Review of Infrastructures and Preparedness Systems in France, Germany and United Kingdom for Potential Releases of Radioactivity into the Environment

Deliverable 1

edited by
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EC Project SAGE

Strategies and guidance for establishing a practical radiation protection in Europe in case of long term radioactive contamination after a nuclear accident

Review of Infrastructures and Preparedness Systems in France, Germany and United Kingdom for Potential Releases of Radioactivity into the Environment

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1 Introduction

In the consequence of the post accidental management after the Chernobyl accident in the contaminated areas of the CIS countries trust and confidence of the affected population into the measures and regulations of experts and authorities have decreased with time. The evaluation of rehabilitation strategies in the contaminated areas clearly demonstrated the importance of involving the population into the management of their daily life to improve the rehabilitation programme implemented by the public authorities. The experience of the ETHOS Project[1] has revealed that an effective and sustainable post accidental management is only possible if the dissemination of a practical radiological protection culture within all groups of population and especially within the professionals in charge of public health is pursued. This project was carried out in a rural district of Belarus and has achieved important social and economic improvements in that area. The ETHOS Project helped the population to control the daily external and internal exposure by measurements of food, feed and environment, and to learn about radioactivity, contamination and exposure pathways. By these measures it became possible to reduce the radiation exposure and risks for the health and thus to improve the whole quality of life.

The object of the SAGE Project is to develop strategies and guidance to establish a practical radiation protection culture in Western Europe in case of a nuclear accident or incident with long term contamination. Although the conditions in Belarus and Western Europe are different, the feedback experience of the day-to-day management of the radiological situation by local authorities, professionals and population living in the contaminated area is very useful for the development of a radiation protection culture in case of a long term contamination in Europe. The situation in the contaminated areas after the Chernobyl accident has shown clearly that the involvement of the population helped to overcome the social, psychological and economical problems which had increased dramatically during the post accidental time. The lessons learnt by the ETHOS Project will influence the SAGE Project in a distinct way and the evaluated strategies for Europe can be tested in Belarus.

An important objective of the SAGE Project is the establishment of special training and education for different groups of the population and professionals. Particularly the professionals in charge of public health have to be educated on the various aspects of long term radiation exposures and potential protection to provide guidance for the population in their concerns of the health consequences of radioactivity. The key output of the SAGE Project will be a handbook on a practical protection culture for professionals and the general population which will help to avoid unnecessary radiation exposure in the daily life and to protect health.

One of the important tasks of the SAGE Project is the review and assessment of current infrastructures for long term management of post accidental situations in the three western European countries taking part in this project, namely France, Germany and United Kingdom. The existing infrastructures and preparedness systems in all three countries have generally improved after the Chernobyl accident and were adapted within the European Community in the last years. Nevertheless this overview was necessary to demonstrate gaps and differences in the systems especially in respect to long term contamination scenarios for establishing a practical radiation protection culture in Europe as developed by the SAGE Project.

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[1] www.cepn.asso.fr/fr/ethos.html

2 Regulatory framework

With the discovery of radioactivity and its commercial use surveillance programmes were implemented step by step to protect man and environment against the risks of ionising radiation. The monitoring duties were increasing rapidly especially when the tests of atomic bombs had started and the first nuclear power plants had been installed. Since years, radiation protection was only focused on man; however, this limitation was questioned more and more especially in the last years. The protection of the environment and non-human biota against ionising radiation becomes more important and is an increasingly important subject of research and politics.

In 1957, Germany, Belgium, France, Italy Luxemburg and the Netherlands founded the European Atomic Community. The EURATOM treaty was concluded for the peaceful use of nuclear energy and regulates inter alia the non-proliferation of nuclear materials and the surveillance of the environment. It was decided that directives of the EU are to be taken over into the regulatory framework of their members within a given time frame. These regulations are in force until present. In addition, national laws and directives in each European country regulate radiation protection. The Chernobyl accident indicated the importance of the monitoring duties of all countries and of harmonized approaches and collaboration. After this event the measurement programmes and monitoring systems were enlarged and improved essentially. Additional simulation and information techniques were evaluated and connected online to facilitate rapid decisions Europe-wide in case of a nuclear incident. The surveillance of the environment in the vicinity of nuclear facilities and the environment in general is enacted in the European and the national regulatory frameworks.

Moreover international and national agencies are consulting governments and authorities in radiation protection. The ICRP (International Commission on Radiological Protection) founded 1928 is an international body under private law. The members consist of a panel of international scientists having proved records of their expertise in radiation protection. Their recommendations are the basis of regulations in respect to radiation protection for occupation workers and the public and form the basis also for national and Europe-wide regulatory frameworks. On a more international level the IAEA (International Atomic Energy Agency) publishes also recommendations concerning radiation protection in the so-called Nuclear Safety-Series and works closely with the ICRP and the EC.

2.1 Regulatory Framework in France

The French regulatory framework for the radiological protection has evolved recently (it has been updated to implement the European Directives 96/29 and 97/43). The Law is now based on five decrees, two of them concerning the protection of public against ionising radiation (the three others are concerning the protection of workers and patients): One decree deals with the protection of the population against dangers from ionising radiations mainly in “normal situations”[2], and the other with the interventions in radiological emergency situations[3].

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[2] Décret n°2002-460 du 4 avril 2002 relatif à la protection générale des personnes contre les dangers des rayonnements ionisants

[3] Décret n°2003-295 du 31 mars 2003 relatif aux interventions en situation d’urgence radiologique et en cas d’exposition durable et modifiant le code de la santé publique

Several other regulatory texts complete the regulatory framework as far as emergency situations are concerned, but they are all focusing on the crisis phase after the accident. They establish the regulatory requirements for:

- The preventive distribution of iodine tablets in the vicinity of nuclear power plants[4],
- the implementation of the alert procedures in case of an accident[5],
- the implementation of national and local emergency plans[6],
- the organisation of the emergency aid (health care) in case of nuclear or radiological accidents, including terrorist attacks using radioactive substances (for example, there is a list of the regional reference hospitals to host the victims from an accident)[7].

Concerning the contamination limits for food, cattle feed and products for export, France is using the values defined by the European Community (EURATOM).[8]

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4 In 1997, the French government decided to distribute stable iodine tablets to those living in the vicinity of NPPs (within a 10 km radius of a nuclear power plant). The next campaign of iodine tablets distribution is scheduled in 2005. (cf. Circulaire interministérielle n°4.483/SG du 30 avril 1997)

5 Décret 90-394 du 11 mai 1990 relatif au code national d'alerte, modifié par le décret n°2001-368 du 25 avril 2001 relatif à l'information sur les risques et sur les comportements à adopter en situation d'urgence

6 Décret n°88-622 du 6 mai 1988 modifié relatif aux plans d'urgence pris en application de la loi n°87-565 du 22 juillet 1987 relative à l'organisation de la sécurité civile, à la protection de la forêt en cas d'incendie et à la prévention des risques majeurs

7 Circulaire DHOS/HFD/DGSNR n°277 du 2 mai 2002 relative à l'organisation des soins médicaux en cas d'accident nucléaire ou radiologique

Circulaire n°2002-800/SGDN/PSE/PPS relative à la doctrine nationale d'emploi des moyens de secours et de soins face à une action terroriste mettant en œuvre des matières radioactives

Circulaire DHOS/HFD n°2002-284 du 3 mai 2002 relative à l'organisation du système hospitalier en cas d'afflux de victimes

Circulaire DGS/DAGPB/HFB n°2002-191 du 3 avril 2002 relative au renforcement des moyens en personnels des services déconcentrés dans le cadre du plan gouvernemental de lutte contre le bio-terrorisme

8 Règlement (Euratom) n°3954/87 du Conseil en date du 22 décembre 1987 fixant les niveaux maximaux admissibles de contamination radioactive pour les denrées alimentaires et aliments pour le bétail après un accident nucléaire ou dans toute autre situation d'urgence radiologique

Règlement (Euratom) n°944/89 de la Commission en date du 12 avril 1989 fixant les niveaux maximaux admissibles de contamination radioactive pour les denrées alimentaires de moindre importance après un accident nucléaire ou dans toute autre situation d'urgence radiologique

Règlement (Euratom) n°770/90 de la Commission en date du 29 mars 1990 fixant les niveaux maximaux admissibles de contamination radioactive pour les aliments pour bétail après un accident nucléaire ou dans toute autre situation d'urgence radiologique

Règlement (CE) n°616/2000 du 20 mars 2000 modifiant le règlement (CEE) n°737/89 du 22 mars 1990 relatif aux conditions d'importation de produits agricoles originaires des pays tiers à la suite de l'accident survenu à la centrale nucléaire de Tchernobyl

The above mentioned French decree on interventions after an accident defines also the responsibilities of the utility where the accident occurred and those of the French authorities towards the evaluation of the circumstances and consequences of the accident (e.g. dose assessment), the information of public and if necessary, the implementation of protective measures; it also defines the training requirements and establishes the needs in terms of protective equipments of the interveners; it states the limitations in relation with the intervention (e.g. dose limits[9], interdiction of intervention for young people and pregnant women) and reinforces the health surveillance of interveners according to the roles they would have - technical staff, medical staff, or other professionals - during the emergency or long term post accidental phases.

The article 43-85 of this decree clearly states that in case of long-standing exposures to radioactive substances, the police authority (generally speaking, the prefect[10] or sub-prefect of the affected region) must take one or several of the following measures (according to the radiological risks he has to appreciate with the help of competent technical supports of the radiological protection and safety authorities):

- Information of the population on the risks,
- delimitation of the area where the protective measures will be implemented,
- implementation of an internal and external doses follow-up,
- access restriction and limitation of the landscape and dwellings uses,
- implementation of countermeasures - especially on food and water supplies - to reduce public exposures (after having received the advice of the IRSN[11]).

Finally, the decree indicates that a long term assessment of the evolution of radiological risks (presence of radioactivity) must be made by the competent authorities and their technical supports.

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9 100 mSv for the technical and medical staff who intervene (300 mSv if the intervention aims at protecting people) with a lifetime effective dose limit of 1 Sv, 10 mSv for other professionals who could participate to the intervention

10 Governor of the county

11 Radiological Protection and Safety Institute (the technical support of DGSNR, the French Radiological Protection and Safety Authority)

2.2 Regulatory framework in Germany

The Atomic Law forms the legal basis of the regularization of radiation protection. § 1 lays down that

- life, health and goods have to be protected against the risks of nuclear energy and detrimental effects of ionising radiation,
- damages caused by nuclear energy and ionising radiation have to be compensated,
- international duties of the Federal Republic of Germany concerning nuclear energy and radiation protection have to be guaranteed.

After the reactor accident in Chernobyl the Precautionary Radiation Protection Act (StrVG[12]) was enacted in the year 1986 regulating the monitoring of radioactivity in the environment (online-information of radiation protection offices by IMIS) and measures to keep the radiation exposure of human beings and the contamination of the environment of as low as possible in case of a radioactive incident. The act determines inter alia

- environmental monitoring duties for Federation and Federal States,
- information system of the Federation (IMIS),
- evaluation of data, information of Bundestag and Bundesrat,
- determination of dose and activity concentrations,
- recommendations of BMU.

Radiation Protection Ordinance (StrSchV[13]) of 13th October 1976 is applied for radioactive materials handling, for storage and safekeeping of nuclear fuels and for installation and operation of reprocessing plants or nuclear power plants and facilities producing ionising radiation as far as they do not underlie the X-ray-Ordinance. Radiation Protection Ordinance describes not only the scope but contains also instructions for surveillance and protective provisions. The ordinance was updated to implement the European Directives 96/29 ("Euratom Basic Standards") and 97/43 ("Directive for Protection of Patients") for radiation protection and issued on 26th July 2001. The ordinance contains a number of important attachments like definitions, exemption limits and derived limit values.

Amongst other things measures for radiological emergency situations, accidents and incidents are regulated like the information of

- according controlling institutions (atomrechtliche Behörden),
- institutions regulating public law and order,
- institutions regulating the civil protection,
- the concerned population with according protection instructions.

The information of the population is assessed in annex XIII. It contains instructions how to behave in case of a radiological emergency situation, for instance

- consumption restrictions of contaminated food,
- rules for hygiene and decontamination,

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12 Strahlenschutzvorsorgegesetz

13 Strahlenschutzverordnung

- to stay in house,
- distribution and application of special prevention agents[14],
- precaution in case of evacuation,
- if necessary special instructions for particular population groups.

Directives concerning radiation and radiation protection issued by BMU have to be followed by states and radiation protection officers.

Medical surveillance of persons exposed to radiation is regulated by law. Control and protection especially of occupationally exposed persons are laid down in both X-ray – Ordinance[15] and Radiation Protection Ordinance[16].

In case of a nuclear accident following medical methods can be used to control the affected population besides physical dosimetry:

- Measurements of ingested activity by whole body counters, lung counters, wound measurement tubes, etc.,
- analyses of excretion (stool, urine),
- chromosome aberration analyses.

A number of the above mentioned rules of conduct and medical measures are applicable and useful for the protection of the population in case of a long term contamination. But a specific regulation by law about measures concerning the living conditions in long term contaminated areas is missing in Germany.

Recommendations to reduce radioactivity in the daily life for people living and working in a long term contaminated area are not or not easily available. The German Commission on Radiological Protection (SSK) presents a number of measures (Willrodt, 1991) to reduce the contamination of food and animal feed. In the agricultural sector measures like

- removal of the upper soil layers,
- use of fertilisers,
- feeding of the cattle with Cs- and Sr-binders,
- growing of alternative plants

are suggested.

For the food processing industry a lot of different measures are worked to reduce radioactivity in food and feed stuff, only a few are mentioned below:

- To can vegetable, fruit and mushrooms with discard of the boiling water,
- to produce fruit juice and wine,
- to boil meat with discard of the boiling water,
- to produce cream, butter and cheese,

[14] E.g.: Iodine tablets, persons aged over 45 are advised not to take the tablets; the risk of side effects is greater than the protection of possible radiation damage.

[15] Röntgenverordnung, part 4: Medical surveillance

[16] Strahlenschutzverordnung, part 2: Protection of man and environment of radioactive material or ionising radiation..., chapter 3, part 7: Precaution of Occupational Medicine

- salting of contaminated meat.

Also for self-supply a list of measures is presented in this publication such as washing and peeling fruit and vegetable, discarding gravy, pickling and salting of meat and fish with discard of the salting fluid, boiling of vegetable and mushrooms with discard of the boiling water.

2.3 Regulatory framework in the United Kingdom

2.3.1 General

Legislation in the UK takes the form of different levels. At the top level is an Act of Parliament, which is debated in both Houses of Parliament before receiving the Queen's signature and becoming law; whilst under debate and external consultation, the legislation in known as a Bill. Under certain Acts of Parliament, Regulations are made to enable the requirements of the law to be met. Regulations are "laid before Parliament" (literally, copies are placed within the assembly and can be read by any of the Members of Parliament) for a certain time; if no objections are raised, then they become law without debate. Regulations can therefore be updated without the need for parliamentary debate, and it is not unusual to have several updates under the same Act; for example, the Ionising Radiations Regulations 1999 replaced the earlier 1985 Regulations. It is also possible to have different Regulations on different aspects of an Act; the Ionising Radiations Regulations 1999 were made under the Health and Safety at Work etc. Act 1974, as were the Radiation (Emergency Preparedness and Public Information) Regulations 2001.

2.3.2 Legislation

Legislation exists in the UK to ensure that emergency preparedness is taken into account by anyone wishing to store and/or use radioactive substances. The responsibility for specifying the emergency procedures, and for informing the public what those measures are, lies with the operator of the particular facility. No limit is specified for the time for which countermeasures may remain in force, so theoretically the regulations can apply forever. However, for an accident happening overseas, where the Regulations are not applicable, restrictions on food are the responsibility of the Food Standards Agency and are made taking regard of the Council Food Intervention Levels (CFILS), laid down by the EU for use after an accidental release of radionuclides (CEC, 1989a, 1989b, 1990). FSA can also make use of a FEPA order to enforce a range of restrictions on food production systems (see later).

Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)

REPPIR implement the articles on intervention in cases of radiation (radiological) emergency in Council Directive 96/29/EURATOM in Great Britain, and draw together the implications of previous legislation for emergency preparedness. The EC Council Directive lays down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (BSS96 Directive). The Ionising Radiations Regulations of 1999 (IRR99) implement most of the BSS96 Directive. Where the requirements of REPPIR overlay those of IRR96, consistent drafting has been applied, and similar terminology has also been used.

REPPIR also cover emergency preparedness for transport by rail; emergency preparedness for the transport of radioactive substances by road, air, sea and inland waterway is covered in the relevant transport regulations:

- The Radioactive Material (Road Transport) Regulations 2002,
- the Air Navigation Order 2000,
- the Air Navigation (Dangerous Goods) Regulations 1994 and Amendment 1998,
- the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997,
- the Merchant Shipping (Carriage of Packaged Irradiated Nuclear Fuel etc.) (INF Code) Regulations 2000,
- British Waterways Board Terms and Conditions: Dangerous Goods BWB 1981 and Schedule of Dangerous Goods BWB 1981 (Class 7).

