EMERGENCY PLANNING BY THE PUBLIC AUTHORITIES IN FINLAND

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Abstract

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The Finnish concept of off-site nuclear emergency response has remained virtually constant since 1976, when the first public authorities' emergency plan was prepared. The first principle is that of remote siting, meaning restrictions on land use within about 5 km from the power plant. In off-site emergency planning two zones are applied: (1) for an area within a radius of about 20 km (zone I), a detailed off-site plan is required, including rapid alerting of the population and evacuations if necessary; (2) for the surrounding area, within a radius of about 100 km (zone II), the special requirements imposed by a potential nuclear accident have to be taken into account in the general emergency preparedness planning. The emphasis on contemplated protective measures for the public has shifted somewhat over the years. Earlier, evacuation was seen as the principal course of action and sheltering was considered mainly as a precaution while awaiting a decision on evacuation. However, a commissioned study on the significance of evacuation and local sheltering pointed out that the level of sheltering afforded by large stone buildings and cellars is sufficient to reduce significantly the doses received. Consequently, the evacuation capacity could be directed to those areas where the buildings provide the poorest protection, i.e. summer cottages and wooden houses with no basements. Subsequently the Finnish Centre for Radiation and Nuclear Safety undertook a survey of the types of houses and building materials in the environs of the nuclear power plants. Rough estimates of the average protection factors of small houses, small house cellars and the ground floor of typical apartment houses were made.

1. NUCLEAR ENERGY IN FINLAND

In Finland there are in operation four nuclear power plant units, which started the production of electricity between 1977 and 1980. The total nuclear net capacity installed is 2310 MW(e), as given in Table I.

Of the electricity produced in Finland in the first half of 1985, nuclear power accounted for 35% or 8.7 TW·h. The average load factor for the four units in 1984 was 89%, as shown in Table II.

The nuclear power plants in Finland are located on coastal sites. The site locations are shown in Fig. 1.

The population density in the immediate vicinity of the sites is low. For each of the sites, the number of permanent residents living within 5 km from the plant is below 100. The number of seasonal inhabitants visiting summer cottages in

TABLE I. NUCLEAR POWER PLANTS IN FINLAND IN 1985

Unit	Type of reactor	Net output (MW(e))	Electricity production startup
Loviisa 1	PWR	445	Feb. 1977
Loviisa 2	PWR	445	Nov. 1980
TVO I (Olkiluoto)	BWR	710	Sep. 1978
TVO II (Olkiluoto)	BWR	710	Feb. 1980

TABLE II. ELECTRICITY PRODUCTION BY FINNISH NUCLEAR POWER PLANTS AND AVERAGE LOAD FACTORS

Year	Electricity production (TW · h)	Contribution of nuclear energy (%)	Average load factor (%)
1981	13.8	35.4	73
1982	15.8	40.2	82
1983	16.7	41.4	87
1984	17.8	41.1	89

this region amounts to about 1000. The cumulative population distributions for the two nuclear power plant sites are given in Fig. 2.

The regulatory authority controlling radiation protection and the safety of nuclear power is the Finnish Centre for Radiation and Nuclear Safety (STUK). STUK is empowered to issue instructions on the application of regulations and standards. Guides have been issued concerning radiation protection and on-site emergency preparedness as well as on radiological and meteorological monitoring in nuclear power plant accidents.

2. THE INFRASTRUCTURE

2.1. The national emergency preparedness organization

In every emergency situation there must be one single authority in charge of directing operations. In Finland, this responsibility generally lies with the fire departments. In airplane accidents, however, the aviation authorities are in charge,

