RED ALERT

INDIA'S NUCLEAR DISASTER PLANS, OUT-DATED AND INADEQUATE.

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Women protesting against nuclear technology, Jaitapur.
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Decontamination of radiation hotspots starts in Mayapuri
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Content

"A major factor that contributed to the accident was the widespread assumption in Japan that its nuclear power plants were so safe that an accident of this magnitude was simply unthinkable. This assumption was accepted by nuclear power plant operators and was not challenged by regulators or by the Government. As a result, Japan was not sufficiently prepared for a severe nuclear accident in March 2011." (IAEA2015)

- Director General IAEA, Yukiya Amano

1. Introduction

Severe nuclear accident can happen everywhere. Following the International Atomic Energy Agency's recommendations, nuclear safety is based on "defence in depth" with five independent levels of protection. The objective of the last level is the "mitigation of radiological consequences of significant releases of radioactive materials" by the means of off-site emergency response. IAEA stresses that even if the efforts described in the lower levels are expected to be effective in limiting the consequences of severe accidents, "it would be inconsistent with defence in depth to dismiss off-site emergency plans" [IAEA1996].

Although they are separated by 25 years, the Chernobyl and Fukushima nuclear disasters have several common features: both are man-made catastrophes ranked at the highest level of the International Nuclear Event Scale (INES). In both cases, massive releases of radioelements lasted ten days and forced the evacuation of over 100 000 people during the emergency phase. They had to escape from locations situated as far as 50 km from the NPP. Both are national disasters with social, economical, political consequences over decades.

The Publication 109 of the International Commission on Radiological Protection dedicated to the protection of people in emergency exposure situations stresses that "the importance of planning for emergency response cannot be over-emphasised. No emergency response can be effective without prior planning" [ICRP109 (44)].

The DEVAST research project in Japan compared the testimonies of refugees from the tsunami and the nuclear disaster [DEVAST2013]. It clearly appears that "the evacuation from the tsunami can be characterized as an evacuation with warning, preparation and knowledge" whereas the "evacuation from the nuclear accident can be described as an evacuation without warning, preparation or knowledge. [...] As a result, the evacuation was organised in an ad hoc and chaotic manner, leaving the population in great confusion." Fukushima disaster happened 25 years after Chernobyl. Why were the lessons from Chernobyl not learnt?

After the nuclear disaster in Japan, nuclear safety has been revised in many countries, leading to stress tests in Europe for example. However, most of the time, emergency plans were not considered in this review process. Stress test examines safety within the fence line of a nuclear installation whereas emergency response deals with public safety outside the fence and offsite. A stress test would generally help in diagnosis of risk and safety assessment of nuclear plants. These tests measure the ability of a nuclear power plant to withstand damage from external events such as floods, terrorist attacks, airplane crash as well as earthquakes. Fukushima forced various governments to examine the defensive abilities of their nuclear installations. However, the ability to contain, minimise, limit or manage a nuclear disaster was not examined with the same vigour. Will the lessons of the Fukushima disaster also be ignored?

Like Japan and other nuclear power states, India also has a set of emergency response guidelines and plans around each nuclear facility. "The counter measures stipulated are sheltering, potassium iodate prophylaxis evacuation and control of foodstuffs" [AERB1999]. All of these emergency plans look similar. Whether it be plans prepared by Japan or prepared by India, these plans essentially fail in adopting lessons learnt from Chernobyl or Fukushima. If the emergency plans remain the same, then perhaps what went wrong in Japan may also go wrong in India or elsewhere?

In India, the emergency preparedness manual for the Rajasthan nuclear power station asserts that "Nuclear Power Plant (NPP) are designed and operated in a manner such that there is no likelihood of off-site emergency condition" [DAE2010].

The executive summary of the National Disaster Management Guidelines: Management of Nuclear and Radiological Emergencies quoting the Three Mile Island and Chernobyl accidents considers that "even though such situations may not easily be repeated, one must be prepared to face nuclear/radiological emergencies of lower magnitudes" [NDMA2009]. Why lower magnitudes, shouldn't one be prepared to deal with nuclear/radiological emergencies of all magnitudes?

French Nuclear Safety Authority also stated on its homepage "a nuclear accident is always possible. Nevertheless, an accident of the type of Chernobyl (at level 7 of INES) with catastrophic consequences for the population and the environment is hardly conceivable in France[1]". After the catastrophe in Japan, they changed their stance in French mass media. The head of the French nuclear safety authority has repeated several times[2] that "a major accident like in Chernobyl or Fukushima cannot be ruled out anywhere in the world, including Europe. We must draw the consequences." At the European level, the Western European Nuclear Regulators Association (WENRA) and the Heads of the European Radiological Protection Competent Authorities (HERCA) both "additionally consider that the possibility of a severe accident scenario (i.e. Fukushima-like) with no or insufficient information on the plant status cannot be completely ruled out" [ATHLET2014].

But it was too late for Japan. Thus, Prof. Yotaro Hatamura, who headed the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, concludes in his report: "It should be assumed that "all possible phenomena would occur". Moreover, it is necessary to recognize that there could be kinds of phenomena, which do not even be recognized as impossible phenomena, in other words, unthinkable phenomena can also occur. [...] It is necessary to make full preparations based on the assumption that unthinkable phenomena might occur."

In Japan, "an evacuation on this scale had never been envisioned – let alone exercised – prior to the accident" [DEVAST2013]. The Nuclear Accident Independent Investigation Commission of Japanese National Assembly (NAIIC) concluded that "the expansion of damage caused by this accident is attributed to the insufficient preparedness on the part of the central government and municipal governments in facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

The Niigata-ken Chuetsu-oki Earthquake, which occurred on July 16, 2007, triggered multiple troubles and failures, including a transformer fire and a leakage of water containing radioactive substances at the Kashiwazaki-Kariwa Nuclear Power Plant. In response to these outcomes, many pundits requested nuclear power plants to put emergency preparedness measures in place to address complex disasters. However, no integrated efforts had been made by the central government and municipal governments to establish disaster preparedness against complex disasters prior to the accident at the Fukushima Daiichi plant" [NAIIC2012].

[1] Un accident nucléaire est toujours possible. Néanmoins, un accident du type de Tchernobyl (de niveau 7 sur l'échelle INES), dont les conséquences ont été catastrophiques pour les populations et l'environnement, est peu envisageable en France. ».
http://www.asn.fr/index.php/S-informer/Dossiers/Les-situations-d-urgence/Que-faire-en-cas-d-accident/L-incident-L-accident updated on the 6th of October 2009. Accessed in December 2013. This sentence disappeared when the web site was renewed early 2014.
[2] Pierre-Franck Chevet, Il faut imaginer qu'un accident de type Fukushima puisse survenir en Europe, interview to Libération, 3rd March 2016
http://www.liberation.fr/futurs/2016/03/03/il-faut-imaginer-qu-un-accident-de-type-fukushima-puisse-survenir-en-europe_1437315
Trente ans après Tchernobyl, « un accident nucléaire majeur ne peut être exclu nulle part », interview to Le Monde, 22nd April 2016

The Independent Investigation Commission on the Fukushima Nuclear Accident adds: "In 2010, for example, the government of Niigata Prefecture, on Japan's western shores, made plans to conduct a joint earthquake and nuclear disaster drill. This was imminently sensible, since just three years before an offshore earthquake had temporarily shut down a TEPCO nuclear power station on the Niigata coastline. But the Nuclear and Industrial Safety Agency (NISA), the nation's main nuclear regulator, advised the local government that a nuclear accident drill premised on an earthquake would cause "unnecessary anxiety and misunderstanding" among residents" [IICFNA2014].

As India has experienced several natural disasters in the past and a large industrial accident at Bhopal, we cannot rule out a complex disaster like in Japan combining natural and nuclear emergencies. Preparing to the worst case is necessary to be able to face smaller accidents. As the emergency preparedness and response (EP&R) should be scaled to cope with any kind of nuclear disaster, we will consider past nuclear catastrophes as a reference. They both could have been worst.

In this work, we limit our investigations to off-site responses to an accident at a nuclear power plant although the guidelines consider other possibilities like terrorism. ACRO did similar analysis of EP&R in Belgium and France [ACRO2015, ACRO2016a]. Note that the Performance Audit of Disaster Preparedness in India also points out that "a large number of consents for transport of radioactive material for safe disposal had been given. However, there is no proper mechanism to verify the sources had actually been disposed off. The regulatory response mechanism to trace and discover lost of orphan radioactive sources in the country was also not effective" [CAGI2013].

Is India well prepared to face a nuclear accident?

Are its response plans to the level of international standards?

Would India have done better in case of a complex disaster like in Japan?

As stressed by the International Commission on Radiological Protection (ICRP), "no emergency response can be effective without prior planning. This planning needs to involve identification of the range of different types of emergency situation for which a response may be required, engagement with stakeholders, selection of appropriate individual protective measures and development of the overall protection strategy, agreement of the areas of responsibility of different agencies and how they will interact and communicate, deployment of the necessary equipment for monitoring, supporting the implementation of protective measures, communicating with those at risk, training, and exercising of the plans." [ICRP109 (44)].

Nuclear Protest at Indian Parliament in New Delhi
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2. Documentation

There are presently 21 nuclear reactors producing electricity in India, located in seven nuclear power plants. The country has 6 reactors under construction and several others planned. If we add research and military facilities, India is one of the major nuclear powers in the world. As a consequence, it should be at the best international level in terms of nuclear safety and emergency preparedness.

We propose here an international comparison of Emergency Preparedness and Response around NPPs in India and various other countries. But documentation on Internet is scarce in India. Emergency plans around each nuclear facility are not available online. On the contrary, there are thousands of pages in the US, Canada or Europe that are widespread on many web sites. In France, local nuclear emergency plans should be available on line according to a recent decree[3].

On the national level, India has taken a definite step by enacting the Disaster Management Act in December 2005 with the formation of the National Disaster Management Authority as the apex body, with the Prime Minister as its Chairperson, and similar authorities in the states with the Chief Ministers as the Chairpersons. This new Authority published in 2009 new guidelines dedicated to the Management of Nuclear and Radiological Emergencies [NDMA2009]. In comparison, France published its first national plan on the management of major nuclear or radiological accidents in February 2014 [SGDSN2014].

In India, the major recommendations of new guidelines should be broadly realised in 8 years, starting with a Short-term Plan of 3 years. It is very difficult to evaluate the progress done so far.

Locally, some of the guidelines are obsolete: the manual on emergency preparedness at Kalpakkam Department of Atomic Energy (DAE) centre and Madras NPP [DAE2011], revised in April 2011, includes an Atomic Energy Regulatory Board (AERB) safety guide [AERB1993] where the intervention levels are based on the Publication 40 of the ICRP adopted in 1984, before Chernobyl nuclear disaster. ICRP's recommendations were updated in 1992 (Publication 63) and in 2007 (Publication 103), followed by the Publication 109 dedicated to emergency. Why have these new recommendations not been taken into account?

The nuclear industry in India as well as the nuclear regulator should fasten the adoption of the latest international recommendations and define clear operational intervention levels. All material related to off-site emergency should be put online.

[3] Décret n° 2015-1652 du 11 décembre 2015 modifiant les dispositions relatives aux plans particuliers d'intervention prises en application de l'article L. 741-6 du code de la sécurité intérieure, NOR: INTE1521935D, ORF n°0289 du 13 décembre 2015 page 23033 http://www.legifrance.gouv.fr/eli/decret/2015/12/11/INTE1521935D/jo/texte

3. Emergency Protection Measures

3.1. Emergency Planning Zones

Protective actions of the population living around a nuclear facility are designed to decrease the exposure to radiations by providing shielding from the radiation plume or by increasing the distance from the radiation source. The ingestion of contaminated foodstuffs should also be limited and potassium iodine tablets might be provided to protect the thyroid gland from an internal exposure of radioactive iodine.

The effectiveness of these actions requires preparation and relevant information to the population who might be exposed. One of the key subjects in regards to radiation protection debated around the world, is the distance up to which these protections should be implemented. In other words, up to what distance from the nuclear plant should the people be informed, trained and prepared for the worse?

Indian National Guidelines [NDMA2009] mention an exclusion zone with a radius of 1.6 km in which no habitation is permitted and a sterilised zone with a radius of 5 km around the NPP where human activities are regulated so as to check undue increase in population. The emergency plan of the AERB [AERB1999] requires information about demographic characteristics up to 16 km. The latter is considered as the Emergency Planning Zone (EPZ). Population centres within 50 km having population in excess of 10 000 should also be indicated.

The emergency preparedness manual for the Rajasthan nuclear power station asserts that "Nuclear Power Plant (NPP) are designed and operated in a manner such that there is no likelihood of off-site emergency condition. However, under any such off-site emergency (OSE) condition, effect will remain limited to 16 km radius" [DAE2010]. The manual of the Kalpakkam DAE Centre [DAE2011] also defines a sampling zone with a radius of 32 km where samples are taken at regular intervals and data is stored for references. Beyond 16 km radius there is no requirement of preparing emergency plans.