The Food and Environment Protection Act 1985 (FEPA)

FEPA authorises the making of emergency orders to prohibit agricultural or fishing activities such as harvesting, movement, sale, preparation and processing of food required to protect consumers from risks associated with contaminated foodstuffs. Potential pollutants include any substance that may create a hazard to human health, and as such the Act is not exclusive to radioactive materials. FEPA orders are normally made by the Food Standards Agency.

The Draft Civil Contingencies Bill

This bill was released for public consultation on 19th June 2003. Comments received by September 2003 will be considered and may be included in the Bill that will be debated by Parliament before becoming an Act, hopefully sometime in 2004. It is therefore not possible to state with any certainty what the final document will contain. However, it is envisaged that new duties will be set out for those engaged in civil protection work at the local level. It will place a responsibility on local organisations to plan, train and practice any type of emergency, not just those of a radiological nature.

Other controls

In addition to legislation specifically made in the UK, regulations issued by the Council of the European Communities specify intervention levels (Council Food Intervention levels or CFILs) (CEC, 1989a, 1989b, 1990) for radioactive contamination in marketed foods and animal feeds. The regulations become binding on EU Member States following a future accident or incident, and would therefore apply in the UK. CFILs are intended to be used in the immediate aftermath of an accident or incident, with revisions allowed to be made if appropriate, and if agreed by a majority of member states.

The intervention levels specified for animal feedstuffs by the CEC are broadly based and relate only to radiocaesium. Based on farming practices that are used generally in the UK, the application of these intervention levels could lead to some animal products exceeding the CFILs. Under contract to MAFF (now FSA), a system of **W**orking levels in **a**nimal **f**eedstuffs (WAFs) has been developed by NRPB, for dairy and beef cattle, pigs, broiler chickens and laying hens (Nisbet, 1998). The system is based on typical diets for different times of the year, and values have been derived for both radiocaesium and radiostrontium. Both short term and long term phases after an accident were considered. It should be emphasised that this system is based on the situation in the UK and the derived values may not be applicable elsewhere in the EU.

3 Existing preparedness systems

3.1 France

3.1.1 Emergency phase

3.1.1.1 Local level

In case of a nuclear accident, only two bodies are legally in a position to take operational decisions at the local level during the very short-term post-accidental phase:

- The **utility** (Electricité de France) operating the NPP where the accident has occurred, is responsible for the organisation of the short-term control of the situation, the evaluation and mitigation of the consequences, the protection of people who are working on-site, the emergency (and then, a regular) information of the authorities by implementing the so called On-Site Emergency Plan ("PUI"[17]). The PUI is mandatory, and is checked and validated by the French authorities. EDF will also provide its help in the decision making process.
- The **prefect**[18] - who is the local administrative representative of the government - will decide what measures are needed in order to guarantee the protection of people environment and goods by implementing the so called Off-Site Emergency Plan ("PPI"[19]) and, if necessary, he will coordinate the action of the neighbouring affected counties. He is also responsible for alerting people and implementing emergency countermeasures (e.g. sheltering, evacuation, distribution of iodine tablets…), and he will give all the available information to allow people to estimate the gravity of the situation and its possible evolution.

In case of an accident, the prefect implements a crisis organisation structure with fixed (PCF) and operational (PCO) headquarters. The PCF is the local place where the decisions are taken by the prefect (at the prefecture facilities). On the spot, as close to the installation as possible, the operational headquarter is under the leadership of a sub-prefect (in France, there is one sub-prefect per district) and he implements the decisions taken by the prefect. PCO is divided into three groups of persons: The headquarter which is responsible for the management of the situation and the implementation of necessary means (PCM), a cell which constitutes a strong link with local elected people (e.g. mayors), and a local press centre. PCM puts together operational services such as firemen department (several firemen specific mobile units named "CMIR"[20] have the adequate equipments to detect radioactivity, to measure doses with WBCs, and to take food/earth/plants samples…), the regional police department ("Gendarmerie") and mobile emergency medical services ("SAMU[21]"). PCM is in charge of off-site radioactivity measurements, access controls in contaminated areas and alert people

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17 Plan d'Urgence Interne

18 France is divided into 95 counties or "departments", each of them under the administrative responsibility of one prefect

19 Plan Particulier d'Intervention

20 Cellule Mobile D'Intervention Radiologique

21 Service d'Aide Médical d'Urgence

and professionals of the health care system (e.g. hospitals and medical services, local and regional - DDASS - social services).

Moreover, the French authorities encourage the mayors of towns located close to nuclear installations to prepare - and implement – local action plans for anticipating, organising and structuring accompanying measures. Local action plans are not mandatory but, if they do exist, they are very useful to reinforce PPIs.

3.1.1.2 National level

Here the main stakeholders are:

- The Ministry of the Interior (Home Office) represented during a crisis by the Civilian Defence and Security Directorate (DDSC): The DDSC helps (with reinforcements and further supplies) the prefect to implement operational measures for safeguarding people and goods.
- The Ministries of Industry, Environment and Health represented by the French Authority for safety and radiological protection (DGSNR[22]) with the technical support of the French Radiological Protection and Safety Institute (IRSN[23]): DGSNR with IRSN are responsible for the control of the safety and radiological protection of nuclear installations. Especially, they will check the usefulness and efficiency of the mitigating measures taken by the utilities. The Ministry of Industry will also coordinate the national communication in case of an accident.
- The General Secretariat of the Interdepartmental Committee of Nuclear Safety (SGCISN): He has in charge the information of the French President and Prime Minister, the coordination of the action of all concerned ministries, and the information of other countries (by following the international conventions in case of radiological emergency).

[22] Direction Générale de la Sûreté Nucléaire et de la Radioprotection

[23] Institut de Radioprotection et de Sûreté Nucléaire (the former IPSN)

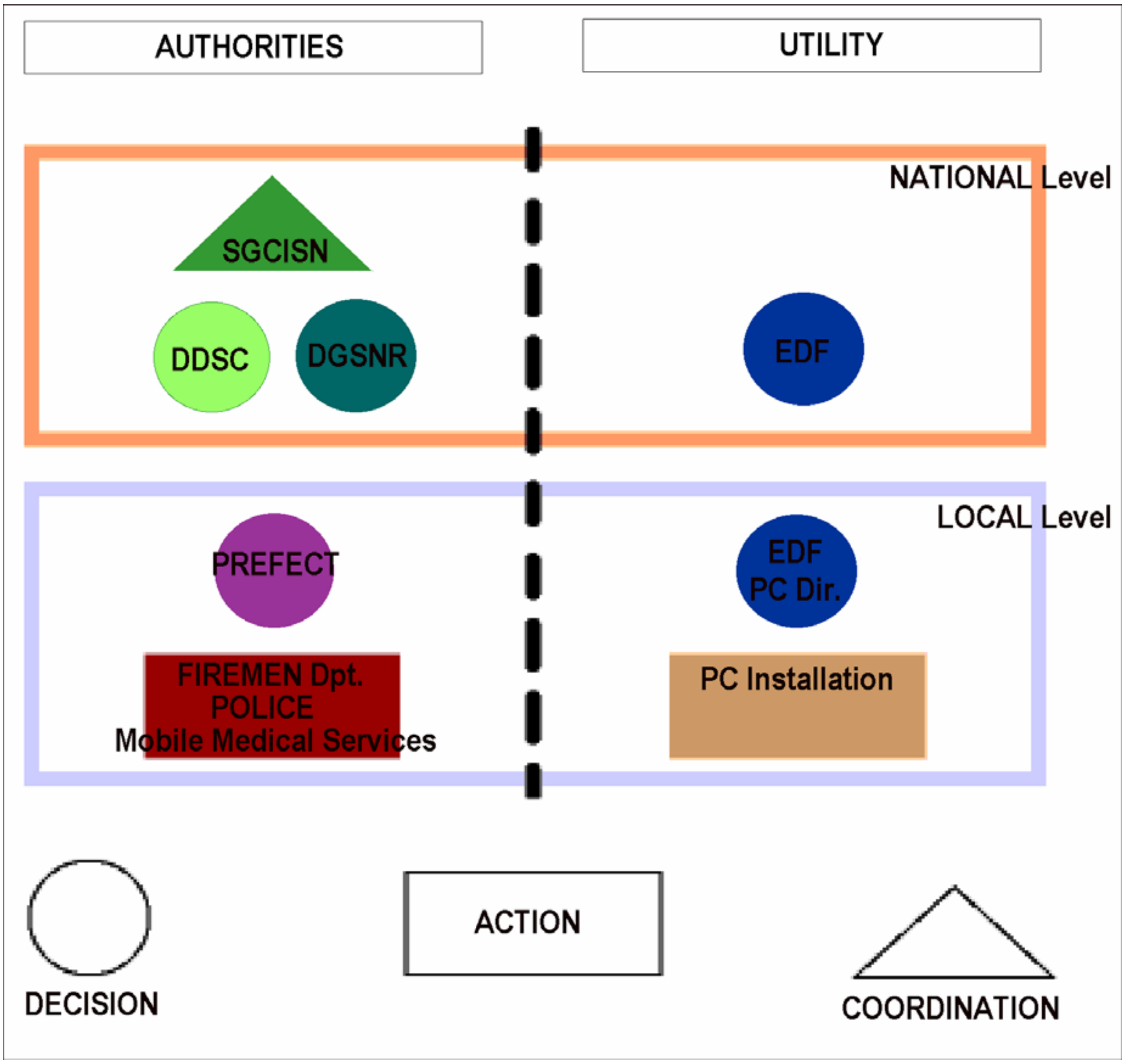

Figure 1. Identification, organisation and roles of stakeholders in care of potential nuclear accidents in France (http://www.asn.gouv.fr/temp/faq/responsabilites.html)

In case of an emergency, the IRSN's technical emergency centre comprises four units:

- A management unit with the task of coordinating the work of two technical units, collating the obtained results and transmitting (using video-conference) the necessary information and recommendations to the DGSNR emergency team,
- a secretariat unit with the task of dispatching the received information and transmitting the previously-validated advice and obtained data,
- two technical units – "installation assessment unit" and "radiological consequences unit" - with the task of processing the received information and analysing it.

A description of diagnosis and analysis tools (specifically, the SESAME and CONRAD systems) which are used in case of emergency by IRSN can be found in the literature.[24]

24 "Organisation and Operation of the IPSN crisis centre in case of accident in a French PWR" by K. Herviou, D. Winter (IRSN).

3.1.2 Long term phase

To anticipate and solve difficulties which could appear during real accident, the French Authorities periodically organise exercises (drills) to train the crisis staff and to test the envisaged means and organisations. These drills are performed at professional, national and international levels. Recently such exercises – and particularly the “Becquerel Exercise”[25] as organised in October 1996 - have led to interesting feedback experiences concerning the medium and long term management of the post accidental situation. Although it is very difficult to compare this drill with the Chernobyl situation because of its potential low levels of doses and the absence of real health consequences, the “Becquerel Exercise” has shown different lacks and problems to be solved.

In 1999 a report written by a Working Expert Group[26] which was in charge of proposing (to SGCISN) organisation means, assessment and management procedures in the medical field during the post accidental phase of a radiological accident identifies different problems and establishes an important set of strong recommendations. These conclusions give a revealing picture of the French situation concerning the long term post accidental management. The most important recommendations are given below.

Scientific aspects:

- A need to check the accuracy of the existing public dose and risks prediction tools and the reliability of corresponding data (e.g. behaviours in terms of diet including local habits such as mushrooms, berries and kitchen vegetables consumption, life outside dwellings, etc),
- a need to identify possible specific groups of population more risk-exposed than others due to their life habits (and hobbies).

Note: In this respect, since 2000, IRSN and ADEME are developing the CIBLEX database as a decision-aiding tool in case of an accident. This database contains social (e.g. time spent outside, food consumption habits, agricultural practices) and demographical data which can be used to help the implementation of correcting actions after pollution or contamination of a French region.

Individual dose control:

- A need to propose procedures to identify and record the exposed population,
- a need to check, if the internal individual doses and food contamination controls, means and procedures are operational or not, according to different accident scenarios taking into account all available human resources and technical equipments in different organisations (utilities, authorities, emergency services, hospitals, veterinary labs, universities, local associations, etc),

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25 This exercise consisted in the total melting of the research reactor “Osiris” located in Saclay, at 50 km from Paris, leading to iodine-131 ($1{,}6.10^{13}$ Bq = 400 Ci), caesium-137 ($2{,}5.10^{11}$ Bq = 7 Ci) and noble gases releases. The scenario led to individual doses above 1 mSv for 75000 persons living in the vicinity (10 km) and also to the contamination of the Rungis national food market. In comparison, the Chernobyl accident led to an iodine-131 release of 7.10^{17} Bq and, the Three Mile Island accident to an iodine-131 release of 10^{12} Bq.

26 Rapport d’étape du Groupe de Travail n°4 « Suivi Sanitaire et médical des populations en phase post-accidentelle d’un accident radiologique », préparé à l’intention de Monsieur le Secrétaire Général du Comité Interministériel à la Sécurité Nucléaire, Janvier 1999 (rapporteurs Dr. P. VERGER, Pr. M. BOURGUIGNON)

- a need to assess the delays and the capacity of measurements (e.g. the maximum number of exams per day, per month, and per year),
- a need to prepare training and to train a sufficient number of persons who might be able to realise and interpret measurements,
- a need to organise the coordination between all organisations able - and authorized - to make measurements.

Medical aspects:

- A need to formalise an individual medical consultation protocol (e.g. content, type of exams, periodicity, technical needs…) in case of a nuclear accident. Obviously, this protocol has to be adapted to different time periods after the accident.
- A need to prepare what the individual health record and follow-up system should be,
- a need to define health indicators (number of consultations, number of sick leaves, specific prescriptions of medicine) which allow a global surveillance of the evolution of the health care needs in the contaminated villages (and in the vicinity),
- a need to prepare the mechanisms and scientific protocols allowing the data recording needed for the realisation of long term epidemiological studies (about cancers and other illnesses). In particular, the administrative legal procedures and possible obstacles/limitations must be removed in advance (taking into account the anonymity of victims, the respect of the medical secret, the obligations with regard to the French law on data processing and individual freedom…).

Information needs:

- A need to adapt the health consequences and long term risk information to the different expectations of stakeholders (public, local medical professionals, social services, mayors…),
- a need to elaborate a set of recommendations and practical guidance in a next future in order to explain people living in the vicinity of nuclear installations what are the precautions they would have to take in their day-to-day life after an accident,
- a need to make an international survey on the existing information documents (presenting the effects of ionising radiations, comparison of risks levels…) and tools and if considered necessary to revise them,
- a need to examine the possibility of the implementation of Local Health Information Centres (“CAIS“[27]), with the following objectives: Register and analyse public claims and questions, defuse rumours on the accident health consequences, assure a practical individual information adapted to public concerns, organise psychological and medical consultations, distribute personal dosimeters and radiometers, organise a local network of “informant persons (trainers)“, etc.,
- a need to prepare training and to train a sufficient number of persons who might be able to welcome people in the Local Health Information Centres, and also those who could have a role in the long term dissemination of information (for example medical professionals).

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27 Centre d’Accueil et d’Information sur la Santé

Financial resources:

- A need to establish the corresponding budget and to envisage immediately financial mechanisms for the implementation of all the above post accidental needs, and victims compensations (the Gravelines drill performed in May 2001 dealt with that last topic).

In conclusion, the information of the population is one of the key elements and probably one of the most important stakes of the long term post accidental situation from the health care point of view. The credibility of authorities is conditioned by its capability:

- To accurately assess the environmental and health situation by using all the available information and surveillance tools and recording individual data (e.g. internal and external doses),
- to provide people with measurement tools (dosimeters, radiometers…) allowing them to judge by themselves (self-control) the exposures levels they are set out (this distribution is not envisaged in the legal framework),
- to inform persons living in a contaminated area (or in the vicinity) continuously about radiological risks and dangers. The information system has to provide people with very practical recommendations, adapted to the individual demands and fears.
- To drive a network of informed and well trained people (especially belonging to the health care system) who would be able to inform people about possible health consequences of the accident.

3.1.3 Availability of whole body contamination control systems in France

3.1.3.1 Equipments available at the French Radiological Protection and Nuclear Safety Institute (IRSN)

The IRSN (of which the agency located at Le Vésinet is the former Office of Protection against Ionising Radiation OPRI) is the technical support of the radiological protection and safety Authorities Directorate (DGSNR). After a nuclear accident in France IRSN-Le Vésinet is one of the key participants in the post accidental management of the crisis phase. There are different fixed and mobile measurement devices. OPRI-Le Vésinet has the following equipments:

Consist of mobile equipments:

- 5 Renault Master-Gemini vehicles, each of them equipped with 4 seats, able to measure thyroid and thorax contamination,
- 1 Renault Master Gemini vehicle, equipped with 2 seats,
- 1 trailer with 12 seats, with a dosimetric laboratory and a chemical laboratory,
- 1 trailer with 4 seats (whole body counting),
- 1 wagon with 32 seats (same purpose, capacity 5000 persons/day),
- 1 mobile laboratory, equipped with 4 shielded cells (for a real whole body counting).

Figure 2. Intervention trailer with 12 WBCs seats

These equipments are able to measure the whole body contamination due to the incorporations of caesium (^{134}Cs, ^{137}Cs) and cobalt (^{58}Co, ^{60}Co) and to determine and register the individual contamination spectra. Detection levels given by OPRI in 1999 were 500 Bq of ^{137}Cs (for seats; with a data acquisition time of 10 minutes) and 100 Bq of ^{137}Cs (for cells; with a data acquisition time of 30 minutes). These detection levels are quite good to sort people out (in function of their levels of contamination) but, they are of less quality in comparison with fixed equipments.