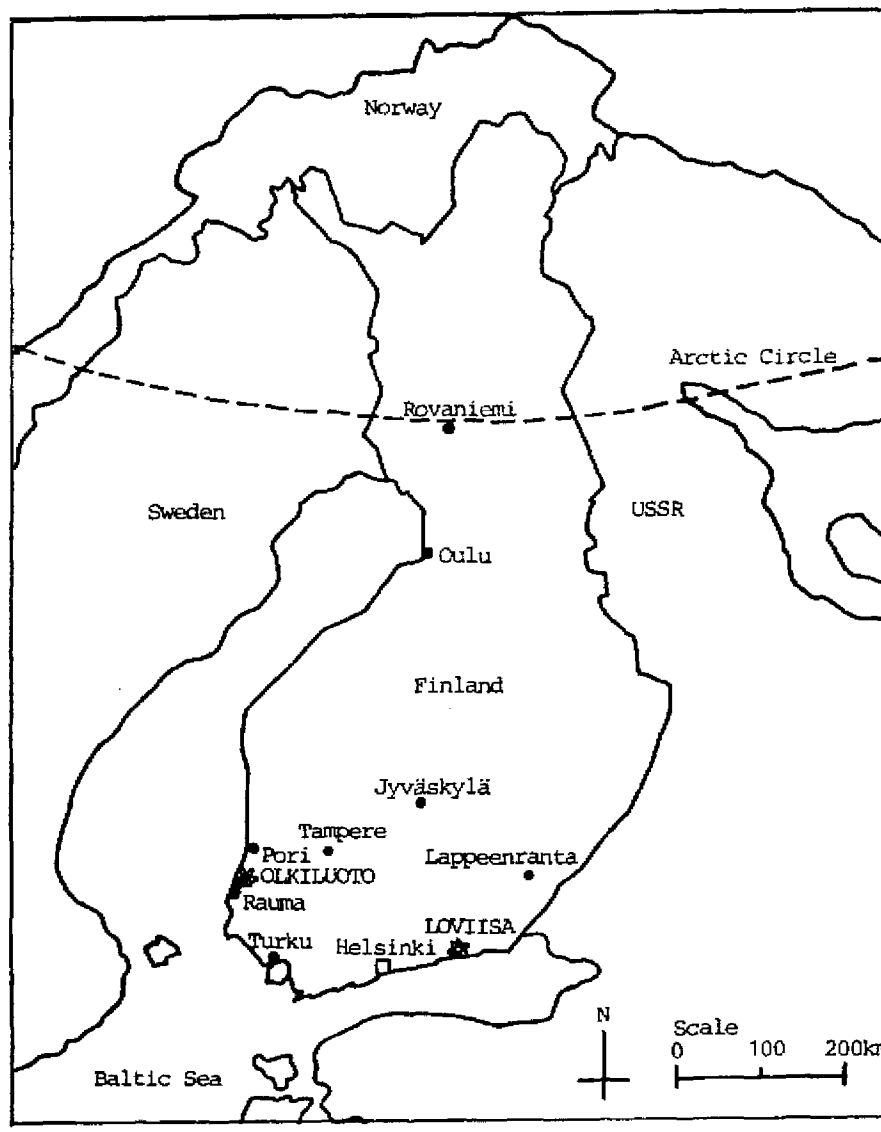

FIG. 1. The site locations of the Finnish nuclear power plants at Loviisa and Olkiluoto.

and maritime rescue operations are managed by the coast guard under the leadership of the frontier guard.

The country is divided into 12 regional administrative units (11 counties and one autonomous province). The local administrative unit is the municipality, of which there are about 460. For emergency planning and preparedness, the municipalities are grouped together into co-operation districts and alarm districts. As a rule, these districts coincide, so that there is one alarm centre serving one co-operation district. Altogether, there are about 60 co-operation districts.