The manual on emergency preparedness for the Kakrapar nuclear power station [NPCIL2011] revised after the Fukushima disaster states that the plan is defined "up to a distance of 16 km. Even in the event of an off-site emergency it is quite unlikely that radioactive materials will spread beyond 16.0 km distance. However, if situation demands, the preparedness plan can be extended beyond the 16 km distance also". However, besides this statement, there is no clear plan for implementing emergency measures beyond the 16 km distance.

On the 16th of March 2011, the U.S. Nuclear Regulatory Commission (NRC) recommended that U.S. citizens within 80 km of the Fukushima Daiichi plant evacuate. NRC justifies this recommendation as a conservative estimate based on limited and often conflicting information about the exact conditions of the reactors and spent fuel pools at the power plant.

Exclusion zone does not exist in other countries. On the 26th of April 2016, French government announced that the EPZ will be extended up to 20km within 2016. [SGDSN2014].

In USA, it is 10 miles (16 km) like in India. There is also a 50-Mile (80 km) Ingestion Exposure Pathway Emergency Planning Zone where the principal health risk is expected to be exposure from ingesting contaminated water or foodstuffs.

After the Fukushima accident, NRC considers that the 10-mile (16 km) and 50-mile (80 km) emergency planning zones established in 1978 remain adequate. This is not the point of view of the United States Government Accountability Office [GAO2013]: "To better inform radiological emergency preparedness efforts, GAO recommends that NRC obtain information on public awareness and likely public response outside the 10-mile zone, and incorporate insights into guidance, as appropriate."

In Japan in 2011, inappropriate size of the EPZ hampered evacuation and lead to confusing decisions.

The Fukushima Nuclear Accident Independent Investigation Commission of National Diet of Japan [NAIIC2012] writes: "Fukushima Prefecture, acting on its own accord, issued an evacuation order for residents within 2km of the nuclear power plant at 20:50 on March 11, approximately 30 minutes before the national government's decision to set the evacuation area to a 3km radius around the Fukushima Daiichi Nuclear Power Plant. [...] The 2km radius was determined by the prefecture as the bare minimum distance considering the 2km evacuation radius used for residents in past comprehensive nuclear emergency preparedness drills."

The evacuation orders were later extended to 10 and 20 km from the NPP. "A 10km radius zone was chosen simply because it was the maximum area for an Emergency Planning Zone (EPZ) as set out in the Disaster Prevention Plan; it was not decided on the basis of any kind of concrete calculations or rational grounds. As for the 20km-radius evacuation zone, due to the progression of the situation, including the hydrogen explosion in Unit 1, a radius of 20km was decided upon simply because of some people's subjective opinions. This can hardly be called a rational decision." [NAIIC2012]

It is worth knowing at this stage that 80% of the radioactive fallouts from Fukushima NPP were carried by the wind towards the Pacific Ocean. Japan would have faced a significant impact on longer distances if downwind zones were inhabited.

As a consequence, the new guidelines of the Japanese Nuclear Regulation Agency define a Precautionary Action Zone with a radius of 5 km with immediate evacuation in case of a general nuclear emergency, an Urgent Protective action Planning Zone between radii of 5 to 30 km with protective action depending on the severity of the accident. There is also a Plume Protection Planning Area between radii of 30 to 50 km where iodine tablets are available and where protective action might be taken if necessary [NRA2012, NRA2013]. The radius of each zone is only indicative, but local authorities have started to consult the public with such a zoning. See e.g Izumozaki in Niigata [Izumozaki2013].

In Europe also some revisions of the emergency planning zone are underway. In Germany, the Commission on Radiological Protection (Strahlenschutzkommission, SSK) recently wrote that "due to their low likelihood of occurrence, the consequences of incidents now classified as an INES level 7 were not used as a basis for determining requirements in terms of emergency preparedness plans". It adds that it "believes that the range of accidents included in emergency response planning should be redefined to more closely reflect an accident's potential impact rather than its likelihood" [SSK2014]. Consequently, it recommends to consider an INES level 7 to frame emergency plans.

Switzerland has also revised reference scenarios noticing that the source term in Fukushima was larger than what was considered for emergency planning. New scenarios with source terms for iodine and aerosols multiplied by 10, 100 and 1 000 have been introduced [IDA-NOMEX2014].

The Western European Nuclear Regulators Association (WENRA) and the voluntary organisation, Heads of the European Radiological Protection Competent Authorities (HERCA) together formed AtHLET, a task force mandated with handling severe accidents where not much information is available. AtHLET considers "that the possibility of a severe accident scenario (i.e. Fukushima-like) with no or insufficient information on the plant status cannot be completely ruled out. EP&R arrangements should therefore also cover such cases." It adds in its conclusions that "as improbable such an accident might be, EP&R arrangements must be prepared for such cases, too.

According to the current studies, international standards and methods used for emergency preparedness and response, an accident comparable to Fukushima would require protective actions such as evacuation to around 20 km and sheltering to around 100 km. These actions would be combined with the intake of stable iodine" [ATHLET2014].

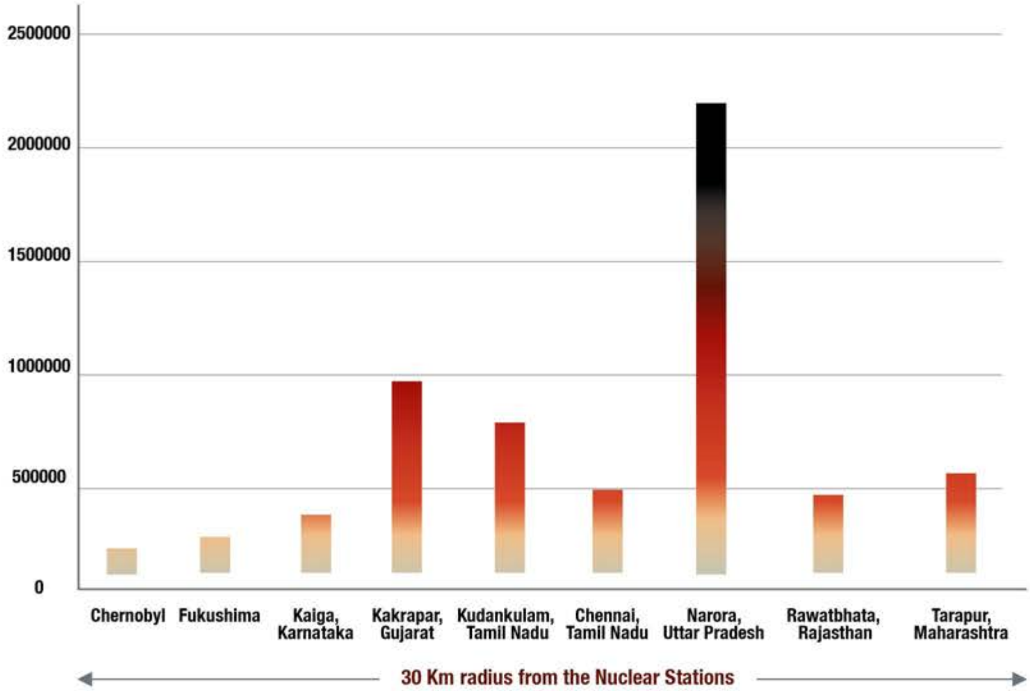
The Belgian Superior Health Council recently recommended implementing ATHLET's recommendations and adapting the Belgian nuclear and radiological emergency plan as promptly as possible in 2016 [CSS2016].

Such scales considerably affect preparation plans. The number of inhabitants around Indian NPPs is listed in Table 1 below. All Indian nuclear power stations are surrounded by a larger number of inhabitants than in Fukushima or Chernobyl. The case of Narora is particularly critical with more than two million persons within 30 km.

Table 1: Estimation of the number of inhabitants around NPPs

NUCLEAR POWER PLANTS	Population living in the radius of: (ref – Nuclear emergency manuals & NATURE2011)			
	16 km	30 km	75 km	150 km
Chernobyl, Ukraine		135 000		
Fukushima, Japan		172 000	1 730 000	7 700 000
Kaiga, Karnataka	23 216	320 000	2 570 000	12 850 000
Kakrapar, Gujarat	308 000	960 000	8 190 000	26 450 000
Kudankulam, Tamil Nadu		750 000	4 770 000	14 900 000
Chennai, Tamil Nadu	210 000	500 000	11 990 000	25 280 000
Narora, Uttar Pradesh	409 802	2 240 000	15 930 000	79 430 000
Rajasthan, Kota Rajasthan	75 000	460 000	4 060 000	15 310 000
Tarapur, Maharashtra		560 000	9 010 000	35 380 000
References	Emergency Manuals	[Nature2011]		

Table 1.1: Total Population within 30km radius from nuclear power stations



To avoid such distances implying many people, Indian authorities keep high operational intervention levels. Recent Atomic Energy Regulatory Board guide [AERB2000] still refers to these obsolete intervention levels [AERB1993]. In particular, this guide identifies three off-site space-time domains with different radiological characteristics and severity for introducing specific countermeasures, viz.,

Domain 1: Near Field – Early Phase;

Domain 2: Near Field – Intermediate Phase, Intermediate Field – Early & Intermediate Phases;

Domain 3: Near & Intermediate Fields – Late Phase, Far Field – Early, Intermediate & Late Phases.

Intervention levels differ from one domain to the other and range from 1 to 500 mSv to whole body and 50 to 2500 mSv to thyroid. Note that the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) does not consider above 200 mSv as "low doses" anymore.

Such intervention levels are very confusing and difficult to apply. How to decide the domain? Which value to choose as an operational limit? The smallest or the largest? Intermediates one? Decisions might differ from one decision-maker to the other. Populations in the first domain cannot accept to have less stringent intervention levels than the populations in the second domain. How to justify such differences in treatment?

It seems that such a wide range of intervention levels is kept to avoid deploying protection measures to too many people.

Emergency Planning Zone around nuclear power plants in India should be expanded by up to at least 30 km off NPPs. Preparation and information of the populations is also necessary beyond this limit up to 100 km.

Greenpeace marks the one-month period following Japan's nuclear disaster, and protests against the use of nuclear energy in India.
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3.2. Sheltering

"Sheltering is the use of the structure of a building to reduce exposure from an airborne plume and/or deposited materials. Solidly constructed buildings can attenuate radiation from radioactive materials deposited on the ground and reduce exposure to airborne plumes. Buildings constructed of wood or metal are not generally suitable for use as protective shelters against external radiation, and buildings that cannot be made substantially airtight are not effective in protecting against any exposures" [ICRP109 (B4)].

Publication 109 of the ICRP states that sheltering is not recommended for longer than approximately 2 days. French national guidelines consider that sheltering should be limited in time because its efficiency decreases with time. Limiting factors are due to the penetration of radioactive elements into buildings, the need of food supply and the potential separation of the family. Children might be at school and parents at workplace. "An actual duration of the order of half a day can be used" [SGDSN2014]. French guidelines add that if the discharge is long or threatens to amplify the sheltering should be followed by evacuation at discharge. The lifting of sheltering is accompanied by information specifying behaviors.

Publication 63 of the ICRP stipulates that "it has been estimated on a generic basis that sheltering will almost always be justified provided that an averted effective dose of 50 mSv can be achieved during the time considered feasible for sheltering. Optimised levels will be lower but not by more than a factor of 10 when consideration is given to specific accident conditions and sub-groups of the population" [ICRP63(62)].

In France, safety rules require the sheltering when forecasts of the exposure of the population exceed an effective dose of 10 mSv for the whole body [SGDSN2014]. It is 5 mSv in Belgium [ACRO2015].

AERB's intervention levels for sheltering range from 20 to 100 mSv for domain 1 and 5 to 20 mSv for domain 2 [AERB1999]. But, in India, sheltering is only possible for the part of the population living in pucca houses. Around Kalpakkam DAE centre and Madras NPP, pucca houses represent less than 30% of the dwelling [DAE2011]. It is about 16% around the Kakrapar NPP [NPCIL2011]. Other dwellings might offer insufficient protection. In particular, there are about 10 000 people living in thatched houses without door who might need to be immediately evacuated in case of emergency.

This issue is not addressed in emergency preparedness manuals. How will Indian authorities deal with the population who cannot be sheltered at home?

3.3. Iodine Prophylaxis

According to the Chernobyl forum, "statistics from the national registries of Belarus and Ukraine indicate that the total number of thyroid cancers among those exposed under the age of 18, is currently close to 5 000. The numbers differ slightly depending on the reporting methods, but the overall number observed in the three countries is certainly well above 4 000" [IAEA2006]. UNSCEAR, the United Nations Scientific Committee on the Effects of Atomic Radiations, reports 6 848 cases of thyroid cancers between 1991 and 2005 among those under age 18 in 1986.

It adds that the dramatic increase in incidence in 1991-1995 among children under age 10 was associated with the accident. The increase in the incidence among children and adolescents began about 5 years after the accident and persisted until 2005 [UNSCEAR2008].