The vehicles are also equipped with technical means for measurement of contamination of water, soil, meat, plants…

If all vehicles are driven and kept in the area of the accident - which is not evident in a long term perspective - and by making the whole system available 10 hours a day - which is quite optimistic - a maximum number of about 3000 controls per day can be envisaged. The cost for one examination can be evaluated to about 100 Euros. The main problem seems to be the number of people well trained to perform the measurements: IRSN-Le Vésinet (the former OPRI) is probably working with insufficient staff to effectively face with the number of people to be measured during the crisis phase of a nuclear accident which is necessarily the same in a more long term perspective. Thus it is clear that, in the post accidental long term phase, measurements would have to be performed by other organisations.

In addition IRSN Le Vésinet has also 3 fixed NaI whole body counters (coffin type).

3.1.3.2 Equipments available at Electricité de France (EDF)

Electricité de France (EDF) is the unique utility operating nuclear power plants in France, and owns 57 operating reactors distributed on twenty sites. Each of these nuclear sites has its own medical services which are responsible for monitoring intakes of radionuclides by workers (WBCs and bioassays). This represents approximately 200,000 whole body gamma counting per year. Since 1999, the "standard" equipment is:

- Two whole body counters with two large NaI detectors (some NPPs have more than one WBC: Gravelines NPP has three WBCs) ; the detection limit is about 150 Bq for ^{60}Co (counting in about one minute),
- one shielded chair with two smaller NaI detectors (one for thyroid and one for thoracic-abdominal region) designed for the contamination with iodine; the detection limit is about 500 Bq for ^{60}Co (counting in about ten minutes).

EDF has also a central radiotoxicology laboratory located in the suburbs of Paris, which analyses all biological samples (urines, faeces, nose blows: 8000 per year).

3.1.3.3 Equipment available at the Atomic Energy Commission (CEA)

Table 1. CEA WBCs capacities

CEA sites	Type of detector	Detection limit (Bq)			Counting duration (min)	Normal & exceptional (crisis) capacity (persons/h)
		^{137}Cs	^{131}I	^{60}Co		
Fontenay aux Roses	NaI (x1)	80	100	80	15	3 (10)
Saclay	NaI (x2)	100 140	100 140		12 3	? (8) ? (20)
Grenoble	NaI	100	50	85	15	3 (10)
Cadarache	NaI+Phoswich* (x1) Ge Hp** (x1)	400 130	30		5	12 (20)
Bruyère le Châtel	NaI + CPX* (x1) Phoswich* (x1)	85	90		15 20	3 (10) 3 (15)
Valduc	Ge Hp (x1)	10	10		20	3 (20)

*Phoswich detector (thallium-doped sodium iodide NaI(Tl) detector) and CPX (gas proportional counter) are used for detection of actinides.
** GeHP : high-purity germanium detector
**The capacity during crisis is an assessment

The French Atomic Energy Commission (CEA) owns one Renault Master-Gemini vehicle (the same type as that owned by IRSN) and different WBCs devices are distributed on six different sites as given in Table 1.

3.1.3.4 Equipments available by the AREVA group

The AREVA Group (nuclear consortium which includes COGEMA, CEA, Framatome,…) has three sites where whole body counting is performed: In Pierrelatte (UOX fuel fabrication plant in decommissioning, FBFC UF4/UF6 conversion plant, EURODIF enrichment plant, …), in Marcoule (PHENIX research reactor, ATALANTE fuel reprocessing facility, MOX fuel fabrication plant, waste management facilities) and in La Hague (French fuel reprocessing site). Capacities in Pierrelatte are given in Table 2.

Table 2. Pierrelatte WBCs capacities

Type of detector	Detection limit (Bq)			Counting duration (min)	Normal & exceptional (crisis) capacity (persons/h)
	^{137}Cs	^{131}I	^{60}Co		
NaI (diameter 80)	600	670	400	10	5 - 10 **(in 5 minutes)**
NaI (diameter 32) for **thyroid**		180			5 - 10 **(in 5 minutes)**
Ge Hp X 4	30	25	25	30	2
Ge Hp X 4	50	45	40	10	5

3.1.3.5 Other available WBCs in France

French Army

The Radiological Protection Service of the French Army (SRPA) has one Renault® Master-Gemini vehicle (same type as that owned by OPRI).

SRPA has also a fixed measurement cell to make thyroid, lung and whole body counting. This WBC is located at the Percy Hospital in the suburbs of Paris. The detection limit is 43 Bq (for ^{137}Cs) and 34 Bq (for ^{131}I).

French Firemen Units

The firemen units are directly involved in case of nuclear accidents. For that purpose, specialized intervention staffs named CMIR (Mobile Units of Radiological Intervention) are equipped with Master-Gemini vehicles, each of them equipped with 4 seats able to measure thyroid and thorax contamination. Like IRSN's vehicles, all these vehicles have embarked software which allows examinations of caesium (^{134}Cs, ^{137}Cs), iodine (^{131}I), cobalt (^{58}Co, ^{60}Co), chromium (^{51}Cr) and bismuth (^{214}Bi) contaminations. In order to determine the contamination levels with other radionuclides, calculations have to be made by IRSN from the results of measurements made "on the spot".

The location of the 5 available Master Gemini vehicles has been chosen with regards to the risk of a nuclear accident (taking into account the number of NPPs in the vicinity):

- Agen (SDIS47),
- Avignon (SDIS84),
- Thionville (SDIS57),
- Lille (SDIS59),
- Nogent le Rotrou (28, Civilian Security Training Centre, US C1).

About 20 French firemen are trained to use Geminis.

It is possible to perform examination for 40 to 50 persons per day with one vehicle.

Three persons are allocated to each car: One medical doctor, one specialised fireman officer, and one specialised fireman. The specialisation of the firemen corresponds to a one-week of training given by IRSN-Le Vésinet experts.

Summary of available WBCs

Figure 3 shows the map of fixed and mobile whole body counter locations in France summing up to a total of 115 devices (Table 3). Fixed WBCs are located in the nuclear installations (NPPs, fuel cycle plants, research centres). In normal situation, most of the mobile vehicles (about 75% of the capacity of measurement) are parked in the suburbs of Paris.

Table 3. Overview of Whole Body Counters in France

Type of devices	Mobile	Fixed	
Whole Body Counters (WBCs)	**89 (seats)**	**26 (sites)**	
Vehicule 1 seat	*1*		
Vehicule 4 seats	*11*		
Vehicule 12 seats (truck)	*1*		
Vehicule 32 seats (wagon)	*1*		
TOTAL			**115**

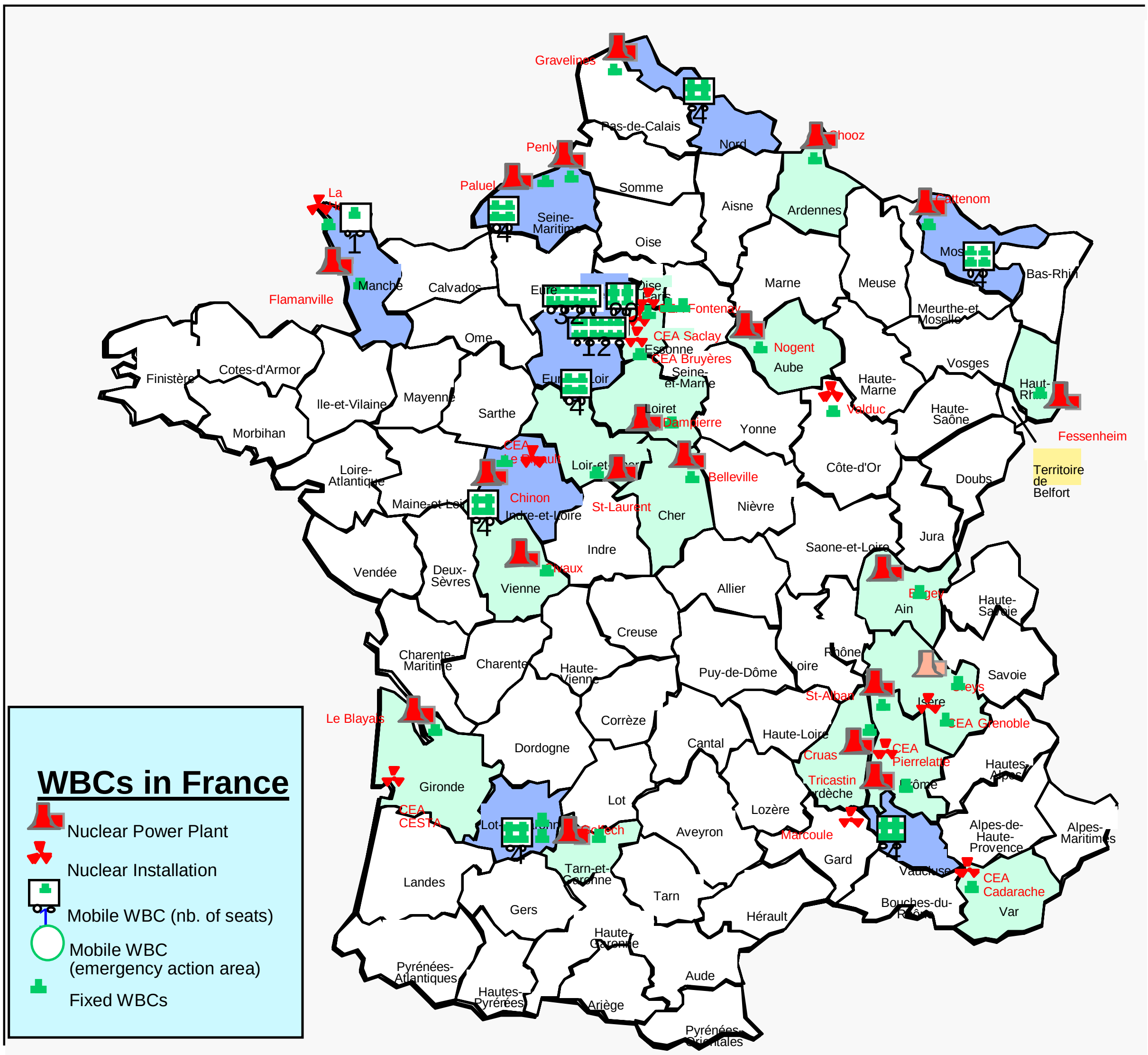
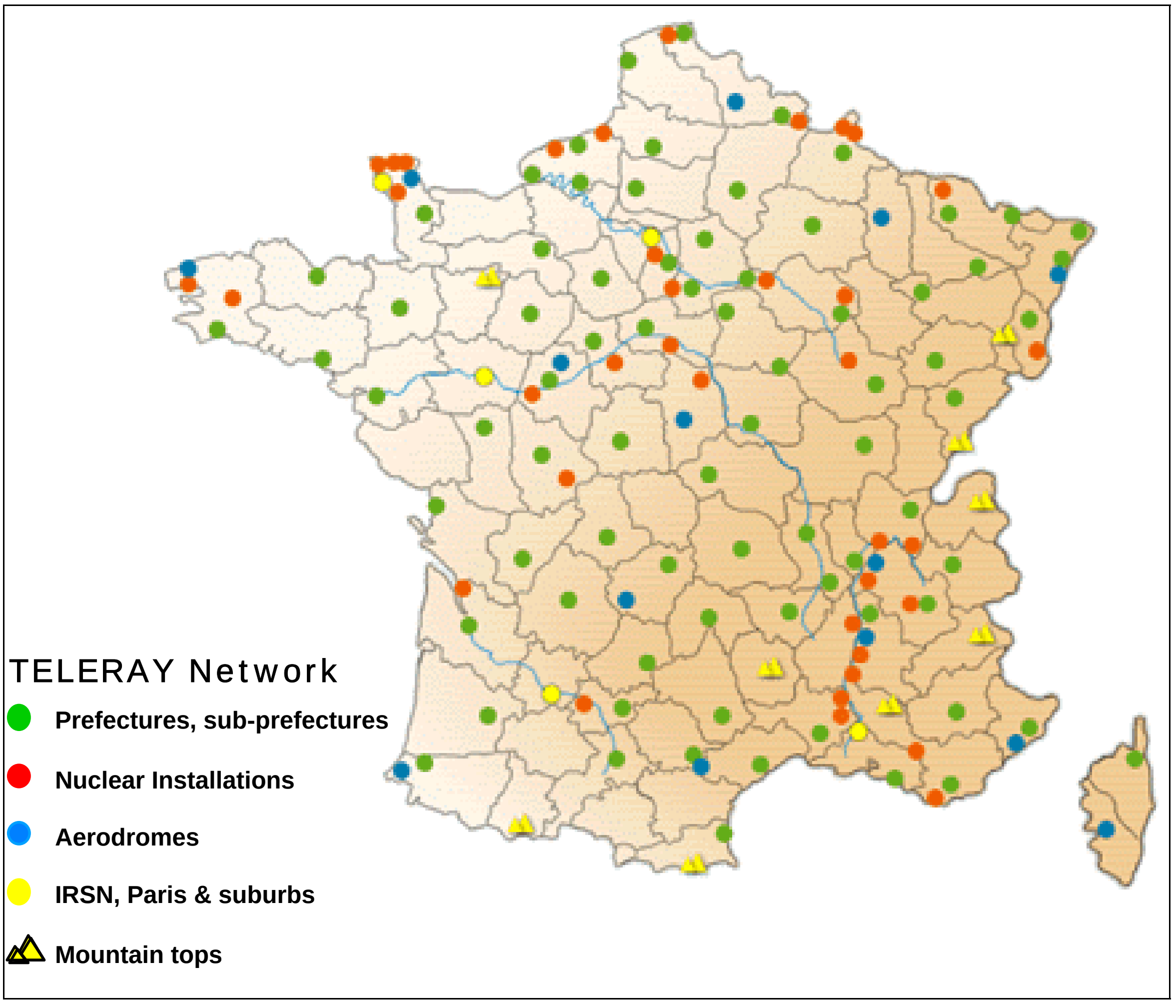


Figure 3. Location of Whole Body Counters in France (1999)

3.1.4 Dose rate and food contamination control systems in France

3.1.4.1 Routine gamma ambient dose rates surveillance

Since 1991, IRSN has installed about 180 Geiger-Müller stations to follow the gamma ambient dose rates (in the range 10 nGy/h-10 Gy/h), coupled with the domestic telephone network (Figure 4). They are widely scattered on the French territory: 9 on mountain tops, 85 in prefectures and sub-prefectures, 10 in Paris and suburbs, 38 in the nuclear installations, 14 in aerodromes (plus 22 in DOM-TOMs and abroad). The network is one of the decision-aiding tools that could be used in case of an accident to determine interventions and countermeasures.



Source : http://www.opri.fr/opri/html_opri/mesure/france.htm

Figure 4. The TELERAY network

3.1.4.2 Environmental sampling

IRSN has also a set of stations where aquatic and atmospheric samples are collected in routine basis (in theory, the system is not designed to be used in case of an accident). In fact, this set of 33 stations (named “OPERA” for PERmanent Observatory of the RAdioactivity) can be considered as a complementary tool to the existing legal surveillance network. These represent more than 30 gamma spectrometry detectors and spectrometry analysis chains, about 20 alpha-beta detectors, multi-detectors and liquid scintillation counters. Recently, in 2001, IRSN has extended its surveillance network by implementing 13 stations (the “SARA” network in Brest, Biarritz, Toulouse, Montpellier, Nice, Montélimar, Lyon, Bourges, Tours, Le Vésinet, Lille, Strasbourg, Etain) designed to detect very quickly - in several minutes - the presence or increase of artificial radionuclides in the atmosphere (alpha emitters such as uranium, plutonium, americium, curium, etc., beta emitters such as cobalt-60 or caesium-137, and radon).

Complementary at seven stations in France (in Alençon, Bordeaux, La Seyne sur Mer, Dijon, Charleville-Mézières, and Orsay) air samples are collected and measured by gamma spectrometry. Another one is installed in La Hague (COGELA reprocessing plant) to measure krypton-85 atmospheric releases.

Another computerised and centralised network named “TELEHYDRO-HYDROTELERAY” has been set up recently to detect contamination of water purification stations by radioactive effluents from industrial and research laboratories and, in the near future, from hospitals having a nuclear medicine service. When established, this network will cover a dozen of towns: Rennes, Nantes, Caen, Rouen, Amiens, Achères, Strasbourg, Nancy, Lyon, Marseille, Toulouse, and Poitiers (where portable equipment is also available). These equipments are designed to perform global counting of gamma emissions and to measure volume activities of iodine-131, technetium-99m and caesium-137 with a detection limit of about 1 $Bq.l^{-1}$.

3.1.4.3 Emergency equipment (radiometers, spectrometers)

Radioactivity counters, radiometers and other dose rates measurement equipments can be found almost everywhere widespread in the country, but they are mostly installed near nuclear installations. Some regional (county level) firemen units are equipped with a few devices (often less than 5 and always less than 20).