The chief of the fire department in the largest or most important municipality is appointed district fire chief. If a large accident involving several municipalities within the district occurs, the district fire chief becomes the emergency director,

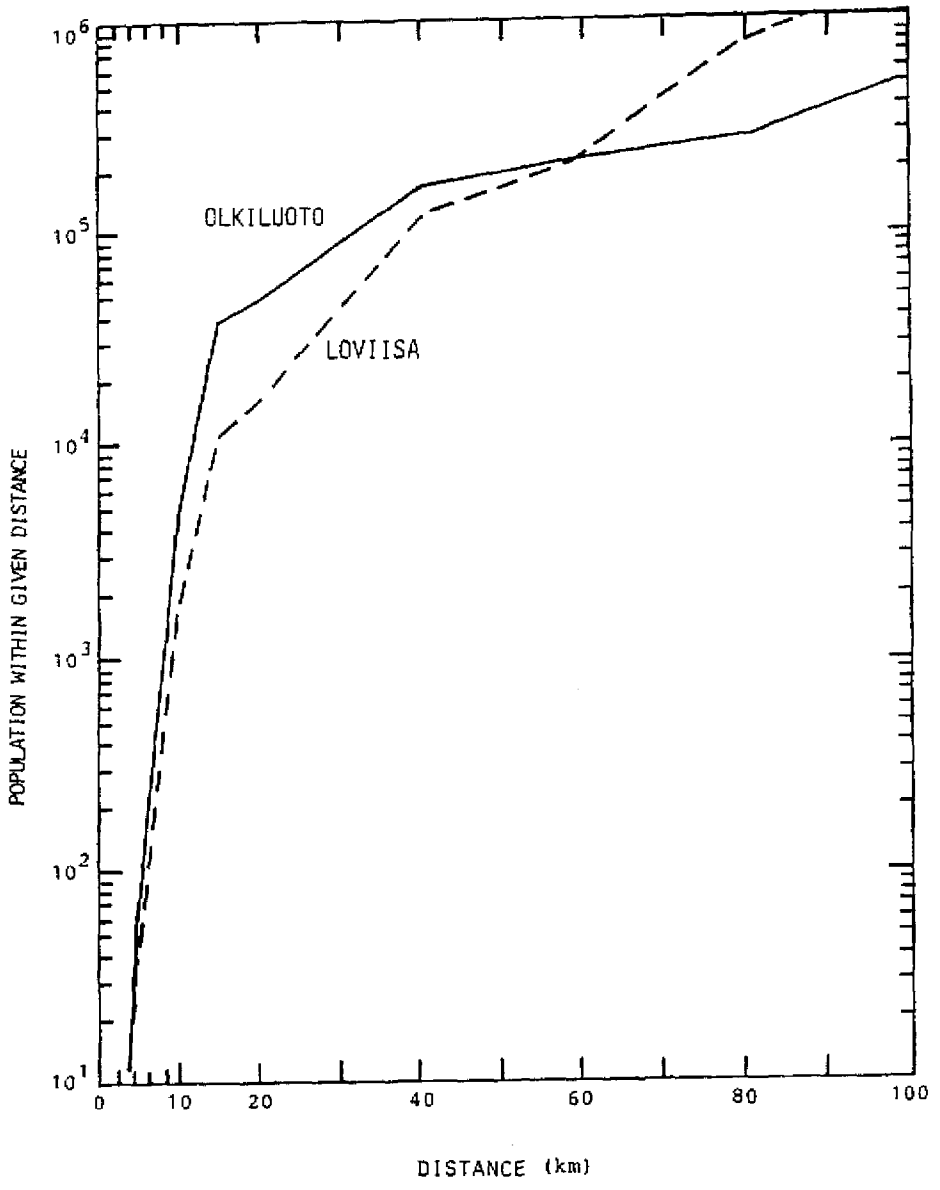

FIG. 2. Cumulative population distributions around the nuclear power plant sites in Finland.

and it is his responsibility to assume control of the rescue operations. This includes accidents that involve municipalities belonging to other co-operation districts and even other counties. In such cases, the county government may, however, assume control and designate a county or state official to act as overall emergency director.

Thus, in peacetime accidents the rescue operations are almost always led by the local authorities. If special national government action is needed to protect the public, the Civil Defence Act of 1958 can be enforced. This means, for example, that command centres can be set up in sheltered accommodation equipped with

emergency communications links. It also provides for despatching civil defence teams or groups for special tasks and for large-scale evacuation of people, if necessary.