Health agency in Québec, Canada, explains that "the efficiency of iodine prophylaxis was demonstrated in Poland where stable iodine was administrated to 10.5 million children and 7 million adults in the aftermath of the Chernobyl accident. Recommended dose was 15 mg for new-born's, 50 mg for children less than 5 years old and 75 mg for others, including pregnant women. Radioactive dose was cut by 40% when the pill was administrated three days after the accident and by 25% when it was four days after. This led to a 5 rem (50 mSv) reduction of the dose to the thyroid (Nauman et Wolff, 1993).

In Japan, the Fukushima Medical University has screened the thyroid of 368 000 children in Fukushima prefecture. As of the 31st of December 2015, after a first echography, 100 children were found to have developed a thyroid cancer confirmed by surgery. One case happened to be benign and there are 15 other suspected cases. Although the occurrence frequency is higher than what is usually observed, Japanese authorities keep claiming that it is not due to the nuclear disaster. They rather claim that such a number is due to the systematic screening. If it is the case, why was surgery necessary? These children could have lived several years with their thyroid gland[4]. A second screening campaign was launched in August 2014. Among 220 000 children having a second echography test, 51 are suspected to have a thyroid cancer, including 16 confirmed cases. On these 51 cases 47 had no problem detected during the first screening [FMU2016]. Japanese authorities continue to consider that this is not due to the nuclear disaster, but such a conclusion is highly debated.

A recent epidemiological study[5] published in a scientific journal with referees, contests the official point of view and concludes that the excess of thyroid cancers is unlikely to be explained by a screening surge. The authors don't see any other explanation than radioactivity.

There is an overwhelmed agreement that radioactive iodine released during a nuclear accident is the main cause of the increase of thyroid cancers among young people. As a consequence, thyroid blocking is an important way to prevent dose to the gland in case of exposure by inhalation and ingestion of radioiodines. It is worth noticing that iodine prophylaxis was not used in former USSR after the Chernobyl disaster. In Japan, almost not.

In Poland, thanks to the iodine administration in the following days of the Chernobyl disaster, no increase of the occurrence of thyroid cancers was observed. On the contrary, in Belarus, were iodine prophylaxis was not implemented, a 100-fold increase of this cancer was observed among children following the Chernobyl accident" [ASSS2012]. In particular, it was the case in the Brest district, the second most affected after Gomel, that is located near the Polish border.

[4] Mizuho Aoki, Experts question Fukushima thyroid screening, The Japan Times, Jul 31, 2014
http://www.japantimes.co.jp/news/2014/07/31/national/science-health/experts-question-fukushima-thyroid-screening/
[5] Tsuda et al, thyroid cancer detection by ultrasound among residents ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014, Epidemiology: May 2016 - Volume 27 - Issue 3 - p 316–322
http://journals.lww.com/epidem/Citation/2016/05000/Thyroid_Cancer_Detection_by_Ultrasound_Among.3.aspx

Publication 109 of ICRP stresses that "there is another measure that prevents radioiodine intake directly (restriction of potentially contaminated food consumption), thyroid blocking is considered to be primarily used for reduction of doses that result from inhalation. Iodine thyroid blocking should only be used to reduce the uptake of ingested radioiodine if it is impossible to provide supplies of uncontaminated food, especially for children and particularly in relation to milk; even if this is the case, iodine thyroid blocking is intended for relatively short periods of time, since efforts should be made to provide supplies of uncontaminated food as soon as possible" [ICRP109 (B2)].

Posology is complicated because, "to obtain the maximum reduction of the radiation dose to the thyroid, stable iodine should be administered before any intake of radioiodine, or as soon as practicable thereafter. If stable iodine is administered orally within 6 h preceding the intake of radioactive iodine, the protection provided is almost complete; if stable iodine is administered at the time of radioiodine inhalation, the effectiveness of thyroid blocking is approximately 90%. The effectiveness of the measure decreases with delay, but the uptake of radioiodine can be reduced to approximately 50% if blocking is carried out within a few hours of inhalation" [ICRP109 (B3)].

It is then better to have iodine tablets at hands to be able to administrate them at the optimum moment.

3.3.1. Distribution of Iodine Tablets

In India, from AERB's website homepage[6], when we select publications on emergency preparedness, one gets publication, Ref. [AERB1999], where it is stipulated that iodine tablets are stored in Emergency shelters. A more recent publication [AERB2005] states that "since early administration of the prophylactic is the key to its effectiveness, to facilitate distribution, the tablets in required numbers shall be stored in multiple locations within the EPZ, preferably in primary health centres (PHCs), hospitals and other health care facilities or other similar organisations of the district."

Some manuals on emergency preparedness list the number of available iodine tablets in shelters. Around Kaiga, for example, the number of available tablets is sometimes lower than the shelter capacity [DAE2011]. How the local authorities will deal with such a situation? Will children have the priority?

In Europe, "pre-distribution is preferred because the tablets are directly available in an event and there will be no conflict other countermeasures, especially sheltering" [HERCA2011]. As iodine prophylaxis should administrated very quickly in case of emergency, iodine pills should be handed before to the population living in the EPZ or even beyond.

This was not the case in Japan before the Fukushima disaster. Stockpiles were stored locally, but the government's nuclear emergency response headquarters and the prefectural government failed to give proper instructions to the public. Consequently, only a very small number of residents in the surrounding area took them [NAIIC2012].

One of the lessons from Fukushima drawn by Anand Grover, Special Rapporteur of the Human Rights Council, in his report about the situation in Japan, is that "the State should take all efforts to ensure that such health goods as stable iodine tablets are made available and accessible, in a timely manner, to mitigate the effect of radioactive iodine on the health of the exposed population" [HRC2013]. Japan nuclear regulation authorities changed their policy after the 2011 disaster and advise prior distribution of iodine prophylaxis within the EPZ with radius of 30 km. It should be considered in the plume protection planning area of 50 km [NRA2012]. Local authorities that are in charge of organising and supporting the distribution have not decided their policy yet. Recently, an evacuation drill to prepare for a nuclear disaster has been held in Niigata Prefecture, but central and prefectural government officials remained at odds over when to hand out potassium iodine pills to residents to mitigate the risk of thyroid cancer in such a scenario. The drill wrapped up without finishing, as officials disagreed over the timing of the iodine distribution[7].

In US, under current regulations, states with populations living within 10 miles (16 km) of a nuclear plant are encouraged, but not required, to maintain a supply of potassium iodide.

In the case of the Fukushima Dai-ichi Nuclear Power Plant accident, the area where a thyroid equivalent dose due to inhalation of radioactive iodine from the plume might have exceeded the criteria for iodine prophylaxis of IAEA extended to about 50km from the nuclear power plant [NRA2012]. It would have been longer distances if the main downwind zone were not the ocean but inhabited territories.

[6] http://www.aerb.gov.in/AERBPortal/viewCodesAndGuides.action?category=Emergency%20Preparedness
[7] Kyodo News, Niigata nuclear disaster drill finds governor, state at odds over iodine pill distribution, The Japan Times, 12th of November 2014
http://www.japantimes.co.jp/news/2014/11/12/national/niigate-nuclear-disaster-drill-finds-governor-state-odds-iodine-pill-distribution/

"The NRC will not require use of potassium iodide by the general public because the NRC believes that current emergency planning and protective measures--evacuation and sheltering--are adequate and protective of public health and safety. However, the NRC recognizes the supplemental value of potassium iodide and the prerogative of the States to decide the appropriateness of the use of potassium iodide by its citizens.[8]"

The NRC is providing funding for a supply of potassium iodide for a State that chooses to incorporate potassium iodide for the general public into their emergency plans. After funding the initial supply of potassium iodide, the Commission decided to fund the replenishment on a one-time basis. 25 states out of 34 have received potassium iodide tablets from the NRC[9]. The American Thyroid Association recommends to pre-distribute iodine to households within a radius of 80 km[10].

After the Fukushima accident, Canada's Nuclear Safety Commission required the pre-distribution of iodine thyroid blocking agents, such as potassium iodide tablets, to all residences, businesses, and institutions within a designated plume exposure planning zone. For the first time, Ontario province has decided to distribute iodine tablets within a 10 km radius around NPPs and to prepare stocks for the population beyond [CNSC2015]. A dedicated Internet site was also developed[11].

In France, the government decided in 1997 to organize the distribution of iodine tablets to people living in the EPZ within a radius of 10 km around nuclear power plants. Since then, the iodine distribution has been regularly renewed in 2000, 2005, 2009 and 2016. The last distribution campaigns were conducted in 2 phases: citizens were initially prompted by a letter to withdraw their pills in pharmacy and those who did not realize that withdrawal after a period of six months received a box of tablets by mail at their home. In 2009, about 50% of the people went to the pharmacy. Stocks should be permanently available in the EPZ and beyond. France has a web site dedicated to the distribution of iodine tablets around NPP[12]. It is in French only.

In Belgium, iodine tablets are also handed to the population within 20 km of a nuclear reactor. Outside of these zones there are large decentralized stocks that can be distributed to the population. Furthermore, every pharmacy in the country has a sufficiently large stock of iodine-containing basic material, allowing a quick production of emergency rations[13].

In Europe, distribution of iodine tablets range between a 5-km-zone around the NPP in Finland to 50 km in Lithuania [EC-TREN2010]. This range has been debated after the Fukushima accident.

In 1993 the Swiss government began handing out iodine tablets to residents living within 20km of a nuclear reactor. It has recently decided to extend the distribution up to 50 km. The number of people receiving a box with 12 tablets would nearly quadruple to 4.6 million, covering residents in the cities of Zurich, Basel and Lucerne. This is more than half of the Swiss population. The cost for the extension, an estimated CHF30 million, should be covered by the power companies[14]. Luxembourg distributed iodine tablets to all its population. The most distant inhabitants are about one hundred kilometres away from the nuclear plant.

WHO notes that after the Chernobyl disaster, the increase in incidence of thyroid cancers has been documented up to 500 km from the accident site [WHO1999].

[8] http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/potassium-iodide/ki-faq.html
[9] https://forms.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/potassium-iodide.html
[10] American Thyroid Association, Nuclear Radiation and the Thyroid, 2011 http://www.thyroid.org/wp-content/uploads/patients/brochures/NuclearRadiation_brochure.pdf
[11] https://preparetobesafe.ca/
[12] http://www.distribution-iode.com/
[13] http://www.nuclearrisk.be/campaign-2011/distribution-iodine-tabs/distribution-zones-iodine
[14] Confédération Suisse, La distribution préventive de comprimés d'iode en cas d'accident nucléaire sera étendue, press release, 22nd of January 2014, http://www.bag.admin.ch/aktuell/00718/01220/index.html?lang=fr&msg-id=51733

More recently, the European AtTHET task force concluded that it may be necessary to protect the thyroid up to 100 km from the NPP in case of an accident [ATHLET2014]. German commission for radiological protection calculated that "it may be necessary to administer iodine blockade to children, young people and pregnant women who are much further away from the plant (>100 kilometres) but within the dispersal direction. These calculations prove that dose levels may be exceeded at distances of up to 200 kilometres away from a plant. Distances of over 200 kilometres were not investigated as a radius of 200 kilometres around German plants and plants located near international borders would cover almost the whole of Germany" [SSK2014]. In Belgium, the Health ministry announced that iodine tablets will be distributed to the whole population,[15] in agreement with the recommendations of the Superior Health Council that also considers that it may be necessary to protect the thyroid up to distances of several tens or hundreds of kilometres [CSS2015] and with the recommendations of the Scientific council of the Nuclear Safety Authority [AFCN2016].

In Québec Province in Canada, Health agency calculated than in case of severe accident, dose to the thyroid could reach 612 mSv at 50 km from the plant [ASSS2012]. This is far more than the operational intervention level.

We recommend that Indian authorities hand out iodine tablets to the population with adequate information up to 100 km around NPPs. Prior distribution should be considered. It is also a good way to enhance awareness to emergency preparation.

[15] Frédéric Chardon, Toute la Belgique va recevoir de l'iode, La Libre Belgique, 28 avril 2016
http://www.lalibre.be/economie/actualite/toute-la-belgique-va-recevoir-de-l-iode-57211c1735702a22d6d187ad

3.3.2. Operational Intervention Level

After Chernobyl disaster, there has been an excess thyroid cancer incidence even in areas where the mean dose to the thyroid in children was estimated below than 100 mGy[16].

There are various definitions of the dose to the thyroid: absorbed dose, equivalent dose, with their own units, milligray (mGy) and millisievert (mSv) respectively. International recommendations use either one or the other. But applied to the impact of radioiodine to thyroid, both units are equivalent. We can replace one by the other.

Indian AERB has fixed various intervention levels for administration of stable iodine depending on the domain, as already shown. For the domain 1, corresponding to near field – early phase, the recommended intervention level is between 500 and 2500 mGy to the gland. This level is between 50 and 500 mGy for the domain 2, corresponding to the intermediate phase of near field and to the early and intermediate phases of intermediate field [AERB1993, AERB1999].