Table 4 and the following map (Figure 5) indicate that there are several counties which are not well equipped with that type of device, and this is even true for sites where a nuclear power plant is not far away (less than 50 km). In a long term post accidental perspective it would be probably difficult to envisage the decentralization of the existing equipments.

Spectrometry devices (mainly gamma spectrometry equipments) can also be found widespread on the French territory. Most of them are fixed and located in research or expertise laboratories (utilities, veterinary labs, Fraud Squad facilities and universities). In normal situation, the existing mobile equipments are concentrated in the suburbs of Paris (mainly in the IRSN-PRI facilities) (see Table 5 and Figure 6).

In conclusion the control of internal and external doses, contamination levels of food, water, landscape and dwellings is certainly a key element for a good management of the post accidental situation. But in France one of the main problems will probably be the availability of technical device to take measurements, especially concerning mobile equipments. Although the existing means are quite important, the types of devices are very disparate and the number of people ready to use all these tools is most probably insufficient.

Table 4. Dose rates measurement devices in France

Type of devices	Mobile	Portable	Fixed
Counters (c/S)	127	171	199
Radiometers, Multipurpose-radiometers	7	253	
Teletectors	1	86	
Scintillometers	4	47	41
Other detectors (^{3}H, Rn, neutrons)	1	5	
TOTAL	140	562	240

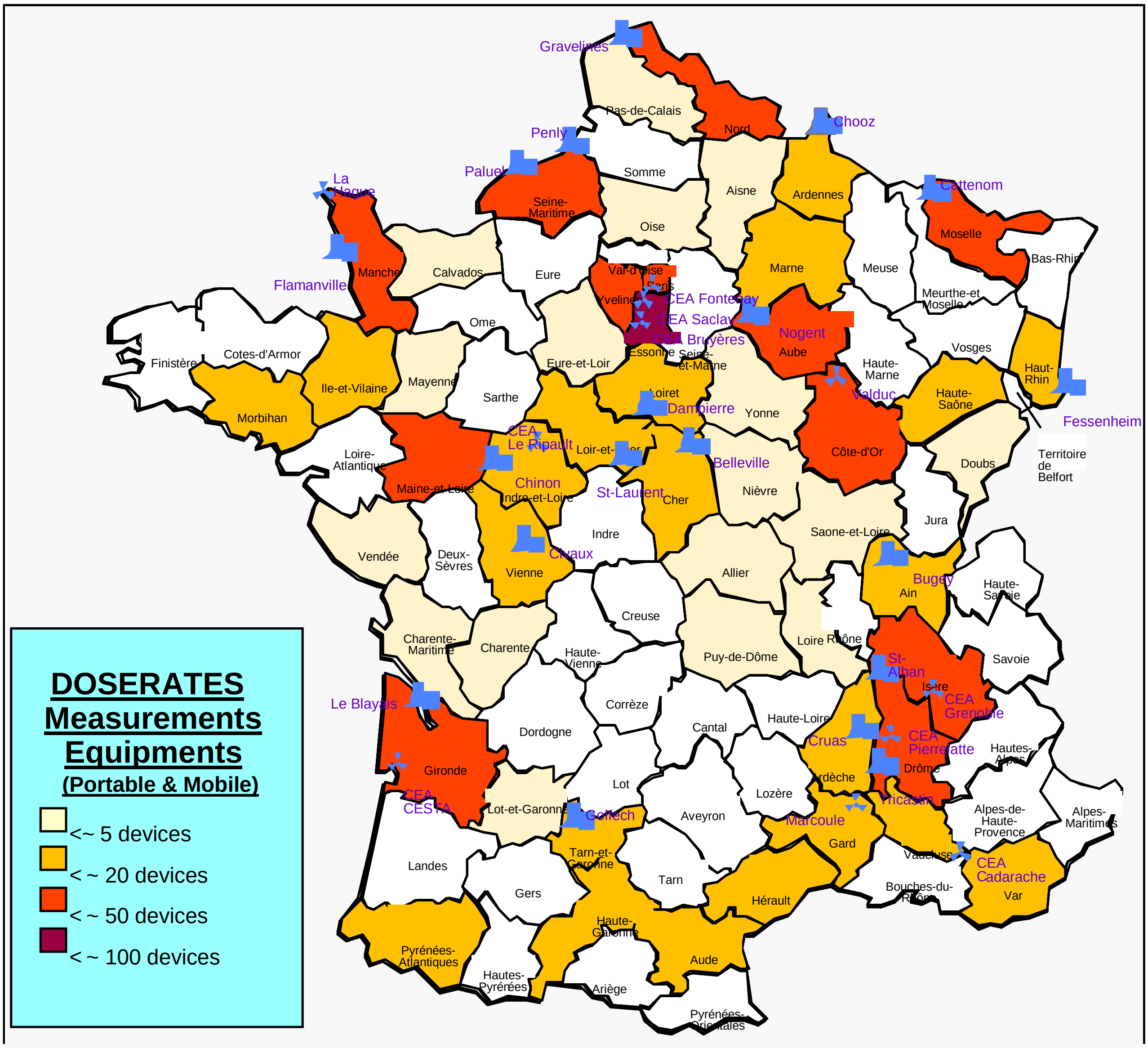


Figure 5. Location of dose rates measurement devices in France (1999)

Table 5. Spectrometers in France

Type of devices	Mobile	Portable	Fixed
Gamma Spectrometry	4	77	
Gamma (NaI) Spectrometry	1	2	49
Gamma (Ge/High-Performance) Spectrometry	3	2	90
Alpha Spectrometry			56
Mass Spectrometry			8
	8	81	213

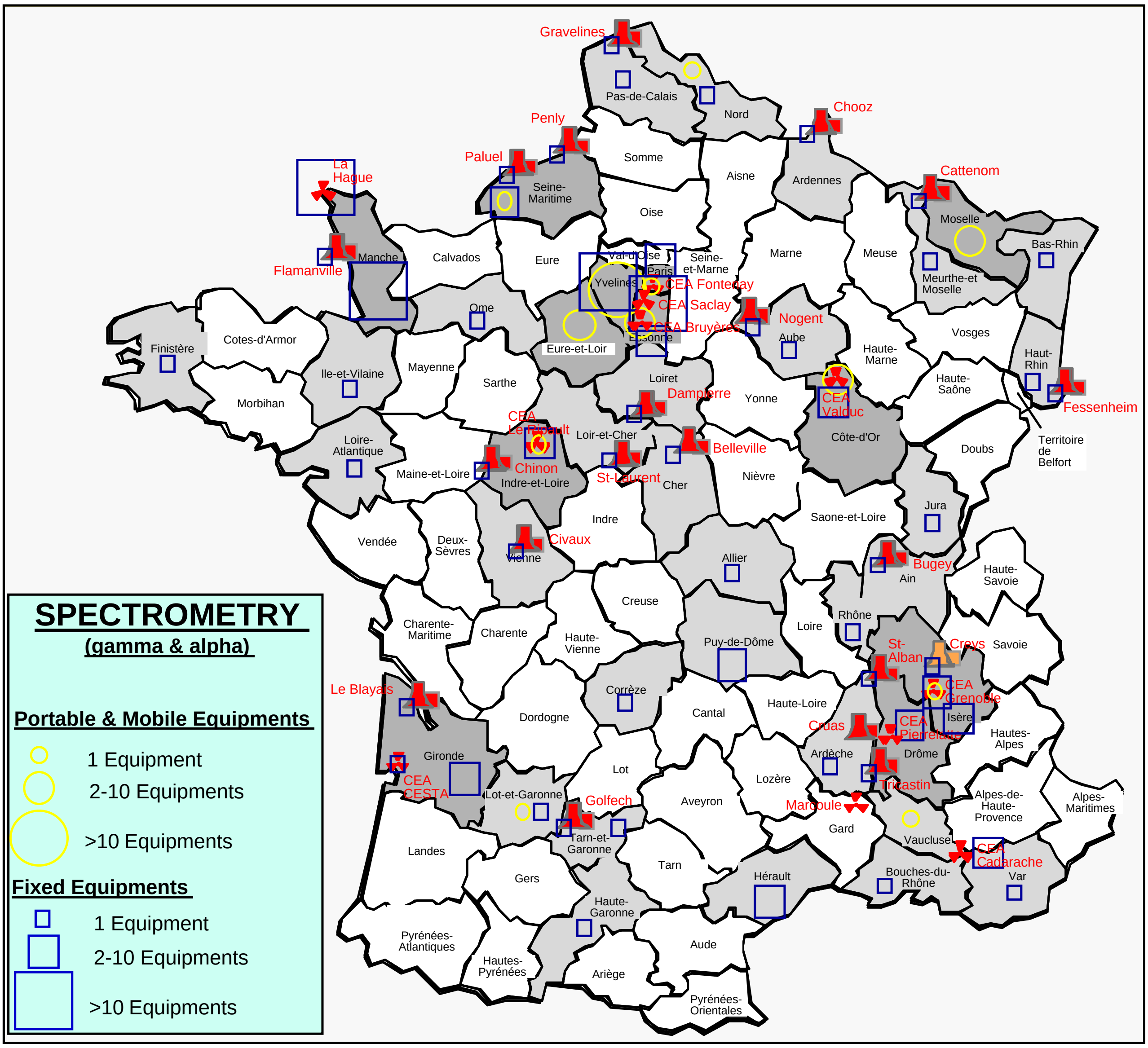


Figure 6. Location of Spectrometers in France (1999)

3.2 Germany

Since the Chernobyl accident monitoring of radioactivity in Germany was extended to a high degree. Not only the environment of nuclear power plants and facilities but also the environment in general is surveyed regularly.

The operators[28] of nuclear facilities are responsible for the surveillance of the environment within a radius of 25 km. They have to keep special emergency plans in case of an incident. In addition the operators are controlled by independent institutions.

The environment in general is monitored by authorities of the federal states (Bundesländer) and the Federation (Bund). Every state has institutions where different exactly defined samples are regularly measured. All data are collected in central facilities of state offices for environmental monitoring of radioactivity. The data of state offices and additional data of the federal measuring network are gathered and evaluated in the ZdB[29] of BfS[30]. Besides the federal measuring network (BfS, DWD[31], BfG[32], BSH[33]…) special federal control stations for monitoring environmental radioactivity are installed, the data are also collected in ZdB. All measured and evaluated data are transferred to BMU[34] for decision support and information. The BMU enacts suitable measures and gives recommendations for the protection of the population, goods and environment in the affected area.

3.2.1 During emergency phase

In case of a nuclear accident in Germany the duties to protect the population are subdivided. The governments of the states are responsible for the civil protection according to regulations of the constitutional law and the federal government regulates the radiation protection according to Strahlenschutzvorsorgegesetz (StrVG). This law regulates the monitoring of radioactivity during the different phases of a nuclear accident.

Countermeasures for civil protection in case of a nuclear accident such as evacuation, staying in house, taking iodine tablets, restricted access and inhibition of contaminated areas, prevention measures for diminishing the inhalation of radioactive substances, are dependent on the severity of the accident as outlined below.

3.2.1.1 At local and regional level

The emergency management in case of an accident in a nuclear facility is exactly defined by different regulations.

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[28] In Germany are three utilities operating NPPs: E.ON, RWE Power AG and EnBW AG

[29] Zentralstelle des Bundes für die Überwachung der Umweltradioaktivität

[30] Bundesamt für Strahlenschutz

[31] Deutscher Wetterdienst

[32] Bundesanstalt für Gewässerkunde

[33] Bundesamt für Seeschifffahrt und Hydrographie

[34] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

BMU has evaluated a "Catalogue of Countermeasures" (BMU, 2001) to reduce radiation exposure following events "with not insignificant radiological consequences". Another document published by SSK[35] is the "Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung bei kerntechnischen Notfällen" (SSK, 1995). This guideline provides means to estimate doses and helps the head of the civil protection authority and the expert adviser for radiation protection for decision making. Both documents, Catalogue and Guideline, regulate the different phases of a nuclear incident or accident in a nuclear power plant (NPP) and describe countermeasures which could be applied by the operating companies of the NPPs and local authorities to protect the population.

- The operating companies of NPPs have special emergency plans in place which were worked out in accordance with civil protection laws (federal states) and the "guidelines for the civil protection in the surrounding area of NPPs" coordinated between federation and states. For significant events in nuclear facilities an "International Nuclear Event Scale" (INES) exists with 7 levels. Levels from 0 to 3 require no civil protection countermeasures, level 4 and 5 single countermeasures, while for level 6 and 7 extensive countermeasures are necessary. Information booklets of the operators of NPPs, how to behave in case of an accident, were distributed amongst the population living near by a NPP because of the amendment of the Radiation Protection Ordinance (StrSchV)[36] in July 2001.
- Lower (head of district authority), upper (for instance the mayor of the capital city of the concerned state) and supreme authorities (home ministry of the concerned state) are responsible for civil protection. They have to coordinate emergency means and countermeasures and to inform and alert population in a proper way. Action forces like police, fire brigades, THW[37] and rescue services are specially trained and educated by according institutions like GSF (see part 4.2) for a nuclear event. The particular state ministry for environment has to inform other departments of the concerned state like health, food and agricultural offices.

In case of a nuclear accident the operator of the nuclear facility has to inform the responsible authority with exact details of the accident, proposal of classification (prewarning, red alert), assessment of risks for the environment, scale of accident (INES), date and time of the accident, name and official position of the person indicating the accident. Communication between nuclear facility and authority has to be guaranteed by telephone, fax, etc. An expert must be appointed by the operator to work together with the head of civil protection authorities. An operational headquarter has to be installed outside of the nuclear facility. Measurements on distinct points of environment have to be carried out for the prediction of contamination. Measurements can be done by the operators of the NPPs, authorised offices (institutes, expert offices) and by action forces like fire brigades. Furthermore independent measurement sites of the states are installed.

By simulation techniques dispersion and deposition of radioactivity can be predicted and theoretical data can be assimilated with real measurements.

To assess the risks in case of a nuclear accident in a correct way and to implement suitable countermeasures specialist counselling is necessary by a contact person of NPP, experts for

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[35] Strahlenschutzkommission

[36] Strahlenschutzverordnung

[37] Technisches Hilfswerk

radiation protection of qualified offices and facilities, doctors experienced in radiation protection, a contact person of the controlling institution and meteorologists.

As assessed in StrVG the duty of states is the monitoring of food, animal feed, fertiliser, pharmaceutical products, products of daily use, sewage sludge and water, drinking and ground water. The states have their own measurement systems, the data are evaluated in the environmental offices which are connected with the BfS.

3.2.1.2 At national level

At national level the important responsible authorities are BMU and BfS.

When incidents occur with not insignificant radiological consequences in larger areas BMU is authorised to enact decree laws to assess dose and contamination limits, to regulate control of foods, animal feed and waste disposal. In agreement with the federal states BMU can recommend measures for the population to reduce radiological consequences. BMU will also inform other federal departments like health, food and agriculture offices.

Within the measurement system IMIS (Integrated Measurement and Information System) an intensive measuring programme exists in case of nuclear events. In that case every 2 hours data are transferred and evaluated with the PARK-system[38], a programme system for the estimation and limitation of radiological consequences.

Participating federal measurement institutions in IMIS are for instance DWD (German Meteorological Service) together with BfS for monitoring air, soil, and precipitation, BfG (Federal Institute for Hydrology) monitoring federal waterways, BSH (Federal Maritime and Hydrographical Office) monitoring North and Baltic Seas, BfF (Federal Fisheries Research Institute) monitoring food chain in water.

All measurement data are gathered and evaluated in the BfS.

An international network is installed between BMU, EU and IAEA and with foreign countries, where bilateral agreements exist.

3.2.2 Precautionary radiation protection

Precaution of radiation protection in Germany is carried out in principle on 4 levels. :

- Level 1:
  Measurements by the control sites in different state offices;
  - e.g. in Bavaria:
    Bavarian State Office for Environment Protection (LfU[39])
    Bavarian State Office for Soil and Plant Cultivation
    Bavarian State of Health and Food Safety,
- level 2:
  Compilation, evaluation and documentation of radioactivity data in every state
  - e.g. in Bavaria:

[38] *P*rogrammsystem zur *A*bschätzung und Begrenzung *R*adiologischer *K*onsequenzen

[39] Bayerisches Landesamt für Umweltschutz

Central Office for Surveillance of Environmental Radioactivity in Bavaria in the LfU,

- level 3:
  Gathering and evaluation of all measured data in the Federation;
  all data coming in from measuring networks and control stations of Federation and states are gathered in the Federal Centre for the Surveillance of Environmental Radioactivity (ZdB),
- level 4:
  Decision and information;
  BMU.

The Federal Control Stations are administrative authorities, consulting the Federal Government in the surveillance of environmental radioactivity. They are an important part of IMIS (see 3.2.3.3). Their duties are:

- Research, especially pathway of contamination,
- development of sampling and analysing methods,
- consulting of the Federal Government,
- evaluation of data,
- reporting,
- implementation of comparing analyses for official and other measuring points of states.

§ 5 of StrVG regulates the evaluation of measured data and the annual reporting of the development of radioactivity in the environment by BMU to the German Parliament. Measurements of air, precipitation, drinking and ground water and food like milk, meat and fish are listed in the annual reports[40] of BMU.

