends that measures be drawn up for the period of transition and recovery. These long-term measures should consist of strategic options that can, where applicable, be adapted to the situation. The aim of such measures is to limit social disorganisation and to address the concerns of the affected population. As regards the disruption of densely populated complex areas, it is important to organise brainstorming exercises, in line with the safety requirements, and this also applies to areas outside the planning zones.

10 . *Greater attention for medical coordination and for vulnerable people in crisis situations*

Conclusion: The process of emergency planning requires the involvement, through the competent authorities, of health care personnel: medical and paramedical personnel, the emergency and hospital services and psychosocial caregivers. The Council notes that the emergency plan gives little attention to vulnerable groups, in particular in the event of a possible evacuation. It is not clear whether sufficient personnel are available to care for vulnerable persons. The Council questions whether the (paramedical) personnel and first-aiders of the Red Cross and Civil Protection are sufficiently prepared to fulfil their role in the event of a nuclear disaster and whether the competent medical authorities are sufficiently coordinated to handle the situation.

Recommendation: It is essential to identify vulnerable persons and the groups that would require special care in the event of the implementation of measures such as the provision of shelter and, more especially, evacuation. The Council recommends that first-aiders be adequately trained and equipped to assist vulnerable persons. Also, it is essential to establish good communication with schools and with the population in general.

11 *Protect external workers in the event of intervention and decontamination operations*

Conclusion: Given that vast swathes of land would be contaminated by radioactive materials for a considerable period in the wake of a serious accident, during the transition and recovery phase a large group of workers, in addition to the response crew, could be exposed to ionising radiation from the contaminated soil, buildings, infrastructure, etc..

Fukushima and Chernobyl showed that many of these workers are "external" personnel who have poor experience or knowledge in the nuclear field and require a number of specific protective measures.

Recommendation: The CSS recommends that the European provisions concerning external workers be proactively extended to accidents and emergency planning, considering interventions and remediation during the recovery phase in areas contaminated by radioactive materials by a nuclear accident. These provisions must include information, directives on training and coaching, procedures for the monitoring of radioactivity and doses and reference levels for exposure to radiation. *Proactive measures must be drawn up in a perspective to monitor the health of these external workers.*

3. Completeness

12 <i>The safety approach must be extended to accident scenarios that are not included in the design or plant life extension</i>
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Conclusion: The fact that accidents do not follow the "scenario" of risk analyses previously carried out has consequences not only for emergency planning but also for remediation. The lessons learned from nuclear and non-nuclear accidents concern the nuclear safety policy in its entirety and, in particular, the risk analysis on which the design and operation of nuclear facilities is based.

Like emergency planning, the safety policy must be a permanent process. Mandatory periodic reviews are a step in this direction. The systemic uncertainties that are inherent to the operation of any complex industrial facility must be analysed and constantly incorporated in the analysis of the risks inherent to a given (nuclear) facility. The technological developments that are designed to reduce the likelihood and severity of a serious accident must also be included in these analyses and must be taken into account with a view to retrofitting. The Council has the opinion that this should include measures - which have in the meantime been incorporated in the design of the new generation of nuclear power plants- to prevent molten corium from penetrating the soil and reaching the groundwater.

Recommendation: During the periodic assessment of the safety of nuclear power plants (and more particularly plant life extension authorisation procedures, the SHC recommends that the risk analysis on which the design and operation of the plant is based be critically examined, including as beyond-design accidents which, even though such accidents are unlikely, can have major consequences.

13 *Take care for population density and mobility*

Conclusion: As regards the short- and long-term measures to be implemented in the wake of a nuclear accident in the case of Belgium, an important element that must be taken into account is the location of nuclear power plants close to densely populated areas. Any measures will therefore be much more complicated than those taken, for example, at the Fukushima disaster. The problem is compounded by the vulnerability of the transport infrastructures in Belgium, bearing in mind that Belgium is an international transport hub, so that it may be necessary to call on neighbouring countries at short notice, for example, to assist with the evacuation of the affected population.