Publication 103 of ICRP recommends that stable iodine is administrated if the equivalent dose to the thyroid might exceed a value fixed between 50 and 500 mSv. IAEA considers that an absorbed dose of 100 mGy by thyroid is a generic optimized value [EC-TREN2010]. "Notwithstanding the generic recommendation, WHO considers that it is appropriate to consider the differing risks for different age groups when developing detailed emergency plans, and also the possibility of differential administration of stable iodine prophylaxis. In this way, the greater need of children for stable iodine and the greater risk of side effects in the elderly, can be separately catered for." Consequently, WHO recommends "planning for stable iodine prophylaxis for children should ideally be considered at 1/10th of the generic intervention level, that is at 10 mGy avertable dose to the thyroid. This level is also appropriate for pregnant women." WHO also considers that "for adults over 40, the risk of radiation-induced thyroid cancer is presumed to be close to zero. For this group, the implementation of stable iodine prophylaxis is determined by the need to ensure prevention of deterministic effects" [WHO1999].

In Europe, situation varies among countries. Some stick to the IAEA guidelines. France, Belgium, Germany, Luxembourg and Switzerland agreed to adopt the lowest value of ICRP, i.e. 50 mSv. Belgium and some other European countries also introduced a 10 mSv level for children and lactating women [EC-TREN2010].

In Japan, new criteria for EP&R are still discussed. Recommendations from the new Nuclear Regulation Authority suggest 50 mSv during the first 7 days as intervention level [NRA2012, NRA2013].

In India, new guidelines from the NDMA consider that "limits of radiation exposure that have been set at a fraction of what can cause any significant harm to activate emergency procedures. This important aspect will be included in the information given to the community to instill greater confidence in them." [NDMA2009] This is definitively not the case regarding the protection of the thyroid.

Indian authorities should adopt the latest WHO recommendations for iodine prophylaxis.

[16] P. Jacob et al, Thyroid cancer risk to children calculated, Nature 392 (1998) 31

3.3.3. Multiple Administration

One dose of stable iodine will provide protection for approximately 24 h. But massive release of radioactive elements into the atmosphere lasted 10 days for both Chernobyl and Fukushima nuclear disasters.

ICRP considers that "normally, evacuation would be preferred to administration of a second dose. Where the potential for prolonged releases indicates that multiple administrations to a sheltering population may be required, the emergency plan should address how this will be achieved. Multiple administrations should not be considered unless a release is actually detected more than 24h after the first administration, and evacuation is not practicable. Ideally, stable iodine prophylaxis should not be used to provide protection against contamination of food. Wherever practicable, restrictions on food should be implemented to provide protection against intake by ingestion" [ICRP109 (Table C3)].

In Europe, "a second intake is envisaged in most countries, mainly in case of long-lasting releases, with a similar or lower dosage than for the first 15
intake. In the United Kingdom and Belgium, stable iodine prophylaxis may be used also as a temporary measure to provide protection for young children against the ingestion exposure pathway, until food restrictions can be imposed. A second intake is generally envisaged 24 hours after the first one. The second intake is sometimes only envisaged for the most radiosensitive population, i.e. newborns, young children, pregnant and breast feeding women. In Romania stable iodine may be administrated several times on a maximum of ten days" [EC-TREN2010].

The Belgium Superior Health Council stresses that radioactive fallouts can last several days, even weeks and that there is no clear strategy of optimized protection in most emergency plans [CSS2015]. The French Institute of Radioprotection and Nuclear Safety has just launched a research program on this issue[17]. Ontario province in Canada has decided to pre-distribute iodine tablets for a couple of days [CNSC2015].

India authorities should clarify their policy about second intake of iodine.

[17] IRSN, Lancement du projet ANR Priodac, 15 avril 2014
http://www.irsn.fr/FR/Larecherche/Actualites_Agenda/Actualites//Pages/2014-04-15-lancement-projet-ANR-PRIODAC.aspx

3.4. Evacuation

"Evacuation represents the rapid, temporary removal of people from an area to avoid or reduce short-term radiation exposure in an emergency exposure situation.

It is most effective in terms of avoiding radiation exposure if it can be taken as a precautionary measure before there is any significant release of radioactive material. Generally, evacuation is not recommended for a period of longer than 1 week" [ICRP109 (B6)].

Evacuation is triggered either as a preventive measure or following release of radioactive materials. "Preventive evacuation is the most disruptive of the early protective actions. The difficulty in making a decision to evacuate prior to a release of radioactivity lies in the limited amount of information that may be available. Judgment is required on the nature of the accident, the chances of escalation and whether the doses that might be received are high enough to warrant the risks, anxiety, disruption and costs associated with evacuation" [ICRP63(63)]. In the latter case, evacuation might be the only remaining option as it was the case around Chernobyl or Fukushima NPPs.

Evacuation is the most complicated protection measure, as it requires good coordination between various stakeholders, relevant information to the public and heavy logistics. It often has to be decided when the situation at the NPP is still uncertain at the very beginning of the emergency. Such a difficult measure requires good preparedness that has to be carefully evaluated. Evacuation is also the most disruptive protection measure for the populations. Especially when evacuation eventually leads to relocation.

In Japan, "a total of 146 520 residents were evacuated as a result of the government's evacuation orders. However, many residents in the plant's vicinity evacuated without accurate information. Unaware of the severity of the accident, they planned to be away only for a few days and evacuated with only the barest necessities. Evacuation orders were repeatedly revised as the evacuation zones expanded from the original 3-kilometer radius to 10 kilometres and later, 20 kilometres, all in one day. Each time the evacuation zone expanded, the residents were required to relocate. Some evacuees were unaware that they had been relocated to sites with high levels of radiation. Hospitals and nursing homes in the 20-kilometer zone struggled to secure evacuation transportation and find accommodations; 60 patients died in March from complications related to the evacuation. Frustration among the residents increased" [NAIIC2012].

In India, evacuation plans are limited to the EPZ within a radius of 16 km around NPP. Even though, Indian NDMA acknowledges that the country is not ready for a massive evacuation that "requires well-defined routes and evacuation strategies. The availability of both adequate transport and good roads (which will provide the evacuation routes), are the main issues to be tackled after taking into account the topology of the site. These problems need to be addressed by the concerned DDMAs/SDMAs as a part of the preparedness/response programme in an all-hazards approach" [NDMA2009].

French guidelines stipulate that "evacuation procedures must be exhaustive: objects to carry away, route, family reunion, information on control of contamination or decontamination" [SGDSN2014]. It would be better to provide such information to all the residents of the EPZ before any disaster.

Comptroller and Auditor General of India "reviewed the NPP sites a Tarapur, Kalpakkam and Kaiga and observed that there was no proper approach road from the Palghar Tahsildar Office to the Plant site of the Tarapur Atomic Power Station and also that the population had increased manifold in the emergency zone at the site due to large scale industrial activity in the Maharashtra Industrial Development Corporation area at Tarapur. These bottlenecks would pose serious impediments in speedy responses for rescue of affected people in case of any emergency" [CAGI2012].

3.4.1. Triggers

"In the context of developing response plans for emergency exposure situations, the Commission recommends that national authorities should set reference levels between 20 mSv and 100 mSv effective dose (acute or per year, as applicable to the emergency exposure situation under consideration)" [ICRP109(b)]. This most recent recommendation of the ICRP is not so easy to implement. Therefore, it adds that "however, the levels of averted dose recommended in Publication 63 for optimisation of protection in terms of individual protective measures may still be useful as inputs to the development of the overall response." The reference level for triggering an evacuation is recommended to be between 50 and 500 mSv in a week.

Indian AERB defined the intervention level for evacuation within the range of 100 to 500 mSv to whole body in the domain 1 corresponding to the early phase near field. The period of persistence is 10 hours and the period of the completion of the countermeasure is 24 hours. No evacuation is planned for the other two domains. [AERB1993,AERB1999].

In France, evacuation is decided as soon as predictions of exposure of the population are larger than 50 mSv to whole body [SGDSN2014]. In the local emergency plans, it is only limited to a radius of 5 km around the NPP [PM2008]. If evacuation happens to be necessary beyond, it will be completely improvised.

In Japan, when the general emergency is declared based on the emergency action level (EAL) established by a utility and the emergency classification defined by the national government, it is necessary to implement the protective actions such as evacuation in the Precautionary Action Zone (PAZ) with a radius of 5 km prior to the radioactive release into the environment. Beyond evacuation is triggered when the effective dose during the 7 first days is higher than 100 mSv. An Operational Intervention Level of 1 mSv/h is also defined [NRA2012].

Indian authorities should consider that they might have to evacuate the population beyond the nearly field. Trigger range is too high in comparison to other countries.

3.4.2. Evacuation Place

Choosing the right evacuation place is one of the key points to the success of the operations. It should be far enough to protect populations from the fallouts but also easily accessible. Population living between the evacuated zone and the shelter zone should be well informed to avoid shadow evacuation that might hamper the transport of the evacuated people.

In Japan there were numerous complaints about evacuation orders that required the residents living near the nuclear plants to evacuate so many times. Over 70% of residents from the areas near the Fukushima Daiichi and Fukushima Dai-ni plants (Futaba, Okuma, Tomioka, Naraha, Namie) had to evacuate more than four times [NAIIC2012].

Indian guidelines do not contain any recommendation about the distance of the sheltering place, but the ones selected in the Manual on Emergency Preparedness of the Kalpakkam or Kaiga DAE Centres [DAE2011] seem to be far enough from the plant.

On the contrary, in France, new emergency plan stipulates that the shelter should be far enough to avoid any other protection measure [SGDSN2014] although many local emergency plans select shelters at about 20km from the NPP. See e.g. [PM2008].

Shelter capacities are one of the key successes of the evacuation process. Around Madras NPP, the total shelter capacity of the rallying post is 176 600 for a population of 210 000 persons. Some of these posts don't have electricity although they should accommodate thousands of people each. Around Kaiga, less populated, situation is better, but the number of place is still lower than the total population within 16 km [DAE2011]. Nothing is said about the fate of the people who cannot be sheltered. Are they supposed to find an accommodation on their own?

As pointed out by the NDMA, "the population density in shelters/camps meant for a trans-located population will be very high. Many persons in shelters will have varying degrees of sickness due to radiation exposure, secondary infections, shortage of power, water and medicines. The sanitary and public health facilities will be in total disarray resulting in repeated outbreaks of waterborne and vector-borne diseases. Temporary shelters housing the trans-located population, even those in case of natural disasters, call for good hygiene practices for maintaining proper sanitation. Accordingly, this particular aspect has to be assigned due care in the planning of temporary shelters" [NDMA2009]. But, the Manuals on Emergency Preparedness of the DAE Centres [DAE2011] do not contain any information about this crucial aspect. This is particularly problematic for people who need special care.

"Another important requirement is to identify alternate sources of food, water and also to provide proper hygiene facilities. Because of the assembly of a large number of persons at the emergency shelters, poor hygiene facilities may lead to the spread of diseases, including epidemics. Thus, in addition to providing good hygiene facilities, good medical care with adequate stock of medicines, will be made available in all areas of possible nuclear emergencies/disasters" [NDMA2009].

3.4.3. Evacuation of Vulnerable People

Evacuation of vulnerable people, especially bedridden people in hospitals was probably the most dramatic aspect of the evacuation during the nuclear disaster in Japan. About 45 of the 440 patients of the Futaba hospital and the nearby nursing home for the elderly died [GPI2012]. Elderly people who need special care are also in danger in case of evacuation.

In Japan, a recent study investigated evacuation-related mortality risks among elderly people from five nursing homes in Minamisoma city, Fukushima Prefecture. Mortality risk was 2.68 higher after the accident than before. Authors conclude that "high mortality, due to initial evacuation, suggests that evacuation of the elderly was not the best life-saving strategy for the Fukushima nuclear disaster. Careful consideration of the relative risks of radiation exposure and the risks and benefits of evacuation is essential. Facility-specific disaster response strategies, including in-site relief and care, may have a strong influence on survival. Where evacuation is necessary, careful planning and coordination with other nursing homes, evacuation sites and government disaster agencies is essential to reduce the risk of mortality[18]."

Japanese NAIIC insists "that it is essential to prepare new countermeasures, utilizing lessons learned from the accident, in order to prevent future situations in which hospitalized patients who are unable to evacuate under their own power during a disaster are left behind, resulting in many deaths. It is necessary for prefectures (including Fukushima Prefecture) and municipalities where nuclear plants are located, and for medical institutions in the vicinity of nuclear plants, to consider and develop revisions of their nuclear disaster response manuals, disaster prevention drills, means of communication, coalitions with other municipalities in case of an accident, and so on, in order to better provide evacuation assistance to hospitalized patients in the case of a disaster" [NAIIC2012].