Via internet one can query pollution and radioactivity levels in the environment. On the websites of the Environmental Protection Offices in Bavaria (www.bayern.de/lfu/), Baden-Württemberg (www.lfu.baden-wuerttemberg.de/), Hessen (www.hlug.de/, //atlas.umwelt.hessen.de/) and other federal states information is listed about actual measurements of food and of equivalent dose rates in the environment of NPPs with exact explanations how to interpret these data. Figure 7 shows an example of the dose rate due to the deposition of ^{137}Cs into the soil in Hessen.

[40] Umweltpolitik: Umweltaktivität und Strahlenbelastung

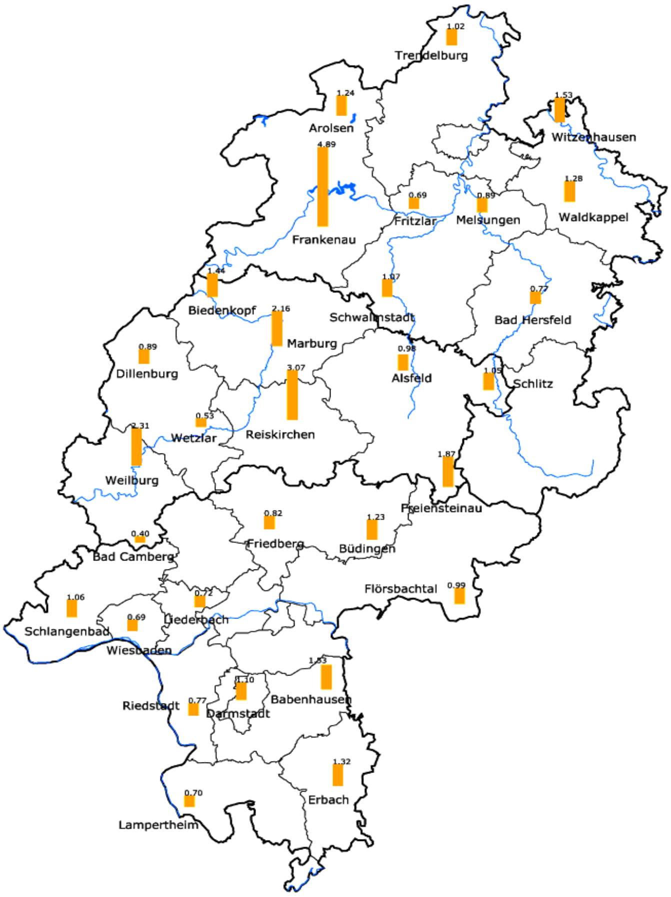

Figure 7. Dose rate (nGy/h) due to the deposition of ^{137}Cs into the soil, mean values of measurements between 1995 -1999 in Hessen, "Umweltatlas Hessen"

All above given information systems are suitable also for the long term, however, were not explicitly composed to consider long term post accidental management. Decision support systems (DSS), like RODOS[41] and CAIRE[42] for measures in case of radioactive contamination, are installed and extended to the in-between and late phase until the reestablishment of normal living conditions.

3.2.3 Monitoring systems

The increasing commercial use of nuclear energy necessitated monitoring of the environment of nuclear power facilities. In the directive for monitoring the emission and immission of nuclear power plants (REI) the basics for individual environmental monitoring programmes of NPPs are regulated. The directive defines type and category of measurement, required detection limits, method and frequency of sampling and measurement, way, form and frequency of reporting and quality control. Moreover it is assessed which areas of environment have to be monitored and who has to carry out the measurements.

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[41] *R*eal-time *o*n-line *D*ecision *S*upport *S*ystem (EU, BMU)

[42] *C*omputer *A*ided *R*esponse to *E*mergencies (BMU)

With the KFÜ-system (Remote monitoring system for NPPs) an additional on-line system was installed at the end of the seventies which measured besides security relevant and operational parameters of NPPs emission and meteorological parameters and monitored the environment of NPPs. All measured data are transferred to controlling institutions like the home offices of federal states. KFÜ does not affect the personal responsibility of the operators of NPPs.

After the accident of Chernobyl the surveillance of general environmental radioactivity was extended on the basis of the Radiation Protection Ordinance (StrVG) from the year 1986 with help of information techniques to IMIS (integrated measurement and information system for monitoring the environmental radioactivity). IMIS (Weiss, 1993) was started up in 1993. This system permits rapid on-line information for offices responsible for radiation protection like BMU and home offices of the federal states. Figure 8 shows an example of radioactivity surveillance in air by measuring the radionuclides ^{212}Pb and ^{214}Pb. Reports of actual activity concentrations in air and ambient dose rates with corresponding maps are published in the internet (www.bfs.de/ion/imis).

An overview of the different monitoring programmes and the legal basis is given in Table 6. As already mentioned the monitoring duties are split between Federation and federal states. Some states have additional surveillance systems for the environment.

Table 6. Monitoring of environment

Object of surveillance	**Environment in general**		**Environment of nuclear power plants**		
Legal basis	StrVG, EURATOM-treaty (Art.35)		AtG, StrSchV		
Responsibility	Federation	States			
Surveillance programme	IMIS §2 StrVG §3 StrVG	Systems of States	REI	KFÜ	Measuring service of the Civil Protection -measurement troupes -radiation detection troupes -monitoring stations

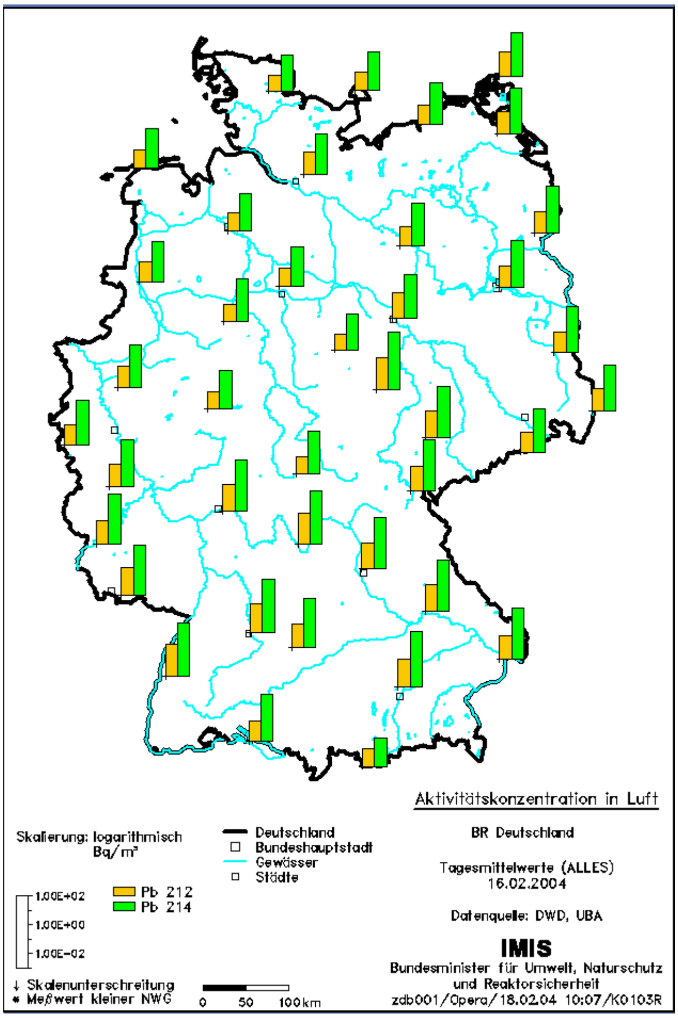

Figure 8. Surveillance of radioactivity in air by IMIS

To fulfil the duties of surveillance simulation techniques are implemented besides the measurement techniques. These techniques are used to predict and evaluate contamination of environment, dispersion of radiation and radiation exposure of the population.

3.2.3.1 REI[43]

As mentioned above with the commercial use of nuclear energy the monitoring of the environment of NPPs and nuclear facilities became necessary. The legal framework for the duty of monitoring NPPs is REI (guideline for surveillance of emission and immission of nuclear facilities), based on the Atomic Law and the Radiation Protection Ordinance.

Measurements and sampling are carried out on the one hand by the operators of NPPs and on the other hand by measuring facilities of the states (independent control and measuring points) and also by independent experts of e.g. BfS (Table 7).

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43 *R*ichtlinie zur *E*missions- und *I*mmissionsüberwachung kerntechnischer Anlagen

Table 7. Measurements in conventional mode

Environmental area	Control point
Air	Operator, independent control point
Precipitation	Operator, independent control point
Soil, grassroots	Operator, independent control point
Plants, natural cover	Operator
Feeding stuff	Independent control point
Food chain land	Independent control point
Milk and milk products	Independent control point
Aboveground water	Operator, independent control point
Food chain water	Independent control point
Ground- and drinking water	Operator, independent control point

REI regulates furthermore the method of measurement (e.g. iodine-131-activity concentration with gamma spectrometry), necessary detection limits (how “exact” the measurement has to be), method and frequency of sampling, type, form and frequency of reporting and the quality control by participation in interlaboratory tests and comparing analyses.

3.2.3.2 KFÜ[44]

A further surveillance of nuclear power plants was the automatically working remote monitoring system KFÜ, installed 1977 after an incident in the NPP Gundremmingen. This system enables the atomic authorities to control NPPs permanently.

The environment of nuclear power plants is divided into 12 sectors and 3 zones (Figure 9): The central zone with a radius of 2 km, the middle zone with a radius of 10 km and the outer zone with a radius of 25 km. In Bavaria 12 gamma-measuring probes are installed, for every sector one probe, moreover four additional mobile measuring probes equipped with Geiger-Müller counters are available.

[44] *K*ernreaktor-*F*ern*ü*berwachungssystem

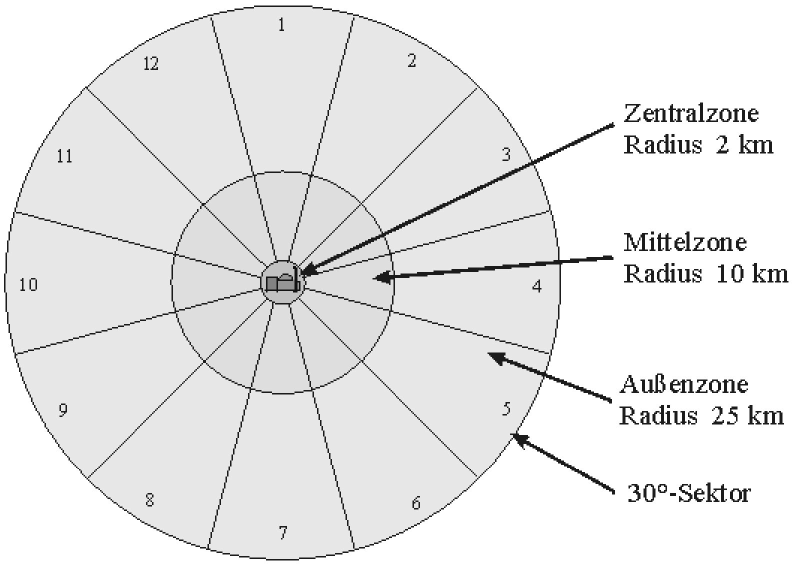

Figure 9. Partition of the surrounding of a NPP in sectors and zones

The measurements cover emission of radioactive noble gases, aerosols and gaseous iodine and immission in the environment by the gamma ambient dose rate (ODL)[45] and radioactive aerosols and gaseous iodine. Table 8 shows the common used detectors within the KFÜ-systems.

Table 8. Types of detector

activity	detector
Iodine	NaI-detector
Aerosol	Plastic scintillation counter
Gamma dose rate	Proportional Geiger-Müller counter
Noble gases	Plastic scintillation counter/Ge-detector

KFÜ-systems are connected with evaluation and modelling programmes to predict dispersion and deposition of radioactivity and calculate radiation exposure of the population. With support of BMU two programmes were developed.

- CAIRE (**C**omputer **Ai**ded **R**esponse **E**mergencies) (Brenk, 1992) evaluates automatically a diagnosis of the radiation exposure by the emission and immission data coming in by KFÜ and to the actual diagnosis a short time prognosis can be attached, both in real-time.
- RODOS/RESY (**R**eal-time **o**n-line **D**ecision Supp**o**rt **S**ystem/**R**echnergestütztes **E**ntscheidungshilfe**sy**stem für den Katastrophenschutz nach kerntechnischen Unfällen) (Ehrhardt, 1997) informs reliably and fast about radiological consequences, precaution and countermeasures. It was at first developed for the civil protection after nuclear accidents. In future RODOS will be established not only for the early and in-between phase but also for the late phase until the reestablishment of normal living conditions.

[45] *O*rts*d*osis*l*eistung

3.2.3.3 IMIS[46]

As a result of Chernobyl the Precautionary Radiation Protection Act (StrVG) was passed. The law regulates the installation of IMIS, a measurement system involving authorities of Federation and states likewise to control radioactivity in the environment area wide. The so called Leitstellen (control points) for radioactivity measurements are installed in different offices and institutes of Federation and states (Table 9). IMIS comprehends

- over 2000 stationary control sites all over Germany for the acquisition of data,
- over 40 radiation measurement laboratories in the states,
- federal control points,
- computer aided communication system for on-line transmission and evaluation of the collected data.

That means on an average of every 15 km in Germany a measuring point of IMIS is installed. Additionally every federal state has at least one and the BfS 10 more mobile measuring vehicles.

Table 9. Federal control points of IMIS

Control Point	Product	Location
Federal Fisheries Research Institute	Fish, fish products, oceanic water plants	Hamburg
Federal Maritime and Hydrographical Office	Seawater, oceanic suspended matter and sediment	Hamburg
Federal Institute of Hydrology	Surface water, suspended matter and sediment in inland waterways	Koblenz
Federal Environmental Agency	Network of the FEA	Langen
German Meteorological Service	Air, precipitation	Offenbach
Federal Food Research Institute	Total food, baby food	Karlsruhe
Federal Office for Radiation Protection	Exhaust air of nuclear plants	München
Physical-Technical Federal Institute	Data of radionuclides	Braunschweig
Federal Office for Radiation Protection	Drinking water, ground water, waste water, sewage sludge, waste material and waste water of NPPs	Berlin
Federal Office for Radiation Protection	Surveillance of radioactivity at mining	Berlin
Federal Institute of Milk Research	Milk, milk products, fertilisers, animal feed, plant and soil	Kiel

[46] *I*ntegriertes *M*ess- und *I*nformationssystem zur Überwachung der Umweltradioaktivität

IMIS is organised in 3 levels: Data collection, compilation and evaluation of data and decision and information level (Figure 10).

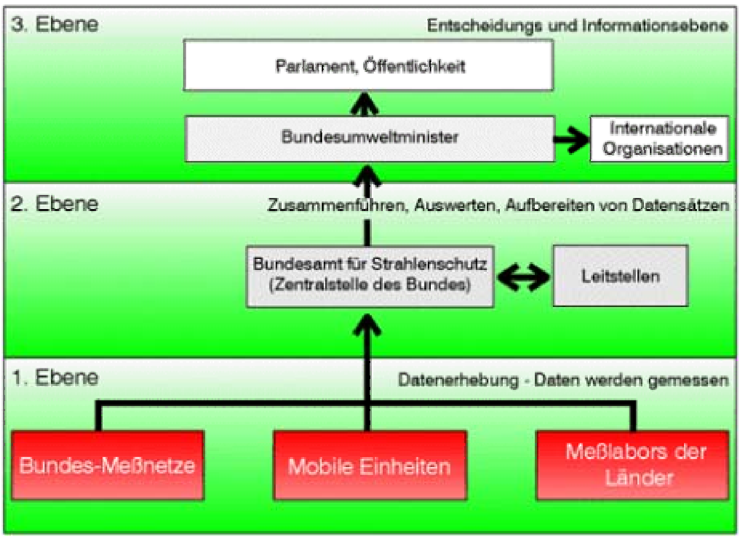

Figure 10. Organisation of IMIS

Two measuring programmes were developed for IMIS, a routine and an intensive measurement programme. The BMU is able to switch to the intensive programme in case of a nuclear incident.

As can be seen in Figure 10 the monitoring duties for the environmental surveillance are subdivided between states and Federation.

The federal authorities control

- air,
- precipitation,
- soil,
- water,
- sediment.

The authorities of the federal states control

- food,
- animal feed,
- fertiliser,
- pharmaceuticals,
- products of daily life.

The measuring systems of the states are connected with IMIS-data network.

The incoming data are evaluated with the real-time model PARK[47] (Gregor, 1991) to predict contamination and radiation exposure. The programme consists of 3 parts.

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[47] *P*rogrammsystem zur *A*bschätzung und Begrenzung *R*adiologischer *K*onsequenzen

- AUTOPARK evaluates in the intensive mode automatically all 2 hours on the basis of the measured data or DWD-prognosis contamination and radiation exposure for a given time period and for all urban and rural districts of Germany.
- DIAPARK works in a dialog mode for different questions.
- DOSISPARK calculates the dose taking into account the variation of time for specific activities in food and accordingly air activities, consume rates, breath rates and habits like staying outside.

3.2.3.4 Environmental surveillance systems of the federal states

In addition to IMIS several states have installed their own systems for environmental monitoring (Table 10). The data evaluated by these on-line systems are automatically transferred to the respective state offices.