2.2. The nuclear emergency planning organization

The Ministry of the Interior handles the general planning, management, supervision and co-ordination of emergency preparedness. For each co-operation district there has to be a general emergency response plan involving the municipalities belonging to the district. All national authorities and government institutions are obliged by the Act on Fire and Rescue Services to assist in the planning and to make pre-arrangements for providing assistance in their own field.

Nuclear power plants are regarded as establishments requiring a special emergency response plan to be drawn up by the public authorities, because the need for major co-ordinated operations in an accident situation is evident. The plan is to be prepared by the local authorities under the supervision of the county government as a separate document, to be appended to the general emergency response co-ordination plan of each of the co-operation districts involved.

The Loviisa power plant is situated in the Loviisa co-operation district and the off-site plan concerns three municipalities of that district and one from the neighbouring Kotka district, which belongs to another county.

The Olkiluoto off-site plan is prepared by the co-operation district centred on the town of Rauma. The plan involves three municipalities of the same district and one from the neighbouring district of Pori.

In addition to actual emergency planning, the public authorities are also required to plan for long-term actions following a nuclear accident. These include radiation level measurements and surveys, health control of the population and measures to control agricultural production..

2.3. The public attitude with regard to nuclear emergency planning

In Finland the general population has not been directly involved in making decisions about nuclear energy. Moreover, in studies concerning public information, it was found out that the information on nuclear energy given by the authorities, media and industry is regarded as reliable. This and other factors have resulted in a situation in which public discussions on nuclear energy have been relatively moderate.

However, public interest in nuclear energy and concern about matters relating to its safety, such as emergency planning, may increase in the near future following discussion about the building of the fifth nuclear power plant unit in Finland. Another current topic is nuclear waste management. A survey is currently being carried out in Finland with the aim of identifying several areas for preliminary site investigations relating to the disposal of spent fuel. Details of all the site investigation

areas proposed will be published simultaneously by the end of 1985, and this will certainly contribute to increasing public interest in nuclear energy.

The evidently very strong anxiety and demand for information in the event of a nuclear accident have been recognized. Consequently, the planning of emergency information is emphasized in guidance on emergency preparedness.

Factors affecting the public attitude towards nuclear energy in Finland were surveyed recently [1]. Emergency preparedness was not included specifically in the study, but it was discovered that the factor having the greatest importance in forming one's attitude towards nuclear energy is one's opinion on the danger of nuclear power plant accidents. It is, however, notable that public acceptance of nuclear energy is higher in the regions near the plant sites, where the public is more informed than in the country as a whole.

3. OFF-SITE EMERGENCY RESPONSE PLAN

3.1. Governing principles

The basic criteria and principles forming the Finnish concept of off-site nuclear emergency response have virtually remained the same since 1976, when the first public authorities' emergency response plan was drawn up for the vicinity of the Loviisa plant site. Although the results of the WASH-1400 study were known at that time, the planning requirements were not based on postulated release categories nor on probabilistic risk analyses. Instead, the principles to be followed were agreed upon as a consensus opinion of the ministry of the Interior and experts on nuclear safety and radiation protection, above all the regulatory authority, then called the Institute of Radiation Protection, nowadays the Finnish Centre for Radiation and Nuclear Safety (STUK).

The first principle is that of remote siting. Within about 5 km radius there shall be no dense housing areas or large establishments that would be difficult to evacuate nor should there be such industries as large-scale food-processing, nor, on the other hand, industries that could pose a danger to the power plant. This is ensured for the future by including an obligation on the local council to consult the nuclear safety authorities when establishing planning regulations for the area.

The most important position taken concerns the extent of the emergency planning zones. Two zones are applied:

(1) For an area within a radius of about 20 km (zone I) from the power plant, a detailed off-site plan is required, including rapid alerting of the population and evacuation of areas in the danger sector if necessary.
(2) For the surrounding area, within a radius of about 100 km from the plant (zone II), the special requirements imposed by a potential nuclear accident have to be taken into account in the general emergency preparedness planning.