As a consequence, new Japanese guidelines recommend: "The triage system to set priority for carry of patients and the carry system to enable to start a curative treatment in 60 minutes in nuclear accident should be arranged in preparation for the occurrence of severely injured patients.
Taking into consideration hospitalized patients or person requiring support in welfare institutes or large amounts of injuries in disaster, ways to carry and provision of medical care for large amounts of patients when nuclear accident occurred should be reviewed and prepared. For preparation of carry of many patients, arrangements of securement of root and acceptance, preparation of carrying means, attendance of medical staffs, screening, and other pertinent matters are necessary. Securement of exclusive personnel for arrangements of carry of patients is recommended. Collaboration with medical institutions at nearby prefectures should be promoted for medical care in nuclear disaster.
For hospitalized patients and elderly people, it may be inappropriate to evacuate quickly and temporally sheltering in institutions may be a suitable measure for radiation protection until receiving institutions designated, because of health risk associated with carry of patients" [NRA2012].

This point is not taken into consideration in Indian guidelines. Probably because evacuation is only considered in the near field of NPP where

[18] Nomura S, Gilmour S, Tsubokura M, Yoneoka D, Sugimoto A, et al. (2013) Mortality Risk amongst Nursing Home Residents Evacuated after the Fukushima Nuclear Accident: A Retrospective Cohort Study. PLoS ONE 8(3): e60192 http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0060192

there is no hospital. But as we already stressed several times, Indian authorities should take into account the fact that they might have to evacuated population living beyond near field as it was the case around Chernobyl and Fukushima NPPs.

Such a change of paradigm for people at risk in case of evacuation is one of the lessons from the Japanese nuclear disaster, but it means that medical staff and caregivers remain. They need a special status, protection and training in addition to access to measurement tools to evaluate the situation on their own.

US NRC guidance emphasizes the importance of verifying the committed resources, such as buses and ambulances, required to support evacuation of the transit dependent and school populations, as well as people with disabilities and those with access and functional needs. Special facility residents are those who reside in special facilities and are dependent upon facility personnel for transportation in an emergency. This includes, but is not limited to, hospitals, nursing homes, jails, and prisons. Special facility personnel are counted in the special facility population group [USNRC2011a].

3.4.4. Evacuation Time Estimate

US regulator request an evacuation time estimate (ETE) that is a calculation of the time to evacuate the plume exposure pathway emergency planning zone [USNRC2011a]. Research shows that a small percentage of the public, about 10%, takes a longer time to evacuate. Therefore, the time to evacuate 90% and 100% of the population should be provided in the ETE study.

This guidance document details the process for the development of ETEs for four population segments including:

- Permanent residents and transient population;
- Transit dependent permanent residents;
- Special facility residents (e.g., hospitals, prisons, nursing homes, etc.); and
- School populations.

State and local emergency response plans typically include early protective actions for evacuation of schools prior to the general public if time allows. However, the development of ETEs should consider that school evacuations begin with the same initial notification provided to the general public. Schools present a unique issue with the expectation that some students may be picked up by parents, relatives, or friends which may reduce the student population requiring bus transportation.

Special events like festivals or sporting events occur within most EPZs and can attract large numbers of transients to the EPZ for short periods of time. To avoid double-counting transients and permanent residents, it is recommended to indicate the percentage of permanent residents of the EPZ assumed to be at special events.

Scenarios include season, day of the week, time of day, weather conditions, special events, roadway impact, or other circumstances that should be assessed. The adverse weather condition is intended to represent weather conditions that are probable within the region. It is not necessary to evaluate those adverse weather conditions that may occur at frequencies of 100 years or longer.

The Evacuation Time Estimate of Indian Point NPP has 400 pages[19].

After the 2011 nuclear disaster, Japan has also adopted Evacuation Time Estimate. A research[20] conducted by Kankyo Keizai Kenkyujo (research institute on environmental economics), a private group, found that at least 8 hours would be needed for everyone living within a radius of 30 kilometres from nuclear power plants to evacuate in the event of a nuclear accident. The research was also based on the assumption that 30% of registered buses and 50% of registered privately owned cars in each of those municipalities would be used for evacuation. The study was also based on the assumption that all of the residents in a given area would start moving simultaneously to evacuate, and traffic-engineering techniques, which take into account such factors as traffic jams, were employed for the analysis. The research dealt with two different scenarios for calculations: cases in which only national highways can be used because of disaster-inflicted damage or emergency vehicles taking other routes; and cases in which all of the routes including national highways, expressways and other major local roads can be used.

[19] http://www.lohud.com/assets/pdf/BH200923215.PDF
[20] Mainichi Japan, 12 hours needed for people within 30-km radius of nuclear plants to evacuate: study, 14th of January 2014 http://mainichi.jp/english/english/newsselect/news/20140114p2a00m0na010000c.html

The shortest evacuation time assuming that expressways and other roads can be used, is estimated to eight hours for residents near the Ôi Nuclear Power Plant in Fukui Prefecture. Nearly six days are estimated to be necessary for residents near the Hamaoka Nuclear Power Station in cases where only national highways are used for evacuation. About 740 000 people are living within a 30-kilometer radius with a limited number of roads available.

Local authorities also have to evaluate the evacuation time. Shizuoka Prefecture decided to map an evacuation plan for residents living within a 31-km radius from the Hamaoka nuclear plant[21] The population in the area is the second largest among areas of the same size surrounding nuclear plants across Japan. In the prefecture's simulation, the 860 0000 residents try to leave in 280 000 cars--one for each household--when roads in coastal areas are wiped out by a tsunami. The simulation considered 12 scenarios, including whether or not prefectural officials regulate traffic, and estimated the amount of time residents need to evacuate outside the area for each case.

The shortest-time scenario is 32 hours and 25 minutes, in which all 280 000 residents evacuate immediately after the disaster unfurls. The longest of the 12 scenarios would take 46 hours and 15 minutes. In this case, the prefecture would instruct residents to stay at home or in other buildings when traffic jams are expected. These evacuation times are far shorter than the longest case of the private study group. Such a disagreement reveals the necessity to have clear rule for ETE.

Depending on the scenario, evacuees would be stuck in their cars for 8 hours if traffic is regulated and up to almost 31 hours, the longest time among the 12 scenarios, in case of major traffic jams everywhere. Remaining in vehicles could pose a higher risk of radiation exposure than staying inside buildings. As a consequence, optimum scenario is not necessarily the shortest one, but the one that leads to the smallest exposure. Such estimations should be handed to the residents living around nuclear plans to convince them to wait inside buildings for much longer rather than taking off immediately.

In US, ETE only needs to consider an evacuation of the NPP that is the focus of the study whereas in Japan the evaluation takes into account other problems that could hamper the process. On the contrary, US guidelines specify to take into account vulnerable people who cannot evacuate on their own.

French authorities assume that autonomous people will evacuate with their own mean of transportation and that they only have to take in charge dependent people in the need. ETE is not required in France.

NDMA explains that "SDMAs and DDMAs will assess the transport needs for evacuation, including those for the emergency response personnel. Identifying and ensuring the availability of access routes and transportation vehicles for evacuation of the affected population are to be ensured as part of the preparedness programme in an all-hazards approach, in consultation with all the stakeholders including DAE. This may require identification and improvement of roads, in addition to carrying out regular repairs of the existing ones, to ensure that the mechanism is in place to mobilise the required number of transport vehicles" [NDMA2009].

In India, buses will be used in case of massive evacuation. Manuals on emergency preparedness list the number of buses needed to evacuate the entire population within 16 km. For the Madras NPP, it is estimated that a total of 2 957 buses would be necessary, "more than 600 numbers of buses are operated by Tamil Nadu State Transport Corporation from Depots in the vicinity of Kalpakkam" [DAE2011]. This means that about 5 rotations per bus would be necessary to evacuate the whole population of the EPZ. How much time would it take? Where will the people remain in the mean time? Who will be evacuated in priority? None of these questions are addressed in the manuals. In Rajasthan, the emergency manual suggests that "preferential evacuation of critical groups like children & women of reproductive age would desirable" [DAE2010]. For Kaiga NPP, the number of available buses seems to be large enough [DAE2011].

There is a clear need to evaluate the time required to evacuate the area around each NPP taking into account population that may need help in evacuation as well as other disasters that could hamper the process.

[21] Asahi, Study: Up to 46 hours needed to flee Hamaoka nuclear plant accident, 24th of April 2014. http://ajw.asahi.com/article/behind_news/social_affairs/AJ201404240069

3.4.5. Shadow Evacuation

US NRC guidance also establishes the need to include a 20% shadow evacuation in the analysis of evacuation time estimates. A shadow evacuation is defined as an evacuation of people from areas outside an officially declared evacuation zone. The shadow population is considered in the analysis to account for any effect of this population group impeding the evacuation of those under evacuation orders.

Population estimates for the shadow evacuation in the 10 to 15 mile (16 to 24 km) area beyond the EPZ should be provided by sector [USNRC2011a].

To better inform radiological emergency preparedness efforts, US Government Accountability Office (GAO) recommends that NRC obtain information on public awareness and likely public response outside the 10-mile zone, and incorporate insights into guidance, as appropriate. NRC generally disagreed with GAO's finding, stating that its research shows public response outside the zone would generally have no significant impact on evacuations. Nevertheless, GAO continues to believe that its recommendation could improve radiological emergency preparedness efforts and is consistent with NRC guidance [GAO2013].

The experience of Three-Mile-Island should to be kept in mind. On the 30th of March 1979 the governor of Pennsylvania advised all pre-school aged children and pregnant women to evacuate a 5-mile (8 km) radius around TMI, everyone else within the 10-mile (16 km) EPZ was told to stay indoors. Of this portion of the population, only 3 500 people were expected to evacuate. However, it was estimated that 200 000 people within a larger 25-mile (40 km) radius chose to evacuate. Approximately 663 500 people were at risk within 20 miles (32 km) of TMI[22].

Indian authorities should take into account shadow evacuation in their assessment of EP&R.

[22] J.H. Johnson and D.J. Zeigler, Socio-Economic Planning Science 20 (1986) 165; Susan Cutter and Kent Barnes, Disasters 6 (1982) 116 http://desastres.unanleon.edu.ni/pdf/2003/agosto/PDF/ENG/DOC540/doc540-contenido.pdf

3.4.6. Evacuation of Livestock

For many herders, it is hardly conceivable to abandon the livestock. In Japan, some them refused to evacuate. Others were going back to the evacuated zone to feed the animals or milk them. But it was not always possible. Many livestock died. Others were released into the wild where they still roam. Some herders could not stand it and committed suicide. This issue is hardly addressed in emergency plans in any country.

In India, there is a clear strategy. Details on resources necessary to feed the animals are listed. In Rajasthan, livestock "will be driven to identified lake or reverted areas of poramboke lands in region of temporary shelters. Cattle be housed wherever grazing areas are available and in identified forest lands if required" [DAE2010]. Emergency manual of the Madras NPP states: "This Action Plan set out the programme of evacuation of livestock from the affected villages to safer areas in the Rallying Posts. The detailed consideration of the various possibilities indicates that the safe and sure method of transport of livestock out of EPZ would be to walk them to the Rallying Posts. The livestock can be expected to cover a distance of about 5 to 6 Km. in one hour and most of the rallying posts are within a few hours from the sectors concerned. The choice of cross country routes would minimise the distance to be walked and the time needed for evacuation. The available bullock carts in the villages can also be used for the transportation of sheep, goats and poultry. The operations for evacuation of livestock are proposed to be initiated after the transportation of the human population out the affected sectors is completed. However it would be preferable to transport the livestock along with the human population which is dependent on the livestock" [DAE2011]. But, no evaluation of the potential exposure doses of the persons evacuating the livestock is done. Nothing is said about their protection. Will they receive iodine prophylaxis, facial masks, dosimeters…?

3.5. Foodstuff and Water

The most important issue for preventing or reducing the internal exposure of the residents in the medium to long term is how to prevent the ingestion of food contaminated with radioactive materials. Therefore, authorities should introduce food restrictions and shipping regulations.

No specific strategy is outlined in the Indian guidelines regarding food and water monitoring. US introduced a 50-Mile (80 km) Ingestion Exposure Pathway Emergency Planning Zone where the principal health risk is expected to be exposure from ingesting contaminated water or foodstuffs.

In France, Post-Accidental Policy specifies that within the heightened territorial surveillance zone, all locally-produced foodstuffs are to be prohibited initially, and recommendations issued to limit the consumption of self-produced foodstuffs or products derived from hunting, fishing or gathering. As soon as materially possible, the radiological verification systems appropriate to each farming production sector will be instituted in order to allow compliant products to be placed on the market. The consumption of drinking water from the public adduction grid will continue to be allowed, except where specific resources and facilities identified during the preparedness stage have proved vulnerable, in which case tap water consumption may be restricted, in particular for infants, small children and expectant mothers. Tap water usually comes from underground resources in France [CODIRPA2012].

Japan adopted the opposite strategy during the 2011 nuclear disaster. Food restrictions were only introduced when measurements showed that some items were more contaminated than allowed. As all the food cannot be quickly monitored, such an approach led to many failures. As a consequence, citizens began to distrust the safety of food for a number of reasons. Till now many consumers avoid agriculture products from Fukushima.