Table 10. Monitoring systems of the federal states

State	System	Measuring devices/stations
Baden-Württemberg	Radioaktivitätsmessnetz des Landes (RAM)	ODL: 35 ODL-Funksonden: 10 Aerosol: 6
Bayern	Immissionsmessnetz für Radioaktivität (IfR)	ODL: 30 Aerosol: 14 Gaseous iodine: 14
Hamburg	Hamburg-internes Programm	ODL: 1 Aerosol: 1 Gaseous iodine: 1
Hessen	Erweitertes Messprogramm des Landes Hessen	ODL: 42 Aerosol: 2 Gaseous iodine: 2
Thüringen	Radioaktivitätsmessnetz Thüringen	ODL: 6

Table 11 shows current detector types that are used in the Bavarian monitoring system IfR and the costs of the measurement modules.

Table 11. Types of detectors of IfR

Activity	Detector	Approximate Cost (€) in 2003
Iodine	NaI	23000 (Iodinemonitor)
Aerosol	Plastic szintillation	43000 (Aerosolmonitor)
Gamma dose rate (noble gases)	Proportional Geiger-Müller	7500

3.2.3.5 Further radiation monitoring

In addition to the official registered centres many private and governmental institutions such as universities provide measurement possibilities with mobile and fix devices to monitor food and environmental samples as well as whole body counting. To provide a detailed overview of those as e.g. given for France is not possible.

3.2.4 Medical Care

In case of radiation exposure a physician authorised in radiation protection (im Strahlenschutz ermächtigter Arzt) should be consulted. In Bavaria the doctors have to attend special courses to obtain the authorisation by the Bavarian Health Office:

- Basic course, 3 days,
- course for “Authorised Physicians”, 10 days.

Since 2002 the authorised physicians have to attend all 5 years a course “to sustain the standard of knowledge”. In Bavaria about 400 doctors have obtained the authorisation in radiation protection.

In case of industrial injuries of people working in nuclear facilities or with radioactive substances special equipped hospitals and research centres with trained experts – the so called regional Centres of Radiation Protection (RSZ)[48] – were installed in Germany for higher contaminated casualties at the beginning of the eighties. The RSZs should be able to perform following measures to elucidate the radiation exposure:

- Ambient dose rate,
- evaluation of incorporated radioactivity and body dose,
- evaluation of neutron irradiation.

Special trained doctors, medicine physicists and technical and medical staff have to care about contaminated casualties in an adequate way and should be able to take measures like

- decontamination of persons,
- medical examination including in-patient treatment and special laboratory tests concerning radiation protection,
- medical treatment to accelerate the excretion of incorporated radionuclides.

Advanced training courses are offered once a year for the staff of RSZs by the Institute for Radiation Protection (IfS)[49] BGFE[50] BG Chemie[51]. The Berufsgenossenschaft (BG) (Employer’s Liability Insurance Association) works with self administration and is mainly paid by employers. Every employer over a certain number of staff has to be a member of this institution.

To the technical equipment of RSZs belong in general part and whole body counters, measurement equipments for single organs like thyroid, decontamination devices, and measuring instruments for alpha, beta and gamma radiation. However, the equipment can vary.

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[48] *R*egionales *S*trahlenschutzzentrum

[49] Institut für Strahlenschutz

[50] Berufsgenossenschaft der Feinmechanik und Elektrotechnik

[51] Berufsgenossenschaft der chemischen Industrie

11 regional centres of radiation protection and two special sections of BG were installed all over Germany (Table 12), with one or two doctors per centre. It has to be mentioned that the RSZ are specially qualified for smaller accidents not for catastrophes. Every RSZ can care for one to three contaminated casualties.

Table 12. List of RSZ

RSZ	Address
Allg. Krankenhaus St. Georg Abt.: Nuklearmedizin	Lohmühlenstr. 5 20099 Hamburg
Medizinische Hochschule Hannover Klinik für Nuklearmedizin	Carl-Neuberg-Str. 1 30625 Hannover
Heinrich-Heine-Universität Düsseldorf Nuklearmedizinische Klinik	Leo-Brandt-Str. 52428 Jülich
Universitätskliniken des Saarlandes Abt. für Nuklearmedizin d. Radiologischen Klinik	66421 Homburg/Saar
Forschungszentrum Karlsruhe Medizinische Abteilung	Hermann-von-Helmholtz-Platz 1 76344 Karlsruhe
GSF Forschungszentrum Institut für Strahlenschutz	Ingolstädter Landstr. 1 85764 Oberschleißheim
Städtisches Krankenhaus Schwabing Institut für Medizinische Physik	Kölner Platz 1 80804 München
Uniklinikum Greifswald Klinik für Nuklearmedizin	Fleischmannstr. 42/44 17487 Greifswald
Uniklinikum Benjamin Franklin Abt. für Nuklearmedizin	Hindenburgdamm 30 12200 Berlin
Uniklinikum „Carl Gustav Carus“ der TU Dresden Klinik für Nuklearmedizin	Fetscherstr. 74 01307 Dresden
Universität Würzburg Klinik für Nuklearmedizin Luitpold-Krankenhaus Bau 9	Josef-Schneider-Str. 2 97080 Würzburg
Berufsgenossenschaftliche Unfallklinik (BG) Ludwigshafen only by the medium of a RSZ	Ludwig-Guttmann-Str. 13 67071 Ludwigshafen-Oggersheim
Institut für Strahlenschutz (BG)	Gustav-Heinemann-Ufer 130 50968 Köln

Furthermore a number of hospitals and medicine universities besides the RSZs are equipped to deal with radioactive sources and are running nuclear medicine sections.

3.3 United Kingdom

3.3.1 During emergency phase

3.3.1.1 At the local level

Local Authorities (LAs) (County, District and Metropolitan)

LAs have a responsibility under REPPIR to provide information to the public in the event of any radiation accident.

Responsibilities exist within several departments:

- Emergency Planning Units,
- Environmental Health Departments – Environmental Health Officers would be principally responsible for monitoring food in the retail chain,
- Trading Standards Departments – Trading Standards Officers would be responsible for screening potentially contaminated non-food goods.

Monitoring responsibilities also include private drinking water supplies.

Several LAs have formed groups for mutual support, or belong to such a group administered by an external organisation. The following are examples:

- LARNet - comprised of about 150 LAs who coordinate their monitoring programmes through the LARNet co-ordination scheme administered by the National Nuclear Corporation (NNC), a commercial organisation. This information may also feed back into the CDF. LAs from Scotland and Wales and Northern Ireland are part of this group.
- SERMG – Southern England Radiation Monitoring Group is a consortium of 43 Las in partnership with the University of Southampton.
- SERMP – Somerset Environmental Radiation Monitoring Programme is a joint scheme involving the County Council and the five District Councils throughout Somerset.
- RADMIL – Radioactivity Monitoring in Lancashire comprises most of the Las in Lancashire supported by Lancaster University – Environmental Science Division and RADMAN Associates, a commercial consultancy.
- Other groups, some part of LARNet, issue independent reports for local information.

In Northern Ireland a Government Department Group coordinates alert, advice and information to LAs.

Water undertakers (Water companies and River Purification Authorities)

Water undertakers supplying mains water receive notification from DEFRA, the National Assembly for Wales, and the Scottish Executive or SEPA respectively. In Northern Ireland a Government Department Group coordinates alert, advice and information to the water industry.

Water supply companies and authorities have a statutory duty to provide a wholesome water supply, and as such are therefore responsible for identifying potentially contaminated water supplies.

Health Authorities (HAs)

Local HAs can activate local facilities and coordinate off-site monitoring of people when notified by the appropriate Government Department(s). They also have access to CEEFAX and PRESTEL information and advice bulletins. If they are approved data suppliers, they are also able to receive data from the CDF.

HA plans must cover:

- The reception and treatment of irradiated or contaminated casualties,
- the activation of local facilities for the monitoring of people who may have been contaminated with radioactivity,
- the provision of advice and information in response to enquiries from the public and other health professionals.

The HA is responsible for coordinating and ensuring the provision of monitoring facilities for members of the public who may have been exposed.

Nuclear Industry

The operators of licensed nuclear sites are required to monitor under normal conditions, and so have a wide range of instruments and laboratory facilities. They are responsible for emergency monitoring within 15-40 km around the particular site. They may provide supplementary data to the CDF (DEFRA) in an emergency.

Under arrangements with DEFRA, British Energy, British Nuclear Fuels, Atomic Energy Authority Technology, Amersham and the Atomic Weapons Establishment (MoD) will assist with the collection of supplementary monitoring data, especially whole body monitoring of people.

The industry provides a technical panel to provide information on possible source terms and other technical aspects to the TCC.

Other

All of these may have involvement at advisory or monitoring stages:

- Rural Payments Agency,
- Regional Government Offices (SE, NW etc),
- Regional Resilience teams,
- research organisations (e.g. Universities etc),
- private industry (e.g. those contracted by EA/SEPA for monitoring in compliance with regulatory obligations),
- regional offices of the Health Protection Agency (possibly).
-

3.3.1.2 At the national level

The key elements of the National Response Plan that would be activated after an overseas accident are shown diagrammatically in Figure 11.

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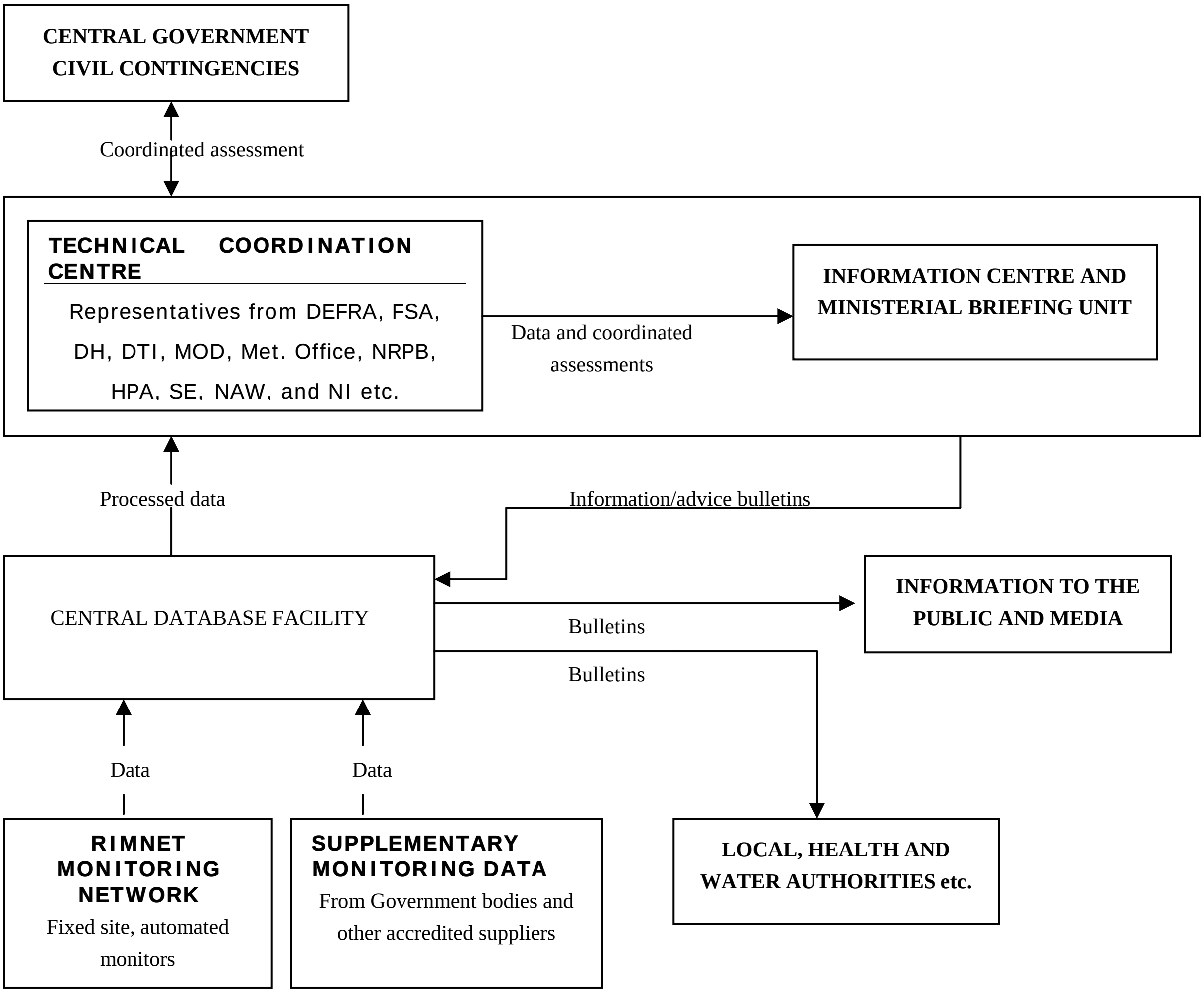

Figure 11. National Response Plan – key elements (after DEFRA, 2000)

The Secretary of State for the Environment, Food and Rural Affairs is the lead minister in the event of a nuclear/radiation incident. Advice and briefing gets to the Minister via the Ministerial Briefing Unit.

The Technical Coordination Centre (TCC) would be established to coordinate actions in the event of an overseas incident. The TCC would be comprised of relevant government departments, including:

- Department of Environment, Food and Rural Affairs (DEFRA),
- Environment Agency (EA)/Scottish Environment Protection Agency (SEPA),
- Food Standards Agency (FSA),
- Department of Health (DH),
- Department of Trade and Industry (DTI),
- Ministry of Defence (MoD),
- Representatives from Wales and NI.

NRPB, HPA, NII (of the HSE) and the Meteorological Office will also be represented. The Government Information and Communication Service (GICS) are likely to be heavily involved. Other Government Departments may be represented, depending on the nature of the accident, for example the Foreign and Commonwealth Office (FCO).

The TCC ensures that all decisions and actions are fully coordinated across Departments. The Scottish, Welsh and NI representatives operate their own incident rooms and coordinate with the national response through their TCC representatives. The TCC will advise Ministers, in conjunction with the Ministerial Briefing Unit on the significance of the incident and help prepare a government response.

The Government provides alert messages, information and advice bulletins through the TCC who will prepare regular information for the public, media and relevant bodies. These will be disseminated via the Information Centre set up by the DEFRA Information Directorate. Regional bulletins will be available on the teletext services CEEFAX and PRESTEL and will include information on:

- Local radiation levels,
- milk and other food,
- water,
- meteorological forecasts,
- commentary on specific local issues,
- advice to the public and farmers.

In the event of a domestic/UK incident there is a local response (strategic – tactical – operational). This is supported, if required, nationally, with a Lead Government Department (LGD) coordinating the national response. The LGD will provide briefings to Parliament and the national media as well as provide a focus for all other Government Departments involved.

DEFRA

DEFRA is responsible for the Radioactive Incident Monitoring Network (RIMNET). This consists of 92 sites throughout the UK where the ambient radiation dose rate is constantly monitored. Results are automatically downloaded to the Central Database Facility (CDF) every hour where they are analysed. Summaries of radiological data are provided to relevant authorities. Data is also supplied by organisations able to make radiological measurements in accordance with RIMNET standards etc. An alert is raised automatically if abnormal increases are noted; if the increase is confirmed, then rainwater collectors are deployed at the relevant sites. The rainwater samples collected, however, must be dispatched to a specialist measurement laboratory for analysis. It is planned to upgrade the system by the end of 2003.

Supplementary data, which actually tend to be the most important information since it gives radionuclide specific information on a range of materials, may be received from a range of organisations. This includes operators of nuclear sites, UKAS accredited bodies, members of the LARNet (Local Authorities Radiation Network) and bodies registered as Approved Dosimetry Services by the Health and Safety Executive. Some hospital departments may also meet the necessary standards.

Data compiled on the CDF is available to the TCC to assist in their decisions. Although primarily designed to collate data in an overseas accident, RIMNET and the CDF would also be utilised in a domestic accident.

Environment Agency (EA)/Scottish Environment Protection Agency (SEPA)

EA and SEPA (in Scotland) are responsible for coordinating environmental monitoring programmes in support of regulatory responsibilities; these programmes are contracted out to commercial laboratories.

The agencies receive notification from DEFRA, the National Assembly for Wales, and the Scottish Executive respectively.

EA and SEPA would provide advice on the quality of mains drinking water through the DWI and SEERAD respectively to the water suppliers.

Food Standards Agency (FSA)

FSA is responsible for food sampling and food monitoring, including bottled water, although external bodies would be used for sampling and measurement.

The FSA issues precautionary food safety advice to the public after an incident, often within 24 h. This advice is necessarily based on very little measurement data, coupled with predictive modelling. A cautious approach is adopted, making use of the CFILs (Council Food Intervention Levels) established by the EU (CEC, 1989a, 1989b, 1990). The FSA can impose statutory restriction orders relating to food and the environment under the Food and Environment Protection Act 1985 (FEPA). This would be imposed in the days following an incident and, although still based on a cautious approach, would make use of measurement data such as deposited activity. Both precautionary advice and FEPA orders can remain in place for many years; indeed sheep in a small area of Cumbria and in North Wales are still subject to a FEPA order on movement that was placed in 1986.

NRPB

NRPB is equipped to undertake environmental monitoring and provide support to Local Health Authorities for monitoring of people. It provides advice to Government Departments on the interpretation of radiological data and as such is represented at the TCC. In addition, it has access to CDF information, and can provide data to the CDF.