On the one hand, these criteria take into account the possibility of a severe reactor accident, in which the consequences of the design basis accidents could be exceeded even far from the plant. On the other hand, the requirements have to be seen from the point of view of society's preparedness as a whole, and the investments adjusted to finite resources.

3.2. Rules and regulations

The nuclear regulatory authority, STUK, has published two guides concerning emergency plans. Guide YVL 7.4 deals with on-site emergency response plans, whereas Guide YVL 7.14 sets the action levels for protection of the public in a nuclear power plant accident. It was published in 1976 and contains guidance on radiation exposure levels that require action to protect the public. The specific actions considered are evacuation, rejection of foodstuffs and the distribution of iodine tablets.

Compulsory action levels according to Guide YVL 7.14 are:

- 0.1 Gy whole-body dose
- 0.5 Gy dose to the skin
- 0.2 Gy dose to a child's thyroid.

For milk contamination by iodine-131 the following action levels are set:

- 2600 Bq/L compulsory rejection limit
- 37 Bq/L non-action level.

For the distribution of iodine tablets no numerically defined action level is laid down.

These predetermined action levels would be needed in a fast-moving accident, when the expert advice may have to come from the on-site radiation protection officer. When the authorities' off-site advisory support group (cf. Section 3.6) is summoned and ready for action, it would take account of the actual situation as far as it can be assessed. This group has the means to make more accurate dose estimations, but it also has more knowledge of factors other than the projected dose, to be taken into account in making recommendations about specific protective actions.

3.3. Plan structure

The Ministry of the Interior has published a General Directive for preparing the special off-site nuclear emergency response plan. The directive has recently been extensively reviewed and a revised version will take effect in late 1985. This will, in turn, lead to rather extensive revisions of the plans prepared by the Loviisa and Rauma co-operation districts.