International recommendations about concentration of radionucleides in foodstuff are given in the Codex Alimentarus of the Food and Agriculture Organisation (FAO) and World Health Organisation (WHO) [CODEX1995]. The Guideline Levels apply to radionuclides contained in foods destined for human consumption and traded internationally, which have been contaminated following a nuclear or radiological emergency. These guideline levels apply to food after reconstitution or as prepared for consumption, i.e., not to dried or concentrated foods, and are based on an intervention exemption level of 1 mSv in a year.

Let's only consider radioactive cesium and iodine for comparison. Note that AERB does not consider tritium although heavy water reactors produce large quantities of this element [AERB1999]. It should be included in the national guidelines.

The Guideline Level of the Codex Alimentarus for cesium is 1 000 Bq/kg for both infant and other foodstuffs. It is 100 Bq/kg for radioactive iodine, whatever the type of food.

In US there are Derived Intervention Levels that refer to the concentration of radioactive contamination present in food which, if ingested at this level over a specified time, may result in the individual receiving a projected dose equal to the Protective Action Guides currently fixed at 5 mSv for committed effective dose equivalent. For all components of the diet, Food and Drug Administration (FDA) Derived Intervention Level is 1 200 Bq/kg for both Cs-134 + Cs-137. There are also Levels of concern (LOCS) for radionuclide activity concentration in imported food fixed at 370 Bq/kg for both cesium. Regarding radioactive iodine, the limit is 170 Bq/kg [FDA2004].

France adopted European standards EURATOM n°3954/87 fixed after Chernobyl disaster with maximum permitted levels for radiocesium in foodstuffs of 1 000 Bq/kg for dairy products and 1 250 Bq/kg for other foodstuffs, except minor foodstuffs. It is 400 Bq/kg for baby food and 12 500 Bq/kg for less important food [SGDSN2014].

Japan, soon after Fukushima disaster, fixed these levels at 200 Bq/kg for diary products, baby food and 500 Bq/kg for other foodstuffs. New guidelines recommend to adopt the same values in case of nuclear emergency [NRA2012]. These levels were decreased after few months in order to regain the confidence of consumers.

Indian AERB considers a radiological parameter in case of contamination with radiocesium for initiating the countermeasures that range between 8 000 Bq/kg in meat to 90 000 Bq/kg in fruits and vegetables from domain 2. Values differ in domain 3. Maximum permitted levels can reach 200 000 Bq/kg in domain 2 for the sum of both cesium [AERB1999]. In addition to the intervention levels, the action levels that will be needed to control the consumption of contaminated food items in the affected areas is another issue. These values are presently not available either for an RDD or a nuclear disaster and are needed to be generated because these are essential in respect of both:

(i) the members of the relief and rescue teams, and

(ii) the public [NDMA2009].

All these values are compiled in Table 2 below.

Table 2: Maximum permitted levels of radioactive contamination of food

		BABY FOOD	DAIRY PRODUCTS	OTHER FOOD	LESS IMPORTANT FOOD
Codex	IODINE	100 Bq/kg			
	CESIUM	1000 Bq/kg			
India Domain 2	IODINE		2 000 Bq/kg (milk)	9 000 Bq/kg (cereals)	
	CESIUM		35 000 Bq/kg (milk)	5 500 Bq/kg (cereals)	
	IODINE		30 000 Bq/kg (dairy)	15 000 Bq/kg (fruits)	
	CESIUM		200 000 Bq/kg (dairy)	90 000 Bq/kg (fruits)	
India Domain 3	IODINE		1 300 Bq/kg (milk)	6 000 Bq/kg (cereals)	
	CESIUM		7 000 Bq/kg (milk)	1 100 Bq/kg (cereals)	
	IODINE		20 000 Bq/kg (dairy)	10 000 Bq/kg (fruits)	
	CESIUM		40 000 Bq/kg (dairy)	18 000 Bq/kg (fruits)	
US	IODINE	170 Bq/kg			
	CESIUM	1 200 Bq/kg			
EU	IODINE	150 Bq/kg	500 Bq/kg	2 000 Bq/kg	20 000 Bq/kg
	CESIUM	400 Bq/kg	1 000 Bq/kg	1 250 Bq/kg	12 500 Bq/kg
Japan	IODINE	100 Bq/kg	300 Bq/kg	2 000 Bq/kg	
	CESIUM	200 Bq/kg	200 Bq/kg	500 Bq/kg	

Indian values are far too high compared to international standards. As a comparison, organic matter with more than 8 000 Bq/kg of cesium is considered as radioactive waste in Japan. In Europe, the limit fixed by Euratom is 10 000 Bq/kg for each cesium. How to explain to the population that the allowed food would be considered as radioactive waste elsewhere? In case of emergency, population will require the adoption of the most stringent standards that were used in Japan.

After the Fukushima disaster, Europe adopted Japanese standards for imported foodstuffs. It contrasts with the situation after Chernobyl disaster, when Belorussia decreased the maximum permitted levels. Europe didn't change its regulation. French guidelines specify that Euratom levels should be adopted within 24 hours after the disaster for a period no longer than 3 months. Europe will have the duty to define new maximum permitted levels within this period taking into consideration specificities of the accident [SGSDN2014].

In Canada, "action levels for food and water are based on an intervention level of 1 millisievert (mSv) applied independently to each of three food groups, assuming that the intervention is completely effective at averting dose." The sum makes a potential of 3 mSv. Note that "in the derivation of action levels, it is assumed that contaminated foods comprise no more than 20% of an individual's annual intake of Other Commercial Foods and Beverages. The remainder consists of food unaffected by the emergency. For consumption of Fresh Liquid Milk and Public Drinking Water, which are generally drawn from local sources, it is assumed that the intake consists entirely of contaminated supplies" [HC2000]. Indian authorities should also justify the maximum permitted levels and discuss them with stakeholders.

In Europe and US, fixed maximum permitted levels are based on the assumption that 10% of the food consumed annually is contaminated. This is not realistic for populations living near the affected areas. As a consequence, French post-accidental policy introduced the delimitation of territories were such levels cannot be applied and the global dose will be used instead [SGSDN2014].

European parliament has recently introduced an amendment to the European legislation requiring that "practices which consist of blending foodstuffs containing concentrations above those permitted by the rules on maximum permitted levels of radioactive contamination in food and feed with uncontaminated or mildly contaminated foodstuffs, so as to obtain a product that complies with these rules, shall not be authorised" [EP2015].

Finally, Japanese experience has shown that citizens quickly started to monitor food on their own, and fix their own reference levels.

Indian authorities should elaborate a strategy about foodstuff and water and adopt more stringent standards limited in time and space.

3.6. Tools and Manpower

Nearly 600 000 people received certificates from Ukrainian, Russian and Belarusian government confirming their role as liquidators during the Chernobyl nuclear accident (UNSCEAR2006). Of course, Chernobyl accident occurred 25 years before Fukushima accident. In comparison with Chernobyl nuclear accident, the manpower used to contain Fukushima nuclear accident was much less. It went down to about 50 workers after hydrogene explosions; they came to be known as Fukushima 50. Of course, eventually the number increased to over 1000 plant and emergency workers. However, it is important to note that this figure only reflects the number of people working at the nuclear plant, there were many others engaged in evacuation, maintaining the shelters, as well as monitoring radiation exposure.

Specialised skills are required to perform each role efficiently. For example, the person responsible for maintaining the shelter would need to understand the importance of maintaining hygiene and preventing any breakout of epidemic. Similarly, a radiation safety expert would need to know how to measure radioactive contamination accurately. While travelling through few cities in Fukushima prefecture, one can always spot an unmanned and automated radiation detection station installed. These stations provide a way to continuously monitor radiation levels. In India, it is difficult to find a shop that sells a basic handheld Geiger counter to measure radiation levels.

There are no independent organisations that are equipped to support the nuclear regulator or the operator in radiation monitoring in India. It is always a team from government controlled organisation that is entrusted with radiation monitoring. Such control over radiation monitoring might not only hamper emergency preparedness and disaster management work but also lead to confusion and loss of trust. Therefore measurement tools and skilled manpower are the two most important factors that need to be included in the emergency plans.

3.6.1. Measurement Tools

Indian authorities recognize that "to handle a nuclear emergency, including a large-scale nuclear disaster, a large number of radiation detection/monitoring instruments and personal protective gear are needed.

Presently, outside the DAE/DRDO establishments, there is hardly any inventory of these units. Even in DAE establishments, the total numbers may just about suffice for an off-site emergency condition from nuclear power plants but not for any large-scale disaster. The non-availability of the required instruments/protective gear in large volumes as well as trained manpower will severely hamper the capability to effectively handle any nuclear emergency/disaster scenario" [NDMA2009].

In Europe, Article 35 of the Euratom Treaty[23] stipulates that "each Member State shall establish the facilities necessary to carry out continuous

[23] http://ec.europa.eu/energy/nuclear/radiation_protection/article35/article_35_en.htm

monitoring of the level of radioactivity in the air, water and soil, and to ensure compliance with the basic standards." This article also asserts that "the Commission shall have the right of access to such facilities; it may verify their operation and efficiency." To our knowledge there is no requirement about a minimal number of detection and monitoring instruments and trained personal. This matter is hardly addressed in emergency plans.

Necessary tools range from software that can predict the fallouts linked to the meteorology in order to guide the emergency response and several measurement apparatus including helicopter that can do a mapping of the contaminated zones. They all need to be very quickly used and the results transmitted to the relevant persons.

The Japanese government had special software designed to forecast the fallout in case of an accident and in order to help during the decision making process of where to evacuate. The so-called SPEEDI software (System for Prediction of Environment Emergency Dose Information) cost 13bn yen and theoretically can make predictions of up to 79 hours. It didn't have the ability to evaluate the quantity of radioelements that was released – so called 'source term'. It then arbitrarily assumed that the source term was at 1 Becquerel an hour, which leads to indicative results that have nothing to do with reality. This partial information never reached the population that were exposed to the fallouts [GPI2012]. Monitoring posts were disabled by the earthquake. Later, from the environmental radiation monitoring and the graphic data constructed by (SPEEDI) released on March 23, the government knew that residents in some areas outside the 30km radius zone may have been exposed to relatively high doses of radiation. Despite this, the government's Nuclear Emergency Response Headquarters did not react quickly, and evacuation orders were delayed for approximately one month [NAIIC2012].

Therefore, sophisticated apparatus are not enough. Good coordination, organisation and training are also paramount to quickly grasp the situation and take the right decision. On this issue, IAEA's Integrated Regulatory Review Service (IRRS) team notes that at present, the only source of information on the situation at the affected plant is a "proformat fax that contains only very basic information on the plant status, which is insufficient for any type of advanced technical assessment, as well as some environmental readings. Therefore, at present, the AERB is challenged in the performance of its emergency response functions by the lack of information on the plant status and actions by the operator" [IRRS2015]. How to forecast the radioactive fallouts and decide offsite emergency actions in such conditions?

Previous experiences show that authorities are largely discredited during a nuclear disaster. If local communities have the possibility to measure radioactivity on their own, this would help them to decide what to do. We do recommend that Geiger counters are dispatched in several locations of the EPZ and that some municipal employees are trained to use them. Training sessions should be regularly renewed. Location of the apparatus should be decided in agreement with local population.

3.6.2. Manpower and Rescue Persons

Radioprotection of nuclear workers is well regulated even in case of an emergency. This is not the case for the many rescue workers and volunteers who might be exposed to radiations. ICRP note that emergency workers and their roles should be identified in advance. They should have appropriate training sufficient to carry out their emergency role, so that they have sufficient information upon which to base informed consent should that be needed, and so that they can contribute to their own protection. They should also be provided with personal protective equipment, and arrangements should be made to assess any radiation doses received. Considering those implementing early protective actions and taking action to protect the public, ICRP recommends that protection should be consistent with the full system for planned exposure situations where this is feasible [ICRP109].

According to a survey by an association of Fukushima Prefecture hospitals, conducted in late July 2011, hundreds of doctors and nurses have resigned from nearby facilities immediately after the accident. The survey found that 125 full-time doctors had resigned from 24 hospitals in the prefecture, or 12% of all doctors working at those institutions. As for nurses, 407 had quit from 42 hospitals in the prefecture, representing 5% of the nursing staff at those institutions. Their departures have resulted in some hospitals suspending night time emergency care and other treatment services. The survey found that the highest number of doctors left from hospitals in Minami-Soma. Thirteen doctors resigned from four hospitals in the city, including one inside the exclusion zone. The figure represents 46% of the four institutions' total doctors. As for the nurses in Minami-Soma, 44 left their jobs at four hospitals, or 16% of those institutions' total nursing staff. The association assumes most of the doctors and nurses who resigned did so due to their desire to leave the area amid concern about radiation exposure [GPI2012].

Japanese Nuclear Regulation Authority concludes that education to radiation protection and radiation emergency medicine for medical personnel and for students in curriculum or training course of medicine, nursing science and radiation technology should be promoted for better understanding and proper recognition of radiation emergency medicine [NRA2012].

In India, NDMA also notes that "presently, there is no network of hospitals in the country which can handle radiation induced injuries on a large scale. The establishment of such a network is essential for handling nuclear emergencies/disasters. There should also be a dedicated and reliable communication facility among hospitals so that they can pool their resources when required" [NDMA2009].