In the short term, NRPB has a formal role on the coordination of monitoring away from the immediate vicinity of the accident site by establishing a Monitoring Coordination Team at Chilton. Thus, NRPB would work closely with FSA, who would be trying to delineate the precautionary advice area (and subsequently refine that area for the possible imposition of a FEPA order). In addition, NRPB would work at a strategic level with other stakeholders (e.g. MoD, nuclear operators, HAs and LAs). It is unclear whether this role would extend to the long term, although Government Departments have a statutory duty to consult NRPB on matters of radiological protection.

NRPB is responsible for coordinating the National Arrangements for Incidents Involving Radioactivity (NAIR) scheme. This scheme provides advice and assistance to the police in incidents involving radioactivity where members of the public may need protection and where no other radiation expert is available.

Meteorological Office

The Meteorological Office provides advice to Government Departments on the interpretation of meteorological and radiological data and as such is represented at the TCC. The Office uses the predictive model NAME for meteorological predictions following an accidental release of radionuclides. NAME can also be used for remobilisation of activity from a wide area, although a one year forecast would typically take a couple of months to run (and cost about 15000 Euro). Other, less sophisticated models, such as HOTSPOT and ADMS that can be operated by NRPB can give results in minutes, although not to the same level of complexity or accuracy.

Ministry of Defence (MoD)

MoD could make various monitoring and mapping facilities, equipment and manpower available in an emergency, provided that it was not an accident for which they had a leading responsibility. In addition, MoD may be able to assist with rapid transport of samples or equipment via helicopters, unless directly involved in the incident.

3.3.2 Long term

There is no pre-determined long term monitoring strategy following an incident in the UK. The organisations/bodies shown are those with emergency response and/or routine monitoring capabilities; it is assumed that they could be asked to help in the long term management of a radiation incident. Organisational infrastructure depends on the type of incident, e.g. civil nuclear, military, overseas, satellite or transport etc. It is not within NRPB's remit to organise this response, so the structure may change without our involvement. The previous list, therefore, is not definitive, but should indicate those with key responsibilities.

3.3.3 Measurement systems

It is estimated that there are several hundred organisations in the UK equipped to carry out some form of radiation monitoring. The activities of individual organisations may be determined by statutory obligations and/or by monitoring objectives coupled with available human, technical and financial resources (McColl, 1997).

Table 13 and Table 14 list indications of the types of instrumentation currently available in and/or to the organisations. Table 13 comprises personal monitoring capabilities; Table 14 comprises environmental monitoring capabilities. Those organisations listed in Table 13 also have considerable environmental monitoring instrumentation and expertise; although these may be made available in the short term after an emergency, it is unlikely that this availability can be maintained, due in the main to operational needs. Since only a few hospitals replied to a request for information, the list may not be comprehensive. Other instrumentation potentially available is given in Section 3.3.3.1.

3.3.3.1 Other equipment

Some specialist equipment was designed immediately following the Chernobyl reactor accident of 1986 to fill specific gaps identified at the time.

Sodium iodide detectors were developed for FSA field officers to monitor radiocaesium levels in sheep before they were allowed to be sold on. Only a few of these monitors are currently in use; the remainder has been serviced and is stored at NRPB.

Simple monitors suitable for detecting ^{131}I and radiocaesium in foodstuffs were developed and are available commercially (Mini Food Monitor).

Under contract to FSA, NRPB developed and built five instruments to measure ^{131}I in milk. The intention was that dairies or creameries would be able to exploit an existing sampling programme to monitor milk rapidly following an accident without having to set up new arrangements and transport samples to specialist laboratories. These are also currently held at NRPB. It is anticipated that they could also be set up for any other gamma-ray emitting radionuclide, although the precise radionuclide would have to be known for accurate calibration.

Table 13. Availability of personal monitoring capabilities

Owner of equipment/location	Type of equipment / capabilities	Availability (potential)
AWE, Aldermaston	Whole body monitoring Lung monitoring Thyroid monitoring	Available for emergency use
Amersham / Amersham Laboratories Dosimetry Service	Thyroid monitoring	Not available for emergency use
BNFL/Sellafield Approved Dosimetry Service	Lung monitoring Whole body monitoring Criticality probe HpGe detector 2 Harwell type wound probes Iodine in thyroid detector	Available for emergency use
BNFL Springfield Works, approved Dosimetry Services	Lung monitoring Whole body monitoring	Available for emergency use
DERA Radiation Protection Services (DRPS).	Whole body monitoring Lung monitoring	Available for emergency use
NRPB, Chilton.	Whole/partial body monitoring (bed counting geometry) Whole body and partial body monitoring, e.g. lung etc (chair counting geometry) Mobile monitoring for whole body Mobile monitoring for thyroid Hand held monitoring equipment	Available for emergency use
Harwell Dosimetry Service (In Vivo Measurement), AEA Technology	Whole body monitoring Lung monitoring Mobile wound monitoring	Available for emergency use

In addition, other equipment available off-the-shelf could be used for area monitoring, and even identification of radionuclides, although the composition of radionuclides would be known in the context of self-help in the long term; a good example is the Exploranium GR 135, which costs around 8000 Euro.

All of the foregoing equipment uses sodium iodide detectors. These are relatively robust but are not very nuclide-specific. In general, therefore, the radionuclide of interest needs to be known for a suitable calibration. However, it does show that, certainly in the long term after an accident, suitable instrumentation for local monitoring can be developed. It is likely that such equipment could be developed and manufactured in large quantities, although it could take up to about a year for stocks to be sufficient. The estimated cost could be a few thousand pounds per instrument, comparable with the cost of existing instruments. It should be borne in mind that the particular instruments may have to be designed and built from scratch. There is however a large cadre of people in the local environment who are experienced in operating monitoring equipment.

Table 14. Availability of environmental monitoring capabilities

Owner of equipment/location	**Type of equipment / capabilities**	**Availability (potential)**
NHS – Hospitals, Medical/Health Physics Departments	Most larger hospitals have monitoring capabilities, and equipment as part of their NAIR kit. Hospitals should have: Contamination monitors, e.g. Mini instruments EP15, Nuclear Enterprises BP4, Berthold LB1210B: Iodine in thyroid monitors, e.g. Mini 44A or 44B with ratemeter; Some may have WBM. Many do not have, or have had to relinquish, WBM facilities due to funding. It is also most likely that the existing WBM are not suitably calibrated for measuring the radionuclides expected after a nuclear incident. Many will have hand-held and fixed thyroid monitors. There are around 60 hospitals UK wide that are prepared to accept contaminated casualties and to advise on, and assist with, the decontamination of personnel based on 1995 data. (However, at the end of 2002 the National Audit Office stated that 37% of UK hospitals were ill prepared for a radiological incident.)	Most hospitals with monitoring capabilities would be expected to continue with monitoring over long term periods.
Local Authorities (County, District and Metropolitan) Emergency Planning Units Environmental Health Departments Trading Standards Departments	Monitoring capabilities exist. Most LAs capable of external dose rates (using Mini 6-80) at specified points. Some co-ordinate under LARNet (formerly LARRMACC), SERMG, SERMP, RADMIL etc. Environmental samples are often measured by the contractor running the programme. Emergency Planning Units may have handheld gamma dose rate monitoring, but not all have this capability. Most trading standards departments have hand held monitors for screening.	Availability unknown
Private industry (e.g. those contracted by EA for monitoring etc)	See EA	See EA
Other Nuclear Industry (in addition to those specifically named)	Dose and contamination monitoring capabilities.	Operate under a mutual support philosophy.

Other; Rural Payments Agency Regional Government Offices (SE, NW etc)	All of these may have monitoring capabilities.	Long term availability unknown
Ministry of Defence	Have access to wide range of monitoring equipment, including mobile.	Long term availability unknown
FSA	FSA commissions contractors and other agencies to carry out sampling and measurements.	Long term availability unknown depends on the contractor.
Northern Ireland Executive	Range of environmental and personal monitoring equipment.	Long term availability unknown
Environment Agency	The EA commissions contractors to carry out monitoring; their equipment could be mobilised in an emergency.	Long term availability unknown
Water Companies and authorities	Monitoring requirements are for gross measurements only; these tend to be centralised to a few laboratories; specific measurements would require specialist laboratories.	Long term availability unknown
Research organisations (e.g. SUERC)	Many university departments and research organisations have monitoring equipment. Extent is unknown, but is likely to be dose-rate and contamination monitors. Southampton University is well equipped for laboratory measurements (Geosciences Advisory Unit). In addition, SUERC possess an airborne survey system that could possibly be used to identify areas most contaminated.	Long term availability unknown

4 Training of professionals

4.1 France

In France there is very few number of radiation protection training especially for medical professionals. In the offered courses only the emergency phase is trained not the long term post accidental situation.

Table 15. Radiation protection training

Trained persons	**Main topics**	**Trained by**	**Training duration**	**Number of trained persons per year**	**Are post accidental issues included in the training**
Students in medicine (teacher training)	Biological effects of radiations Instrumentation (X-ray, scanners, IRM, imaging techniques…)	Universities	A few hours (specific training completed later on according to the kind of specialization)*	n.a.	NO
*Family practitioners (they are not specialized)	Nothing else but the initial teacher training				
Students in medicine & engineers (specialization)	Fundamentals Sources and risks Biological effects Regulations Occupational RP Public RP Patient exposures External and internal irradiations, contamination Nuclear safety Accidental situations	University of Grenoble (DESS Radiopathology-Radiation protection)	1 year (~450 hours)	20 incl. a few number of physicians	YES/NO (option 18h)
Occupational Doctors	Sources and risks Radiobiology, Radiopathology Regulations Techniques (Nuclear Medicine, Radiopathology, Radiodiagnosis Occupational RP in nuclear installations	University (UFR Cochin)	127 hours (courses) + 36 hours (practical exercises)	10?	NO

Nuclear Physicians	Occupational, patient and public RP	INSTN (National Institute of Nuclear Sciences & Techniques)	6 days	15	NO
	Regulation on the qualified expert training		2 days		
Radio-pharmacists	Occupational, patient and public RP		6 days	12	NO
	Regulation on the qualified expert training		2 days		
Emergency Staff (SAMU)	Basic principles Biological effects Emergency care	DGSNR (RP & Safety French Authority)	1 day (since 2003)	15?	YES (emergency phase only)
Medical Physicists	Patient RP & dosimetry	INSTN (National Institute of Nuclear Sciences & Techniques)	6 weeks (training courses)+ 32 weeks (practical training)	20	NO
	Occupational and public RP Regulation on the qualified expert training		1 week		
Firemen (Intervention units)	Fundamentals Biological effects Regulations Nuclear installations Transport Means of protection Measurement techniques Crisis organization	Themselves (Training Centre) without external validation	4 levels of training: 1 week to 2 weeks (depending on the individual responsibilities in case of an accident)	?	YES (emergency phase only)

4.2 Germany

Training and education courses in radioactivity protection are mainly performed for persons working and handling with radioactivity like operational doctors, physicians in nuclear medicine sections, scientific and technical staff in nuclear facilities and research centres. Seminars about radioactivity for teachers, students and the public are organised by several institutions. Special training courses are offered for emergency services like firemen and radiation detection troupes. Extensive practical and technical exercises are regularly - at least once a year - performed in nuclear power plants with participation of the corresponding authorities.

The main institutions authorized for education and training of radiation protection in Germany are the GSF-Research Centre for Environment and Health near Munich, the Research Centre Karlsruhe and the Hahn-Meitner-Institute in Berlin.

GSF-Research centre (www.gsf.de/kurse) offers basic courses of radiation protection for medical and non medical professions. For physicians special training is implemented by courses dealing with:

- Radiation protection for examination with X-rays,
- radiation protection for handling with radioactive material,
- special course for authorised physicians,
- radiation protection in nuclear medicine and therapeutic radiology.

For occupational groups according to § 15 of StrSchV (working not in the medical sector) special courses are obligatory to be authorised for work. Group leaders of fire brigades have to attend training in radiation protection. Continuing training courses are arranged for authorised physicians, technical staff and firemen.

Education in radiation protection comprises in principle the following subjects:

- Legal situation, important regulations and laws,
- physical basics, radioactivity, nuclear radiation,
- radiobiology, risks, biokinetics of radionuclides,
- measurements and dosimetry, terms and units,
- practical training.

The whole programmes of radiation protection courses of the Research Centre Karlsruhe and the Hahn-Meitner-Institute in Berlin can be queried in the internet at following addresses:

http://Fortbildung.fzk.de/ and www.hmi.de/strahlenschutz .

Courses of radiation protection focussed on long term contamination are not offered. Radioactivity concentrations in food and ambient dose rates as a consequence of long term contamination can be easily queried in the internet on websites of environmental authorities (in Bavaria: www.bayern.de/lfu/strahlenschutzvorsorge/). However, information about the handling of contaminated food in a, e.g. to peel fruit, to boil vegetable and to pour away the water, to make butter of contaminated milk etc…, is not widely spread, but is important in case of a long term contamination. IAEA published reports 1992 (IAEA-TECDOC-647, May 1992) and 1994 (Technical Reports Series No. 364) about radioactivity reduction in food during food processing and food processing parameters. An article was published by SSK (Willrodt, 1993) with different measures for reducing or avoiding contamination in food and feed. The described countermeasures, however, are more suitable for agriculture and food and feed processing industry not for the population in the daily life. In case of a long contamination information and education courses about measures to reduce radioactivity in contaminated foodstuffs have to be provided for the population to help them in their daily life.

4.3 United Kingdom

Formal training for radiological emergencies is mainly directed towards those with a professional interest. Emergency exercises at nuclear facilities take place regularly, with major players involved at the relevant Off-site Centre. However, these exercises typically last one or two days. There is an increasing tendency to extend these exercises to three days in order to consider the start of the recovery phase.

The following courses are designed mainly for the short-term, although again the availability of expert help for training for the long term is demonstrated.

4.3.1 NRPB

NRPB currently runs training courses for non-specialists. A series of Radiation Emergencies Awareness Courses are run for LA professionals (such as emergency planning officers and environmental health officers), press officers, the water supply industry and emergency service professionals. Since the courses are advertised on the Board's website, it is possible that members of the public could attend. NRPB also provides training to the emergency services on behalf of RADSAFE, a consortium of nuclear operators providing mutual support in a radiation transport accident. In addition, NRPB also runs courses for the RADSAFE responders. As coordinators of the NAIR scheme, NRPB organises training courses for NAIR responders. LAs that have a nuclear facility within their boundary would send senior staff to the Local Emergency Centre in the event of a radiological incident (or exercise); courses have also been run under contract to the nuclear industry for those staff.

In addition, specific courses have been run in the past at the request of various bodies, for example EA/SEPA, FSA, NII, EHOs, Trading Standards Officers, and recently CCDCs (Consultants in Communicable Disease Control) from the HPA.

Further details of courses run by NRPB are available on their website at www.nrpb.org/training/index.htm.

4.3.2 Emergency Planning College

Courses are organised at the government-run Emergency Planning College at Easingwold for emergency planning officers from LAs, and for other emergency service professionals. One three-day course of particular interest for public health physicians, accident and emergency doctors, primary care doctors, EHOs and emergency planners is entitled "Managing the health consequences of exceptional biological hazards".

Further details of courses run by the College are available on their website at www.epcollege.gov.uk.

5 Discussion

The regulatory framework in France regulates the protection of the public against ionising radiation in normal and emergency situations. After a nuclear accident the responsibilities of the concerned utility and the French authorities are defined. The legislation includes also the protection of workers and patients. Contamination limits for food, cattle feed and products for the export are the values as defined by the European Community are used by France.

The utility operating NPPs in France is under control of “Electricité de France”. The crisis phase after an accident is managed at the local level by two bodies, namely the concerned utility and the prefect of the affected department and at the national level by different ministries and authorities.

Nuclear accident simulations are periodically organised by French Authorities and important lessons from those can be learnt concerning medium and long term management. It is obvious that different lacks and problems still are to be solved e.g. in medical aspects, individual dose control and in financial aspects. The trust into authorities must be ensured by profound information of the population. A summary of the recommendations concluded from the simulation exercises is given in a report written by a Working Expert Group[52].

The equipment in France concerning body contamination control is well documented. A detailed list shows the distribution of equipment as WBCs (mobile and fixed), thyroid and thorax counters often mobile in intervention trailers (Master Gemini vehicles). The vehicles are also able to measure the contamination in the environment (ambient dose rate), since they are equipped with the according technical means. Several institutions like IRSN, EDF, CEA, as well as the French army and French Firemen Units are equipped similarly. The equipment is concentrated around nuclear facilities, however, due to the mobility of the equipment it should be possible to monitor not only body contamination but also the radioactivity in the environment, food and feed, and the gamma ambient dose rates even in regions where no NPPs are situated. Additionally, about 180 Geiger-Müller stations widely scattered over France control the gamma ambient dose rates on a routine operation scheme. A change in radioactivity concentration in water and air would be detected at once during regular analyses of water and atmospheric samples. The surveillance network is supplemented by a further computerised and centralised network which will cover a dozen of towns. The equipment is suited in principle to measure long term contamination, although some counties in France are not well equipped with radioactivity counters, radiometers and dose rates measurements, and it would be probably difficult to envisage the decentralization of the existing equipments.