Recommendation: Within the framework of nuclear emergency planning, the SHC recommends that particular attention be given to the aspects relating to the vulnerability of large displacements of the population in a densely populated country where traffic is congested. Therefore, provisions must be made not only for consultation with neighbouring countries but also for integration within a long-term strategy to make arrangements to displace and accommodate large groups of people.

14 *The interaction of nuclear risks and other industrial risks might enhance a crisis*

Conclusion: Most of the nuclear power plants concerned are located in the vicinity of industrial complexes. For example, the Doel facility is located in Antwerp's harbour and industrial district. This type of location brings additional risks that are not always taken into consideration. A complex chemical factory close to a nuclear facility cannot always be shut down quickly, and a loss of control of the factory could give rise to risks that might enhance the consequences of the nuclear accident. These factors must be taken into account in the vulnerability analysis and in the emergency plans.

Recommendation: The CSS recommends that interaction with nearby industrial facilities be incorporated in the vulnerability analysis and the periodic safety assessment of nuclear power plants and that the nuclear and non-nuclear emergency plans be reviewed on this basis.

15 *The structure and functioning of crisis centres must be periodically assessed*

Conclusion: Every nuclear power plant must have an emergency plan that is specific to the company site. The emergency plans of companies were reassessed within the framework of the stress tests, but this was not the case for the off-site emergency planning

under discussion in this opinion. The Council does not see in the Belgian nuclear emergency plan any link with the emergency plan of companies, apart from the obligation for the management of the companies concerned to notify the authorities in the event of problems.

Recommendation: The CSS recommends that the nuclear emergency plans be subjected within a European framework to a "stress test" along with an independent assessment and that this include the role of the competent authorities and the crisis management centres with regard to operation, strategy and communication.

16 *Take into account scenarios concerning the dispersion of radioactivity in the aquatic environment*

Conclusion: It can be said that up till now when a nuclear accident occurs it is mainly the spread of radioactive materials in the Atmosphere that has been taken into consideration. The atmosphere is the most important medium through which radioactivity spreads and this type of dispersion is the most detrimental for health and the environment. The lesson learned from Fukushima is that radioactive materials can also contaminate the groundwater and surface waters and therefore spread far and wide. This danger also raised its head during the Chernobyl disaster. Propagation of contamination by groundwater and surface water, accompanied or otherwise by the deposition of radioactive materials dispersed in the atmosphere, can seriously impact the supply of drinking water, agriculture and the environment. As was the case in Japan, in Belgium the possible contamination of the marine environment must also be taken into consideration.

Recommendation: In order to prepare for serious nuclear accidents, the SHC recommends that attention should also be given specifically to the spread of radioactive materials through the groundwater and surface water and towards the sea. In the short term, the main problem would be the threat to the supply of drinking water. In the long term, however, we would also be faced with problems with agriculture, livestock, fishing and the contamination of plants and animals.

17 *Address the problem of nuclear waste in the event of a prolonged nuclear crisis*

Conclusion: A serious nuclear accident produces large quantities of radioactive waste. The waste comes from the facility, the adjacent structures and the cooling water. In order to handle the wastewater and to remediate the contaminated areas, technology must be deployed to treat large quantities of radioactive water, contaminated soil and decontamination waste. Fukushima is a telling example of this. In spite of the investigations that have been carried out and the problems that have come to light concerning the management of waste at Chernobyl and Fukushima, as yet there has been

no analysis of the management of this type of radioactive waste from an potential accident in Belgium or in Europe.

Recommendation: During the work to be carried out in preparation for the consequences of a serious nuclear accident, the CSS recommends that arrangements be made for the monitoring, characterisation, storage and treatment of the liquid and solid radioactive waste that would be produced in the course of the management of an accident and as a result of the contamination of the surrounding (residential) area. The Council recommends that the NIRAS-ONDRAF (Belgian National Agency for Radioactive Waste and Enriched Fissile Material) be involved in an exercise focusing on this issue and that this need be analysed at European level within the framework of the policy on nuclear waste management.