It adds that "civil defence organisations near existing NPPs are provided training on emergency preparedness. Their volunteers also participate in off-site emergency exercises.

Civil defence is expected to play a significant role in future nuclear emergency/disaster scenarios arising from facilities other than NPPs.

Civil defence personnel are normally trained in handling natural calamities. Therefore, selected civil defence personnel will be trained extensively in the subjects of radiation, radioactivity, radiation protection, use of monitoring instruments, use of protective gear, shielding, decontamination, waste disposal, etc" [NDMA2009].

Regarding safety authorities, IAEA's IRRS team "expressed concerns regarding the absence of dedicated full-time specialists. A total of 8 to 12 staff assigning 20-30% of their time are dedicated to the area of EPR. The organisational chart shows an emergency preparedness unit and an emergency preparedness coordinator, but the IRRS team was informed that these are functions that do not require full-time positions. The IRRS team observed that there are no staffs dedicated on a full-time basis to EPR. Although during the mission no other such areas were found, but taking into account the above mentioned assignment of tasks beyond the prime areas of expertise, the IRRS team considers it important that the AERB evaluates across its organisation if there are other important areas where there should be dedicated full-time experts" [IRSS2015]. This could be very problematic in case of accident.

4. Information to Population

4.1 Warning

Immediate warning of the population together with means of communicating relevant information is a prerequisite of any emergency plan. As one mean of communication might be disabled by the disaster redundancy is necessary to reach everybody. This generally includes sirens, automatic calling devises and usual mass media. In Japan a warning system for natural disasters is implemented in most smart phones.

Department of Atomic Energy[24] had categorised nuclear power plant accident and emergencies as on site emergencies and offsite emergencies. On site emergencies are further classified into four categories, i) Emergency Standby, ii) Personnel Emergency, iii) Plant Emergency and iv) Site Emergency. Only in case of Offsite and Site emergency is the local authorities informed of the situation. In case of an Offsite Emergency, the local district authorities assume control over the emergency procedures whereas in other cases, it is the NPCIL and the AERB that is responsible.

Indian NDMA notes that "a reliable communication infrastructure is one of the key elements in any response mechanism. Presently, the DM communication linkage from the district to the state headquarters and then to the national level (including linkages with DAE with regard to a radiation emergency) is neither dedicated nor adequate.

Information should be quickly available even in case of small incident without any consequences outside the plant to avoid panic and undue stress. In US, licensees must notify state/local/tribal agencies within 15 minutes of emergency declaration, and NRC within 60 minutes. Local jurisdictions sound sirens and disseminate emergency alert system messages with appropriate protective action decisions [FEMA2013].

Recently in Germany, a newspaper[25] revealed from internal documents kept secret by authorities[26], that communication problems hampered an emergency drill. Circulation of information between federal and local authorities was too slow. In case of real accident, millions of people would have been exposed to the radioactive fallouts without any protection of the thyroid.

There is a need to strengthen the same at the district and state levels. The creation of a dedicated National Disaster Communication Network (NDCN) is on the anvil at NDMA as a part of the mitigation project. It is an important requirement because public networks like landline telephones and mobile or cellular phones are the first to collapse due to a sudden increase in traffic in the event of an emergency" [NDMA2009].

[24] http://dae.nic.in/?q=node/37
[25] Sebastian Heiser, Protokoll des Super-GAUs: Was am Tag X passiert, Die Tageszeitung, 24th of October 2014 and linked articles. http://blogs.taz.de/rechercheblog/2014/10/24/protokoll-des-super-gaus-was-am-tag-x-passiert/
[26] These documents are published on line by the daily newspaper: http://s3.documentcloud.org/documents/1306783/gau-bund-plus-2.pdf

4.2. What Information?

The content of the messages sent to the population is also a key element in any emergency response. Indian guidelines state that "the information and broadcasting department of the district, in association with an authorised information officer, ensures the smooth flow of information to the media to avoid panic and spreading of rumours." [NDMA2009] Such a goal might leads to the underestimation of the risks, especially at the beginning of the emergency when uncertainties on the disaster are large. In case of worsening scenario, credibility of the authorities will be challenged.

Japanese NAIIC writes in its report: "Detailed accuracy was made a priority, at the expense of quickly getting the information to those who needed it for informed decisions. Mr. Edano, the cabinet secretary, repeatedly stated that there were no immediate health effects from the release of radiation, giving the public a false sense of security. In his statements, however, the necessity and urgency of the evacuations was never adequately explained from the residents' point of view, and the government never followed up with evidence that would support his statements. This caused a great deal of anxiety among the public. Last but not least, the government chose to release information purely from a subjective perspective, rather than reacting to the needs of the public." [NAIIC2012]

The Government of India has identified the Department of Atomic Energy as the nodal agency for providing the necessary technical inputs to the national or local authorities for responding to any nuclear or radiological emergency in the public domain. Crisis Management Group is backed by resource agencies of various units of DAE [NDMA2009]. DAE also administrates Nuclear Power Corporation of India Limited (NPCIL). In case of an emergency at the NPP, this will lead to great confusion to the public.

The credibility of the authorities is necessarily challenged after a nuclear accident. With Internet people can quickly find answers to their own questions independently from the authorities. Social networks played a tremendous role in Japan to dispatch warning and information. Mass media are also keen to ask independent experts their own point of view. Indian communication policy focused on reassuring populations will probably be ineffective in case of an emergency.

On the European level, the Aarhus convention on access to information, public participation in decision-making and access to justice in environmental matters stipulates in its article 5: "In the event of any imminent threat to human health or the environment, whether caused by human activities or due to natural causes, all information which could enable the public to take measures to prevent or mitigate harm arising from the threat and is held by a public authority is disseminated immediately and without delay to members of the public who may be affected." This is a completely different philosophy intended to help the public to take the right decision.

The latest Euratom directive stipulates that "member States shall ensure that, when an emergency occurs, the members of the public actually affected are informed without delay about the facts of the emergency, the steps to be taken and, as appropriate, the health protection measures applicable to these members of the public." [EURATOM2014]

French emergency plan goes further and insists on the fact that communication must also take into account uncertainty that is inherent in any crisis. It must take into account the questions of the population; admit unknowns, failures or difficulties [SGDSN2014]. This is very important to the credibility of the message.

On the contrary to India, French emergency plan states that "communication must be based on a clear separation of roles and responsibilities of each source of information: the operator shall report on the management of the accident. [...] It communicates with the public on actions it implements to manage the accident. The state communicates on crisis management. It gives the evaluated risk and the protective measures to be applied by the population. It can rely on local authorities to inform the public" [SGDSN2014]. Such a clear distinction is necessary for the credibility of the information.

French Nuclear Safety Authorities recognized during the Fukushima disaster that communicating about the accident required a lot of manpower. In case of an accident in France, they would have difficulties to both manage the emergency response and communicate to the same level[27].

When people are highly upset, they often have difficulty hearing, understanding, and remembering information. Research shows the mental stress caused by exposure to real or perceived risks can significantly reduce a person's ability to process information. Consequently, communication during a radiological emergency must be timely, clear, accurate, and frequent. This can best be accomplished by having template radiological risk communication products readily available that can be modified as needed at the time of the event. US authorities have prepared messages that address nearly 400 likely questions and concerns in an emergency and approved in advance, saving valuable time during an event. It is also a good way to ensure that the organisation has consistent messages and speaks with a single voice or with many voices in harmony [USNRC2011b].

Risk communication during a radiological emergency will directly influence events. Poor risk communication can fan emotions and undermine public trust and confidence.

In US, a Joint Information Centre (JIC) integrates incident information and public affairs into a cohesive organisation designed to provide consistent, coordinated, accurate, accessible, and timely information during crisis or incident operations. A single JIC location is preferable, but the system is flexible and adaptable enough to accommodate multiple physical or virtual JIC locations [USDHS2008].

Finally, for large-scale emergencies, there may be international consequences as pointed out by the ICRP. "These may result from: international trade and concerns that produce/trade items may be contaminated; the perceived need for protective measures in other countries and therefore the need to harmonise the response across country borders; and the need for authorities to ensure the safety of their nationals in an affected country and to deal appropriately with people from an affected country crossing their borders. It is important that national authorities ensure effective international communication with authorities, particularly in countries that could be affected in the event of an emergency. There would be advantages in co-ordinating the response as much as possible" [ICRP109 (55)].

Indian authorities should reconsider their communication policy in case of an emergency to be sure that the delivered information meets the demand of the affected or potentially affected population.

[27] Autorité de Sûreté Nucléaire, private communication

4.3. Social Media

The private foundation's investigation report of the Fukushima disaster stresses that "with the flood of information through social media, Japan's public became more confused about the state of the nuclear reactors and their release of radioactive materials. Consequently, the public became more anxious. In newspaper polls conducted in April, one month after the disaster, public opinion showed that nearly 70 percent of the Japanese public considered the government's provision of information and explanations to be inadequate" [IICFNA2014].

"In Japan, the public used social media platforms after the earthquake to communicate and record damage, confirm personal safety, gather information, as well as to express thoughts and opinions. Likewise, those who were affected by the Fukushima Daiichi Nuclear Power Station accident turned to social media for information on safety, refuge, and radiation" [IICFNA2014].

"An underlying problem was the weak state of the government's information transmission system: It lacked staff with close knowledge and understanding of social media. Rather, it employed people with a background in portal sites and used volunteers from advertising companies; but portal sites and advertising largely use one-way communication models, and not real-time two-way communication. The Cabinet's Public Relations Office and IT public relations advisers would not welcome bloggers into their midst until September. As social media flourished, mass media waned" [IICFNA2014].

Then, the report concludes that "with social media, it is often much more important to receive and analyze information, and then communicate to followers, fans, or readers than simply to transmit information. The government needs to construct techniques and system to survey and analyze social media postings. With existing technology, it is already possible to gauge Internet's users search term; such information can help governments know how to respond to the public" [IICFNA2014].

Indian authorities should listen to these recommendations, keeping in mind that social media do not to reach all generations and levels in society.

4.4. Necessity of Good Information Prior to Disaster

The difficulties to communicate during an emergency should lead authorities to well inform the population before the accident. IAEA's Convention on Nuclear Safety requires that "each contracting shall take the appropriate steps to ensure that, insofar as they are likely to be affected by radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response" [IAEA1994]. In India, emergency plans cannot be accessed on Internet. Without access to emergency plans, how can the population be prepared?

European countries (see Belgium[28]and Luxembourg[29]for example) have dedicated Internet sites giving basic information on what to do in case of an emergency in the various languages used in the country.

The U.S. Government Accountability Office considers that "those in the 10-mile zone have been shown to be generally well informed about these emergency preparedness procedures and are likely to follow directions from local and state authorities in the event of a radiological emergency. In contrast, the agencies do not require similar information to be provided to the public outside of the 10-mile zone and have not studied public awareness in this area. Therefore, it is unknown to what extent the public in these areas is aware of these emergency preparedness procedures, and how they would respond in the event of a radiological emergency. Without better information on the public's awareness and potential response in areas outside the 10-mile zone, NRC may not be providing the best planning guidance to licensees and state and local authorities" [GAO2013].

[28] http://www.risquenucleaire.be/
[29] http://www.infocrise.public.lu/fr/index.html

4.5. Lessons from the Kakrapar Accident

The Kakrapar power station (KAPS) consists of two operational PHWRs of 220MW capacity and two under construction PHWRs of 700MW capacity. On 11th of March 2016, nuclear reactor unit one experienced a small loss of coolant accident. The accident caused leakage of heavy water from one of its coolant channels and subsequently resulted in an emergency being declared. According to regulator and the operator, emergency due to loss of coolant accident lasted for 11 days until the leak was located and stopped. During the emergency period, the reactor core was cooled by emergency systems. Regular water was circulated within the reactor to maintain temperature of the plant and occasional venting of pressure was also reported.

The loss of coolant is serious in any nuclear reactor. The exact quantity of the heavy water leakage is not known, as neither the operator nor the regulator has made this information available.

It is worth knowing that the IAEA's IRRS team "toured the KAPS emergency facilities and noted that the Site Emergency Control Centre (used by the Site Emergency Director and his Advisory Group) is located in an office that is not protected against potential hazards and would not be suitable for protracted operation during a severe emergency. The IRRS members were informed that this is consistent at all NPPs and will be corrected once On-Site Emergency Support Centre, planned as a result of the Fukushima accident, is completed for all NPPs" [IRRS2015].

During emergency, all together, the regulator released four statements, the first one on the day of the accident (11th March 2016), the second update after three days gap (14th March 2016), the third update after two days gap (16th March 2016) and the latest update after a gap of six days (22nd March 2016). These updates were made available on their website. All of these updates have been vague assurances that lacked substantial information such as the quantity of heavy water leak, recorded measurements of radiation within the 20km radius from the plant as well as within the reactor building [AERB2016].