Although education for occupational workers are well organised, only few radiation protection training courses are offered in France for medical professionals. These training programmes, however, are limited to the emergency phase and no courses are offered how to handle long term post accidental situations. In case of a long term contamination it would also become necessary to include training of teachers, nursery teachers, doctors and people dealing with communication such as in information centres which would have to be created in such case.

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52 Rapport d´étape du Groupe de Travail n°4 « Suivi sanitaire et médical des populations en phase post-accidententelle d´un accident radiologique », préparé à l´intention de Monsieur le Secrétaire Général du Comité Interministériel à la Sécurité Nucléaire, Janvier 1999 (rapporteurs Dr. P. Verger, Pr. M. Bourgignon)

Environmental monitoring and handling of radioactive material is exactly defined and regulated in the German legislation. The regulatory framework comprehends the operation and controlling of nuclear facilities, transport of nuclear material and the work with radioactive matter and nuclear waste disposal.

In case of a nuclear accident the duties are split between the Federation and the Federal States. The states are responsible for the civil protection (short time), which will result in slight differences in disaster management. Radiation protection is the duty of the Federation. The course of a nuclear accident is divided into three phases: Pre-release, release and post-release phase. During the first two phases rapid decisions like possible evacuation, distribution and taking of iodine tablets might be necessary. The post-release phase may last for weeks, months or even years depending on the accident. In this phase the main exposure ways and the extent of the contamination are known. The Chernobyl accident has revealed that the main radionuclides contributing to a long term contamination were first of all ^{137}Cs and to a minor degree ^{90}Sr, however, this depends on the accidental conditions and scenarios, e.g. during the fallout of the over ground atomic bomb tests in the fifties and early sixties the fraction of ^{90}Sr and ^{240}Pu to the dose was significantly higher.

After the accident of Chernobyl research programmes were carried out for simulation and modelling techniques to better evaluating the radiological consequences after a release of radioactivity into the German environment. Simulation programmes like ECOSYS (Müller, 1993) facilitate the calculation of the distribution of radioactivity into the environment. Data evaluated by ECOSYS in food, plants and processed food were compared with measured data and showed a good agreement. Based on the exposure pathways of the main radionuclides the radiation exposure to man can thus reliably be predicted. Using appropriate countermeasures it is possible to reduce the radiation exposure of man effectively. Countermeasures for long term contaminated urban, industrial (Andersson, 2003; Eged 2003) and rural environment have been worked out in the STRATEGY-project[53]. The project describes measures with regard to their feasibility, acceptance and costs and also accounts for social and ethical aspects. For urban and industrial environments Monte Carlo simulation programmes have been installed on PCs (e.g. Briesmeister, 2000; Eged, 2004)) for the calculation of dose distributions and dose redistributions after implementation of countermeasures.

Based on the knowledge of the distribution of contamination, of the most important exposure pathways and the most effective countermeasures it should be possible to reduce the radioactivity in the environment and the radiation exposure of man considerably. By regular monitoring of environment and food as it is already fulfilled in Germany by the different existing measurement programmes the long term consequences of a nuclear accident should be generally under control. Also the health care system for contaminated persons is in principle regulated. The RSZs and corresponding departments of hospitals are equipped for personal monitoring, such as whole/partial body counters, thyroid monitoring or urine analysis.

Precondition for the functioning of existing systems established by authorities is the trust of the population in public authorities and experts. Without adequate understandable information and education of the population this trust will not be achieved.

In case of a long term contamination the experience made in Belarus and Ukraine showed that it should be possible for the population to control their individual situation by own measures. For this case monitors are necessary which are not expensive, easy to handle and which

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53 *S*us*t*ainable *R*estor*a*tion and Long-*T*erm Mana*g*ement of Contaminated Rural, Urban and Industrial Ecos*y*stems

produce reliable results. The experience of Chernobyl in this respect was not optimal in Germany: Individuals started to measure without being able to evaluate the results in a correct way. Therefore it is concluded that the population has to be trained and educated in a reasonable manner. The possibility of information and communication has to be improved, e.g. via internet, in communication and information centres and by personal contact with experts.

In the following some experience of the Chernobyl accident obtained in the UK is critically evaluated and generic conclusions are deduced. The exact nature of the accident will always influence the reactions to it. However, long term strategies can be planned in a more timely fashion compared with those necessary for an immediate response to an emergency.

In the long term the radionuclides of interest and their relative composition would be known. If the main radionuclides of interest emit gamma rays, then any simple monitoring instrumentation could be suitably calibrated based on the exact composition details. If the main radionuclides were not gamma ray emitters, it may be possible to use any minor gamma ray emitters present in the contamination as markers, and use the known ratios between them and the important radionuclides. In either case, a relatively simple monitor based on a sodium iodide detector could be used. If the current models available on the market are not suitable, or cannot be suitably calibrated, then experience indicates that such instrumentation could be designed. Production of sufficient numbers to satisfy a potentially high demand may however take a year or so, a timescale that might still be adequate in the context of long term self-help. The cost of such instruments is presently about 3000 Euro.

As an example of the way in which a situation might develop, the affected area could first be mapped out, possibly using an aerial survey. The results could be coupled with information on the occupancy of the area to enable ground-based surveys to focus on the areas of principal interest. These surveys might be carried out by the LAs or their monitoring coordinators. In addition, the map of deposition could be linked with radioecological considerations, such as soil type, land use etc., to elicit vulnerable areas (Howard, 1999).

Groups of LAs would probably work together and share facilities, as happened after the Chernobyl accident and is still continuing today in the UK. It is unlikely that measurements of dose rate or contamination would be made on a daily basis, so sharing would be a viable option. In Belarus, for instance, once areas of potentially high contamination had been identified, continuous monitoring was not necessary, and occasional measurements sufficed. Checks on foodstuffs before consumption or sale, however, would probably need to be carried out more frequently as confirmation that intakes were being maintained at a level acceptable to the community. This is particularly important in the case of wild foods such as mushrooms and berries that proved to be highly contaminated after Chernobyl depending on location and species, although the collection of such foods is perhaps not as prevalent in the UK as it is in Belarus. However, provided the equipment was not too expensive, or where found to be politically expedient for local representatives, the self-help culture could well be also applied in areas where the activity concentrations in foodstuffs were below the relevant CFIL, so that residents could reduce their intakes even more.

It is unlikely that contract analytical laboratories would wish to be involved with rapid turn round measurements for environmental materials on behalf of individuals, especially after the main emergency phase is over. While it is unlikely that simple instrumentation would be provided at a parish level, it is conceivable that a district council might provide a limited but regular mobile service, setting up, for example, at a local school or health centre.

Personal monitoring, such as whole body measurement or urine analysis, could be carried out at a few central locations where the relevant equipment was available. At present in the UK, it is not considered suitable for whole body measurement capabilities to be situated locally, mainly because of cost and data interpretation, which is a highly specialist topic. However, it is understood that such facilities, and training in their use, have been made available in Belarus; it is not inconceivable, therefore, that a similar arrangement could be made in European countries. In the long term, it would also be inappropriate for mass urine or faecal monitoring, and in any case this could not be carried out on a local basis, again because of cost and the need for specialist interpretation.

Training in the use of equipment and the general interpretation of the results could be cascaded from existing training providers to local professionals, such as EHOs or regional officers of the HPA, and thence to local council officials and members of the public. Information would need to be shared at the local level as well as at the national level; the latter is useful in determining the overall effect of the accident, and where if necessary to provide extra resources. Regular monitoring of the local situations (results and advice) would also be needed at national level to ensure that the training delivered was adequate and effective, and also perhaps that actions being taken were consistent.

6 Conclusion

In France where the nuclear power is used to produce the main part of electricity supply, the long term post accidental management has not been solved satisfactorily until now. The infrastructure has been created for the management of the emergency phase only. Regular control of the environment, food and feed, the possibility of measuring the body contamination also by mobile equipments facilitates the management of a long term contamination, since the radiological situation can be summed up.

However, in France the management of a long term contamination causes problems concerning the availability of the technical measurement equipment which is centralised, the devices are very disparate and the technical staff ready to use these tools is insufficient and not sufficiently trained. Nevertheless the centralisation of administration in France facilitates the implementation of countermeasures.

Also the situation of the affected population especially in case of a long term contamination is critical, since no courses are offered for the population, so that they can carry out and interpret their own measurements in their individual surrounding as home and garden. The education of the children must be supported by well trained teachers. In case of a long term contamination it is necessary to inform the population about all consequences and risks by creating local information and communication centres with the corresponding well trained staff.

In Germany the long term phasing out of nuclear energy has been decided by the red green government. But still NPPs are working in Germany and a lot of NPPs are operating abroad. A nuclear incident can never completely be excluded. The infrastructure to manage the consequences of a nuclear accident was essentially improved after the Chernobyl accident and can be used also for long term contamination. The environment in general and the environment of NPPs are controlled regularly. The contamination in food and feed except mushrooms and berries from the wood has decreased since Chernobyl to the level before the accident. Nevertheless domestic and imported fresh vegetable and fruit, milk and milk products and mushroom are controlled by special sampling programmes. In case of an incident all sampling and monitoring programmes have to be intensified.

The trust of the population which had radically decreased after the Chernobyl accident by insufficient and late information can be supported by the possibility of extensive information, advisory service and training and even of providing means for own individual measurements.

Especially in case of long term contamination training and educating courses are necessary for physicians, teachers, nursery teachers and consultants at the local level. If these occupational groups are well trained the information demand for the concerned population should be guaranteed. How and to which extent these training courses and information centres are installed will depend on the contamination itself and on the costs of these measures.

The infrastructure for coping with the long term effects following a radiological incident exists in the UK, although it has not necessarily been specifically designed for this purpose. This is mainly due to the actions and reactions initially following the Chernobyl accident in 1986, and lately the September 11th event. Work is continuing to address some of the issues raised, and this report should therefore only be taken as a snapshot at the current time.

The resources available for long term monitoring are limited. However, suitable technology exists that could provide simple support at a local level, and over a timescale of several months a large number of instruments could be made available if the need arose. In addition, the ability to respond to novel instrumental needs has been demonstrated, and it is anticipated that the required technology could be designed reasonably quickly in a future accident – especially for long term strategies.

Training is currently available, and could be expanded if the need arises. The technique of "Training the trainer" could be used, whereby training could be given to local professional representatives, such as EHOs and hospital physicists for example, and then cascaded down further as necessary. The exact role of the regional offices set up by the new HPA is not clear at this stage, and it is possible that they may be involved, not only in training and operational measurements, but also in advice on the results of those and other measurements. This function is currently carried out on their behalf by NRPB.

7 Summary

For the European SAGE-Project a review of the existing infrastructures and preparedness systems in France, Germany and United Kingdom concerning radiation protection with regard to a long term contamination after a nuclear accident was made.

Protection of the population against ionising radiation, the protection of workers and patients, the operation of nuclear facilities and transport and handling of radioactive material is clearly regulated in the legislation of all three countries in a very similar way. The European Directives 96/29 and 97/43 are implemented in the regulatory framework of France, Germany and the United Kingdom. Exemption limits, intervention reference levels and intervention levels are defined. The countermeasures in case of a nuclear incident are worked out and will be implemented according to the principle of proportionality.

In all three countries broad and extensive measurement systems mostly online exist for monitoring nuclear facilities, the environment, food and feed, thus the slightest change in radioactivity will be registered. In case of release of radioactivity simulation and modelling programmes will help to predict the distribution of radioactivity in the environment and the exposure to man. By this way suitable and acceptable measures can be carried out.

The medical care is guaranteed for smaller nuclear incidents. In case of a disaster like Chernobyl difficulties are predictable. The RSZs in Germany are not equipped for greater accidents. In Germany there exists no list of the medical equipment of the hospitals for the health care of casualties as it does in France. The medical staffs need a persistent training and education to pertain expertise in nuclear knowledge. The medical and technical preparedness systems have to be equipped with functioning devices.

All the above mentioned controlling systems are applicable for the situation of a long term contamination. It exists also a long list with recommendations for decontamination procedures concerning food, feed, rural and urban areas (STRATEGY, Willrodt, 1993). However, for the “normal” population living in a contaminated area for a prolonged time even under low radiation exposure these systems and measures will not help and are not suited for their daily life.

After the Chernobyl accident the confidence of the population in the authorities had dramatically decreased because of bad and late information. At that time it was not possible to be informed about the actual situation in a reasonable way and to get recommendations how to behave. Especially families, schools and kinder gardens had no guidance how to protect the children.

This review clearly shows that the infrastructure in all three countries regulates the situation during and shortly after a nuclear incident but not in case that a radioactive contamination will last for long time. For that situation it is necessary to install local information centres in the affected area with sufficient trained staff. To improve the confidence of the population in possible measures implemented by the authorities a copious and understandable information and education must be provided. Especially doctors, teachers, kindergarten teachers and mothers have to get the possibility to be educated in a reasonable way how to deal with a short, middle and long term contamination. The concerned population must be able to control the own radiological situation by measuring their environment and their food and by reducing food contamination by appropriate reasonable measures.

If all these aspects are regulated it will be possible to return to an almost normal life even in case of a long term contamination. However, it is difficult to sustain awareness in the population and by authorities and especially funding, when there is no actual or acute event.

8 Abbreviations

CEPN	Centre d´Etude sur l´Evaluation de la Protection dans le Domaine Nucléare
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
NRPB	National Radiological Protection Board

8.1 France

CAIS	Centre et Accueil et d´Information sur la Santé
CEA	*Atomic Energy Commission*
CMIR	Cellule Mobile D´Intervention Radiologique
DDSC	*Civilian Defence and Security Directorate*
DGSNR	Direction Générale de la Sûreté Nucléaire et la Radioprotection
EDF	Electricité de France
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
OPRI	*Office of Protection against Ionising Radiation*
PPI	Plan Particulier d´Intervention
PUI	Plan d´Urgence Interne
SAMU	Service d´Aide Médical d`Urgence
SGCISN	*General Secretariat of the Interdepartmental Committee of Nuclear Safety*
WBC	*Whole Body Counter*

8.2 Germany

BfF	Bundesforschungsanstalt für Fischerei
BfG	Bundesanstalt für Gewässerkunde
BfS	Bundesamt für Strahlenschutz
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
BSH	Bundesamt für Seeschifffahrt und Hydrographie
CAIRE	*Computer Aided Response Emergencies*
DWD	Deutscher Wetterdienst
IfR	Immissionsmessnetz für Radioaktivität
IMIS	Integriertes Mess- und Informationssystem zur Überwachung der
INES	*International Nuclear Event Scale*
KFÜ	Kernkraftwerks-Fernüberwachungssystem
LfU	Bayerisches Landesamt für Umweltschutz

NPP	*Nuclear Power Plant*
ODL	Ortsdosisleistung
PARK	Programmsystem zur Abschätzung und Begrenzung radiologischer Konsequenzen
RAM	Radioaktivitätsmessnetz des Landes
REI	Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen
RODOS	*Real-time on-line Decision Support System*
RSZ	Regionale Strahlenschutzzentrum
SSK	Strahlenschutzkommission
StrVG	Strahlenschutzvorsorgegesetz
THW	Technisches Hilfswerk
ZdB	Zentralstelle des Bundes für die Überwachung der Umweltradioaktivität

8.3 United Kingdom

AWE	Atomic Weapons Establishment
BNFL	British Nuclear Fuels plc
BSS96	Basic Safety Standards in Council Directive 96/29/EURATOM
CCDC	Consultant in Communicable Disease Control
CDF	Central Database Facility
CEEFAX	Teletext service run by the British Broadcasting Corporation
CFIL	Council Food Intervention Level
DEFRA	Department of Environment, Food and Rural Affairs
DH	Department of Health
DTI	Department of Trade and Industry
DWI	Drinking Water Inspectorate (part of EA)
EA	Environment Agency
EHO	Environmental Health Officer
FEPA order	Order made under the Food and Environmental Protection Act 1985
FSA	Food Standards Agency
GICS	Government Information and Communication Service
HA	Health Authority
HPA	Health Protection Agency
HpGe	High purity germanium detector
HSE	Health and Safety Executive

IRR99	The Ionising Radiations Regulations 1999
LA	Local Authority (County, District and Metropolitan)
LARNet	Local Authorities Radiation Network
LGD	Lead Government Department
MAFF	Ministry of Agriculture, Fisheries and Food (now divided between DEFRA and FSA)
MoD	Ministry of Defence
NAIR	National Arrangements for Incidents Involving Radioactivity
NHS	National Health Service
NI	Northern Ireland
NII	Nuclear Installations Inspectorate of the HSE
NNC	National Nuclear Corporation
NRPB	National Radiological Protection Board
PRESTEL	Teletext service run by the Independent Broadcasting Authority
RADMIL	Radioactivity Monitoring in Lancashire
RADSAFE	a consortium of nuclear operators (mutual support in a radiation transport accident)
REPPIR	The Radiation (Emergency Preparedness and Public Information) Regulations 2001
RIMNET	Radioactive Incident Monitoring Network
SEERAD	Scottish Executive Environment and Rural Affairs Department
SEPA	Scottish Environment Protection Agency
SERMG	Southern England Radiation Monitoring Group
SERMP	Somerset Environmental Radiation Monitoring Programme
TCC	Technical Coordination Centre
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
WBM	Whole Body Monitor

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10 List of Tables

11 List of Figures