4. Cross-border approach

18 *Any large-scale nuclear accident would require an international approach to emergency measures*

Conclusion: Any serious accident involving nuclear plants in Belgium would have consequences beyond the border, particularly in the event of a serious accident caused by a failure of the reactors at Doel and Tihange or in power plants less than 100 kilometres from our borders (Gravelines, Chooz and Borsele). As regards emergency planning, the issue must be taken up at European level. The Council notes that there is no European Control Agency that is able to act, to provide logistical support and to guarantee coordination in the event of a cross-border nuclear crisis.

Recommendation: The CSS recommends an analysis of ways in which within the European Union safety monitoring and crisis management can be harmonised and reinforced. In the event of a cross-border nuclear accident, centralised management is essential if we are to limit in a coherent and efficient manner the consequences for man, the environment and the economy, along with a more harmonised international approach and adequate technical resources. With this objective in mind the Council suggests to structure a European Nuclear Safety Authority.

19 *There is a need for a harmonised European approach to emergency planning and long term starteggies and liability*

Conclusion: Although agreements have already been concluded between neighbouring countries with a view to the exchange of information and cooperation in the event of a cross-border nuclear accident, the Council notes that there are still considerable

differences in approach among European countries. Furthermore, the criteria of the short-term measures have not been harmonised. The Council is particularly concerned about the reference values to be used for the measures to be implemented, the tools for aiding decision-making in the event of a crisis and the lack in agreements relating to the evacuation of the population on both sides of the border.

France is the first Member State of the European Union that has given any thought to the means of intervention or the measures to be implemented within a vision on long-term crisis management. In other European countries, these means and measures are still at an embryonic stage and will not be mandatory at European level until 2018. Radioactive contamination of the environment could trigger a prolonged international crisis. The absence of European harmonisation with regard to insurance and the insurability of nuclear reactors can seriously complicate the implementation of a long-term remediation strategy following a nuclear accident.

Recommendation: The CSS recommends that arrangements be made for increased international consultation and cooperation on emergency planning within the context of nuclear accidents, both bilaterally between neighbouring countries and at European level, including as regards insurance-related aspects.

Research must be carried out if we are to draw lessons from accidents and past experience in the area of emergency planning. In the light of issues connected with quality and urgency, the Council is of the opinion that research and development in the area of nuclear safety and emergency planning must take place in a European context. The Council supports the program of strategic research of the NERIS platform and recommends that more broad-based and more active support be given to Belgian participation in European research.

5. Steps towards a precautionary strategy

20. An adequate nuclear safety policy requires a precautionary strategy enlarged with a participatory approach also for emergency planning

Conclusion: A nuclear safety policy with emergency planning as cornerstone aims to prevent accidents and, if in spite of everything an accident did occur, to reduce the consequences of an accident as much as possible. However, the Council is of the opinion that a proper nuclear safety policy must be based on the precautionary principle as an element of sustainable development. Issues related to the development of nuclear energy, the safety of nuclear facilities and the consequences of an accident are complex and fraught with uncertainties. These issues inevitably touch on human values on which it is difficult to find agreement within society. Given all these different elements (complexity, uncertainties and ambiguity), a precautionary approach is required. As an accident with serious consequences for health and the environment cannot be ruled out, the implementation of this type of strategy means that, already in the immediate future, it is essential to broaden the approach to emergency planning and safety policy.

Recommendation: The Council is therefore opting for a strategic approach that encompasses wide swathes of territory, envisages realistic crisis phases and includes the possibility of European cross-border impact, while drawing lessons from past nuclear and non-nuclear accidents and examining in detail less likely accident scenarios.

The Council also requests that the vulnerability analyses, emergency planning and communication be of a participatory nature focusing on citizens' concerns, taking into account the distribution of risks and costs as well as the long-term perspectives. This type of crisis preparation approach extends the notion of prevention to precaution. This precautionary strategy requires the implementation of measures to ensure that the appropriate actors, including the citizens, are involved within a legal framework.

The full advisory report can be found in Dutch (<http://tinyurl.com/HGR-9235-Fukushima>) and French (<http://tinyurl.com/CSS-9235-Fukushima>).