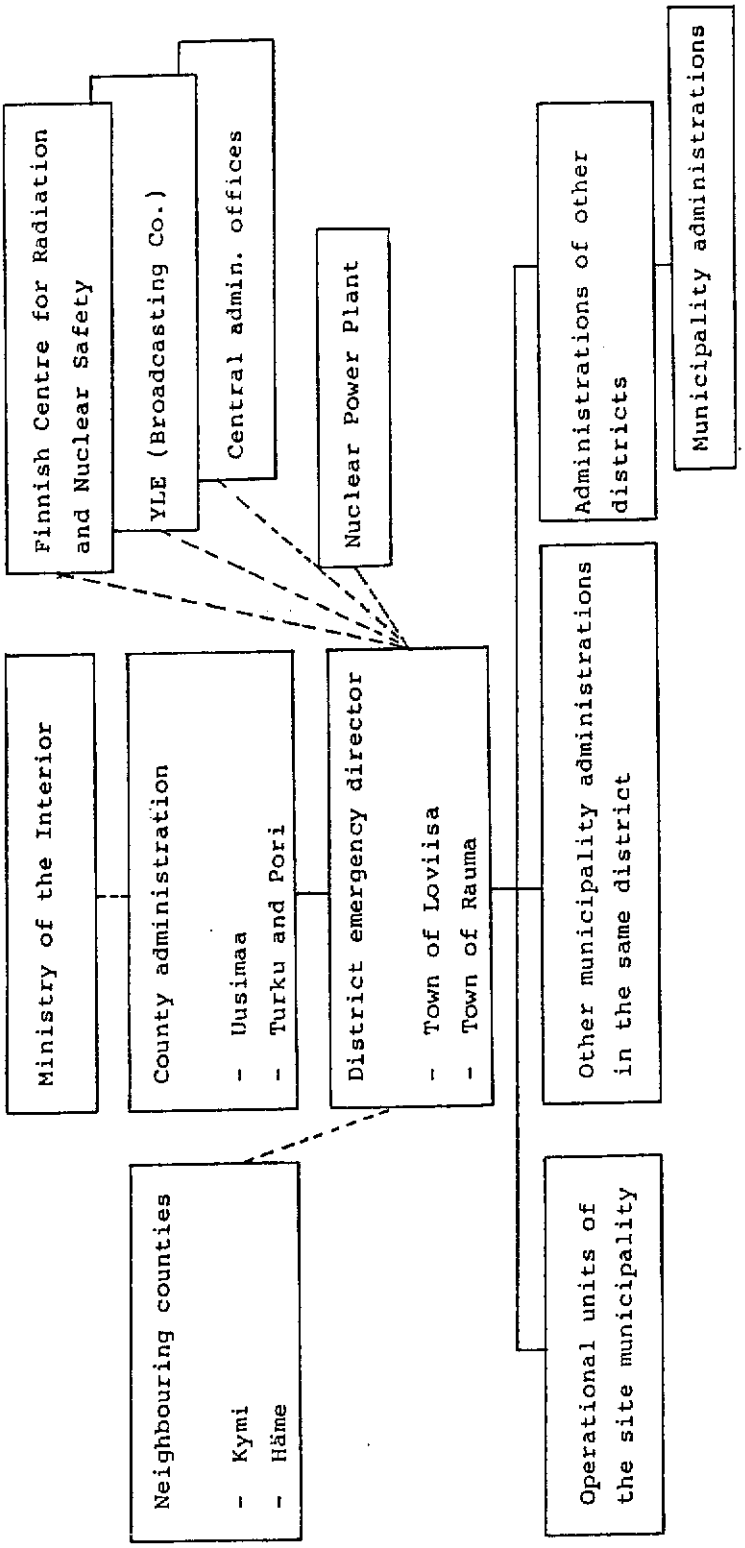

FIG. 3. A schematic outline of rescue services.

According to the General Directive, the off-site nuclear emergency response plan shall define the tasks and responsibilities of the public authorities, institutions and establishments involved in rescue operations and protection of the public. Specifically, it shall deal with

- starting the operations
- leadership
- communications
- co-ordinating the response of the authorities involved.

3.4. Responsibilities of the organizations involved

Each administrative branch is responsible for emergency preparedness arrangements in its own field. Figure 3 shows the co-ordination of the operations of the public authorities in a nuclear accident.

3.5. Interface between off-site and on-site plans

Co-ordination of the off-site and on-site emergency response plans is ascertained in the evaluation stage. The off-site plan is approved by the county administration after submitting it for consideration to the Ministry of the Interior and to the nuclear regulatory authority, STUK. The latter oversees the co-ordination. Correspondingly, before STUK approves the on-site plan of the licensee, it obtains the opinion of the county and local authorities, through the Ministry of the Interior.

There are several sectors where off-site and on-site plans are interdependent. The site emergency director of the licensee's organization must notify the authorities if a site emergency is declared. If a general emergency is declared, an alert must be given, using a standard form. The alert must include wind data, expected environmental effects (if appreciable) and a recommendation on the action required to protect the public. The off-site emergency response organization shall, in turn, inform the site emergency director of protective actions undertaken.

It is also the responsiblity of the licensee to make radiation measurements in the vicinity of the plant, in order to determine the actual dispersion conditions should a release occur. This shall include the capability to collect and analyse air samples. An efficient two-way exchange of measurement results is necessary, since the bulk of the external radiation measurements is carried out by patrols of the fire department.

3.6. Decision-making process and advisory support

The off-site emergency director, i.e. the district fire chief or the person whom the county administration may have assigned, makes all decisions about:

- alerting the general public and the instructions to be given subsequently
- controlling access to the emergency area

- instructions concerning sheltering
- evacuations
- disposition of rescue equipment and materials
- terminating the emergency operations.

The emergency director is assisted by a leadership group, the members of which plan the operations and implement the decisions that concern their respective administrative sector. The group is called to the district command centre in the event of an accident. It is headed by the district fire chief. Usually at least the following local officials are members of the group:

- the police chief
- the leading physician of the health centre
- the civil defence chief
- the director of social services.

In order to facilitate communications, the site emergency organization automatically despatches a liaison person to the district command centre. This person can advise the authorities on matters concerning nuclear technology and the state of the plant.

The emergency organization also has other associated experts and liaison persons who can be called to the command centre when needed. These may represent, for example, the maritime rescue service, the military forces and the municipal information service.

On the national level, the Finnish Centre for Radiation and Nuclear Safety (STUK) acts as the safety authority and as the emergency advisory support organization. An expert group of STUK will be formed upon receiving the authorities' alert. The group is to advise the emergency organization about protective measures that require the assessment of the environmental consequences of the accident and includes a meteorology expert from the Meteorological Institute. It will be alerted through the county alarm centres and will notify the district command centre when it is assembled and ready to take over the responsibility for recommending protective actions, relieving the on-site emergency director of that task. The expert group has at its disposal a real-time computer system to assist in the dose predictions and in the evaluation of the environmental consequences of a release.

The group may also send a liaison person to the district command centre, but this is not always feasible in practice.

Information about the progress of the accident directly from the power plant is also available for the expert group in STUK. The Department of Nuclear Safety sets up an office group to assess the progress of the accident and the safety status of the plant and also sends to the plant site a plant group, which follows the actions at the plant and reports to the office group.

For the assessment of the safety status of the plant, a computerized information aid is being developed in STUK. The first stage of the system provides computerized

data transfer from the plant to STUK starting immediately after the declaration of an emergency in a nuclear power plant. Every ten minutes about 80 readings of instruments monitoring plant status, radiation release and meteorology are available for the office group of the Department of Nuclear Safety in STUK. The second stage will include an information processing and display system.

3.7. Evacuation and sheltering

In Finland, the emphasis on the measures contemplated for the public has shifted somewhat over the years. Earlier, evacuation was seen as the principal course of action and sheltering was considered mainly as a precaution while awaiting a decision on evacuation. The reduction of the total projected dose by people staying indoors was not credited, for example, in dose predictions in exercises.

In 1979 the Ministry of the Interior commissioned a study on the significance of evacuation and local sheltering in a nuclear accident [2]. The study concluded that the average protection afforded by small houses and by apartment houses against the external radiation is sufficient greatly to reduce the number of persons receiving high doses. The usefulness of sheltering could be enhanced by giving the public better information about sheltering techniques. If everyone could be offered shelter in large stone buildings, cellars or civil defence shelters, the doses received could be reduced very significantly. Consequently, the evacuation capacity could be directed to those areas where the buildings provide the poorest protection, i.e. summer cottages and wooden houses without basements.

Essentially all buildings with a volume of 3000 m^3 or more constructed since the passing of the Civil Defence Act in 1958 have to have a civil defence shelter, designed to withstand the collapse of the building. These shelters are very effective against external radiation, giving an estimated protection factor of over 300, and they are equipped with intake air filtering. In the vicinity of the nuclear power plants the apartment housing areas with such civil defence shelters are 7–20 km from the sites. Limited use is possible in a nuclear accident, although peacetime use of these shelters as storage rooms, etc., is allowed, subject to a 24-hour notice of removal.

In 1981 the Finnish Centre for Radiation and Nuclear Safety undertook a survey of the types of houses and building materials in the environs of the nuclear power plants [3]. Within a radius of about 6 km from the plant, all permanent dwellings were surveyed. Furthermore, the dominant house types and building materials were determined in the population centres and towns within the rest of the emergency planning zone I.

Almost all houses close to the power plants are wooden one- or one- and-a-half storey buildings with ridge-type sheet iron or tile roofs. More than half of the houses in the area have a cellar with a concrete ceiling. The apartment houses in the towns of Rauma and Loviisa are typically narrow-frame three-storey

buildings with flat roof and heavy concrete ceilings. The walls are usually prefabricated concrete elements. The following average protection factors were estimated:

– small houses	2–3
– small house cellars	20–30
– apartment houses, ground floor	10–20

These rough figures may be used by the radiation experts in the dose estimates. At a later stage it may be possible to introduce detailed data in the computer system designed to assist the authorities' expert group.

All municipalities in Finland are required to make evacuation plans for states of emergency. The Ministry of the Interior has instructed certain cities and municipalities to plan also for the alerting and evacuation of the population, e.g. in areas having hazardous industries or transports.

The new General Directive for off-site nuclear emergency planning (cf. Section 3.3) defines the concept of evacuation as follows:

In emergency planning zone I the evacuation plans must take into account the special requirements imposed by a nuclear accident. If evacuations are deemed necessary in zone II they are to be carried out by adapting the existing municipality evacuation plans to the situation.

In a peacetime accident, the evacuation is handled jointly by the police and the fire department. The emergency director has the legal mandate to move members of the population, cattle and property as deemed necessary.

3.8. Other protective measures

Blocking off the sparsely populated area surrounding the site is considered an obligatory precaution in a serious reactor accident. At the two sites in use in Finland, this is easily achieved on land at a distance of a few kilometres from the plant. The barrier points and detour routes are to be included in the emergency plan, and implementing access control is the responsibility of the police, with the assistance of the coast guard. It is also foreseen that it might be necessary to restrict traffic in a larger area potentially affected by cloud passage or radioactive ground contamination, in order to reduce the possible collective dose and to secure the flow of emergency traffic.

The distribution of iodine tablets to the population is recognized as a countermeasure and the following approximate quantities are kept in store:

– at the power plants	about 3 000
– at the local health centres	about 10 000
– at the Helsinki University Central Hospital	about 100 000

The stock at the power plants and the local health centres is intended for the emergency personnel and for the population within emergency zone I.

The decision to distribute tablets to members of the public is made by the health authorities on the recommendation of the national expert advisory group and is implemented by the health centres. The tablets contain 200 mg of KI and the stock is renewed every 5 years.

3.9. Information to the public

A special 'notice for households' has been prepared jointly by the county administration and the power company at each site, and distributed to every house owner or tenant within about 5 km radius. The notice is printed on a hard plastic sheet and is to be kept in a visible place. It contains information about:

- the alarm signals
- what action to take
- where to assemble in case a notice of evacuation is given.

The use of the alarm signals is also explained in the local telephone directories and the anticipated action is the same in all types of accidents.

In an accident situation the principal information medium is the radio. By arrangement with the state-owned public broadcasting company, official bulletins can be read over the radio and television either interspersed with regular programmes or by detaching a regional network or transmitter for these bulletins.

4. PREPAREDNESS

4.1. Plan maintenance and training of personnel

The off-site plan must also include a training programme. The training shall comprise co-operation between authorities as well as training in the special tasks of each authority in a nuclear power plant accident.

Training in connection with the preparation and major revisions of the plan has been arranged by the Ministry of the Interior and the Finnish Centre for Radiation and Nuclear Safety. The off-site emergency response plan shall include a system of review of the plan at regular intervals. The annexes containing addresses and telephone numbers must of course be updated continuously. The plan itself is to be reviewed yearly.

4.2. Emergency drills

The position of the regulatory authorities is that an off-site emergency drill, involving all the local authorities concerned, must be held before the licensee is given an operating licence. The first such drills were arranged in Loviisa in 1976 and in the Rauma co-operation district in 1977, before the startup of the first unit at the sites.

Subsequently, drills involving the county administration and neighbouring co-operation districts have been held. In 1983 a surprise drill was held at Loviisa. The authorities were instructed in advance to oversee their plans, but the exact date of the drill was not known beforehand.

The emphasis of these drills is on leadership, co-operation and communications. Certain tasks such as radiation measurements, traffic control and evacuation of groups of volunteers have been practised in some of the training drills. The public has not been involved. However, the authorities have tried to take advantage of the public attention attracted by the drills to provide further information for the public about emergency plans and preparedness for nuclear accidents.

The new General Directive concerning off-site planning specifies that emergency drills supervised by the county administration are to be held at least every three years.

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