It is clear that the lesson we learn from Kakrapar accident is that limiting the flow of information based on different categories of emergency does not help reduce rumours and stress in the immediate vicinity. NPCIL and AERB claimed that within two days of the accident, they managed to survey an area of 20km radius from the plant for levels of radiation. But no data is available. They should be available on line as fast as possible to help population living in the vicinity to grasp the situation.

In case of NPCIL, the company that operates the reactor, the first statement[30] in regards to the accident appeared on their website 5 days later on the 16th of March 2016. It contains no information related to the accident, except claiming that everything was "working as intended" and "normal". Although the site director at Kakrapar nuclear station did release a statement locally on the day of the accident, the statement was released at 16:22, about seven and half hours after the accident. A second statement[31] was uploaded on the 22nd of March 2016, 11 days after the accident.

Media reports suggest that the Kakrapar nuclear accident was classified as plant emergency. The protocols for a 'Plant Emergency' do not require local authorities to be informed. Nevertheless, as close to a million people reside within the 30km radius from the Kakrapar nuclear plant, they would need constant updates in terms of radiation level and the progress made. To receive information with gaps of two days, three days and five days does not allay fears but only adds to stress. Moreover, there is chance that it could lead to unnecessary panic. Therefore, as learning from Kakrapar accident, it is important to provide regular updates as well as involve the local community to build trust. These updates are not only for the ones living in the immediate vicinity of the reactor but also for the media, for the experts, for the government bodies and for the emergency services to be prepared for the worst case scenario. A regulator does not have the right to editorialise, pick and choose, what information should be given to whom.

[30] http://www.npcil.nic.in/pdf/news_16mar2016_02.pdf
[31] http://www.npcil.nic.in/pdf/news_22mar2016_01.pdf

At some time, the emergency will end. When possible, returning to pre-emergency situation should be done in an open and transparent manner, including stakeholders who might want to check on their own the situation.

5. Ending Emergency

Indian emergency preparedness manuals are laconic regarding this issue: "The announcement of the termination of the emergency shall be done only by SED, in consultation with KEC, after ensuring the following conditions have been met.

- The plant is under control and the sources of radiation within the plant have been contained.
- The activity releases from the plant are within the specified limits.
- Off-Site radiation/contamination levels are within the specified limits" [DAE2011,NPCIL2011]

Prepared announcements for terminating emergency do not include the possibility that contamination levels are higher than specified limits neither [NPCIL2001]. What about a situation where levels are not within the specified limits? It is not considered?

For a major accident resulting in the release of radioactive materials, some significant residual contamination of the environment may persist for a long period of time and continue to affect the population for decades. We cannot access some territories 30 years after the nuclear accident at Chernobyl. Food monitoring is still necessary on larger territories. In some parts of Norway, grazing animals are still treated with Prussian blue when they are in mountains in order to decrease the milk contamination within specified limits. ICRP recommends that the management of long-term exposures resulting from emergencies should be treated as an existing exposure situation [ICRP109 (113)].

It adds that "there are no predetermined temporal or geographical boundaries that delineate the transition from an emergency exposure situation to an existing exposure situation. In general, a reference level of the magnitude used in emergency exposure situations will not be acceptable as a long-term benchmark, as these exposure levels are generally unsustainable from social and political standpoints. As such, governments and/or regulatory authorities will, at some point, identify a new reference level for managing the existing exposure situation, typically at the lower end of the range recommended by the Commission of 1–20 mSv/year" [ICPR109 (116)].

Nevertheless, Indian guidelines do not take into account the possibility of a long-term residual contamination. France has recently published Policy Elements for Post-Accident Management in The Event of Nuclear Accident [CODIRPA2012]. It is currently limited to a small-scale accident, but new policy for severe accidents in under preparation.

Transition between emergency and existing situation phases is difficult as it appears in Japan. Reference levels expressed in effective doses shall be set in the range of 1 to 20 mSv per year for existing exposure situations and 20 to 100 mSv (acute or annual) for emergency exposure situations. Transition between 20 mSv to 1 mSv might take time with radioelements like cesium 137 with a half-life of 30 years. Decontamination of large areas proved to be ineffective. How to do the transition?

ICRP explains that "national authorities may take into account the prevailing circumstances, and also take advantage of the timing of the overall rehabilitation programme to adopt intermediate reference levels to improve the situation progressively" [ICRP111 (o)].

Presently, Japan has no calendar for such a transition. The return policy of the population in evacuated zones is still based on an annual limit of 20 mSv. Population, especially with young children, are reluctant to go back to their home. Actually, if the return level were fixed to a lower value, non-evacuated people would not understand and feel abandoned [ACRO2016b].

Anand Grover, Special Rapporteur to UN Human Rights Council, notes that "ICRP recommendations are based on the principle of optimisation and justification, according to which all actions of the Government should be based on maximizing good over harm. Such a risk-benefit analysis is not in consonance with the right to health framework, as it gives precedence to collective interests over individual rights. Under the right to health, the right of every individual has to be protected. Moreover, such decisions, which have a long-term impact on the physical and mental health of people, should be taken with their active, direct and effective participation." He adds: "As the possibility of adverse health effects exists in low-dose radiation, evacuees should be recommended to return only when the radiation dose has been reduced as far as possible and to levels below 1 mSv/year. In the meantime, the Government should continue providing financial support and subsidies to all evacuees so that they can make a voluntary decision to return to their homes or remain evacuated" [HRC2013].

Transition should be democratically discussed with stakeholders and the civil society. People should also have the opportunity to choose whether they want to come back or not without any discrimination. As the European research group EURANOS explains, "for some people, it may be preferable to stay away from the area until all decontamination measures have been carried out. For others, it may be more important to return home in the knowledge that some remedial work may be necessary at a later date. In this way the social and psychological needs of individuals can be met and excessive levels of stress avoided" [EURANOS2008].

United Nations state that internally displaced persons (IDP) are persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, as a result of various causes including "natural or human-made disasters, and who have not crossed an internationally recognized State border". Evacuated persons from the contaminated places by the nuclear accident enter into this category and should benefit from the rights guaranteed by the Guiding Principles on Internal Displacement [UNESC1998].

In particular, "competent authorities have the primary duty and responsibility to establish conditions, as well as provide the means, which allow internally displaced persons to return voluntarily, in safety and with dignity, to their homes or places of habitual residence, or to resettle voluntarily in another part of the country. Such authorities shall endeavour to facilitate the reintegration of returned or resettled internally displaced persons." They add that "internally displaced persons have the right to be protected against forcible return to or resettlement in any place where their life, safety, liberty and/or health would be at risk" and that "special efforts should be made to ensure the full participation of internally displaced persons in the planning and management of their return or resettlement and reintegration" [UNESC1998]. This is definitively not the case in Japan, leading to a lot of suffering of displaced persons [ACRO2016b].

In contrast, U.S. guidelines require relocation when people may be exposed to 20 millisieverts or more of radiation in the first year and 5 millisieverts or below from the second year. The long-term objectives are to keep doses at or below 50 mSv in 50 years. The relocation protective action guide addresses post-plume external exposure to deposited radioactive materials and inhalation of re-suspended radioactive materials that were initially deposited on the ground or other surfaces [USEPA1992, FEMA2013].

Recalling that "displacement nearly always generates conditions of severe hardship and suffering for the affected populations", these Guiding Principles on Internal Displacement provide them guaranties.

Indian authorities should define their post-accidental policy taking into account international standards on Human rights.

6. Engagement with Stakeholders

During emergency there is no time to discuss with the stakeholders about the measures decided to protect the populations. This should be done before as recommended by ICRP: "During planning, it is essential that the plan is discussed, to the extent practicable, with relevant stakeholders, including other authorities, responders, the public, etc. Otherwise, it will be difficult to implement the plan effectively during the response. The overall protection strategy and its constituent individual protective measures should have been worked through with all those potentially exposed or affected, so that time and resources do not need to be expended during the emergency exposure situation itself in persuading people that this is the optimum response. Such engagement will assist the emergency plans by not being focused solely on the protection of those at greatest risk early in an emergency exposure situation" [ICRP109 (54)].

The main statement of the Indian NDMA is particularly relevant: "Since all emergencies are initially local in nature, the implementation of DM programmes through a holistic approach begins at the community level. While individuals are responsible for the safety, preparedness and well-being of themselves and their families, the community, along with its private sector and volunteer organisation partners like NGOs and CBOs will be involved in a proactive manner to develop and implement the DM programme tailored to the local needs. The community based approach will, in addition to ensuring a sense of ownership and clear understanding of the mutual responsibility, build confidence and generate self-help capacities particularly with respect to vulnerable and marginalised groups like women, the elderly and physically challenged people. In many cases, the response capability of the community (i.e., fire, police, medical, civil defence, public works, etc.) will be sufficient to deal with routine incidents. Therefore, the community is the key player as well as the major beneficiary of the DM process on a sustainable basis" [NDMA2009].

But NDMA repeatedly claims that "despite the initiatives taken at various levels to allay apprehensions about radiation and the nuclear energy programme, presently the public perception of the possible adverse affect of any nuclear/radiological accident is far detached from the ground reality." Or says that "most people perceive that any small nuclear/radiation-related incident will lead to a situation like Hiroshima or Nagasaki, or the Chernobyl accident" [NDMA2009].

This arrogant standpoint ignores the basic knowledge of local population concerning problems that authorities might face in case of emergency. They have many questions that need to be addressed before the accident.

Indian guidelines miss this key point and their strategy is reduced to educate the population about the beneficial aspects of nuclear radiation and to remove their misgivings about it. "Once people are sensitised about this subject, it will help in removing prejudices/misconceptions of the general public about nuclear radiation/programmes and they will treat a nuclear/ radiological emergency like any other type of natural or man-made emergency" [NDMA2009].

The aim of the NDMA is clear: "Once a community becomes familiar with the beneficial aspects of nuclear energy and the capability of nuclear facility operators in India to handle the hazards, their anxiety and fear towards the nuclear energy programme, in general, and nuclear accidents, in particular, will reduce considerably" [NMDA2009].

We cannot overemphasize that the main goal of consulting the stakeholder in general and the civil society in particular is to adapt emergency response plans to their needs and constrains. European EURANOS group also stresses that "stakeholders need to be involved at the planning stage to help determine appropriate reference levels for emergency exposure situations and trigger levels for the implementation of emergency countermeasures." [EURANOS2008]. In France the new national guidelines were not discussed with the civil society. But the new local response plans are submitted to the so-called Local Information Committee (LIC) in which labour unions, environmental organisations, and experts participate together with local assembly members.

Setting of LIC for each nuclear facility was obligated by the Act on nuclear safety and transparency in 2006. At least twice per year, these LICs organise hearing on the business activities from operators and on the regulatory activities from the French Nuclear Safety Authority. They can ask them any questions concerning safety and operators must answer the question within 8 days. They can also conduct monitoring of the environment by delegating to, or cooperating with specialized organisations. In case of trouble, operators have to transmit the information immediately and the LIC shares it with its members by email. Later on, they can conduct unique investigation if needed in the case of leakage of radioactive materials. Note that LICs have no authority over nuclear facility operations as they have no approval right, but Nuclear Safety Authority's consultation with LICs is mandated.

It is also very important to keep in mind that a severe nuclear accident will necessarily challenge the credibility of the authorities. In Japan, even the Prime Minister lacked of confidence towards the diagnostic of its relevant administration during the emergency phase of the nuclear disaster.

In addition to EP&R plans discussed and accepted by all stakeholders, it might be very useful that some relevant people in close contact with communities are equipped and trained to do radioactivity measurements in order to directly show the result of the affected population and answer to their questions. Such a programme means regular training.

In Japan, emergency planning was not discussed with the population to avoid scaring them. Previous safety authorities were also more interested in promoting nuclear energy and were afraid that Japanese might be more reluctant. Now, all emergency plans are put online to be openly discussed with stakeholders including the civil society.

Engagement with the stakeholders is crucial to emergency planning. This should be done in the spirit of a real dialogue, each part bringing its own contribution and knowledge. Indian authorities should implement the system of instituting Local Information Committees around each nuclear installation. This should be incorporated through legislation and through a parliamentary process.

7. Conflict of interest

NDMA explains: "The Government of India has identified DAE as the nodal agency for providing the necessary technical inputs to the national or local authorities for responding to any nuclear or radiological emergency in the public domain. [...] CMG is backed by resource agencies of various units of DAE.

These resource agencies are expected to provide advice and assistance in the areas of radiation protection and measurement, medical assistance to persons exposed to high radiation doses, communication support, seismological inputs and help in the dissemination of information to the public." It adds that "the 'Intervention Levels' of radiation dose for various actions by the members of rescue and relief teams and the 'Action Levels' to control the consumption of contaminated food items in the effected areas are needed to be generated by the experts from DAE and AERB" [NDMA2009].

But, the Department of Atomic Energy (DAE) administers the Nuclear Power Corporation of India Limited (NPCIL) operating commercial NPPs. There is a flagrant conflict of interest for DAE: protection of the population versus protection of the economical interests of nuclear industry. This will lead to great confusion and inappropriate measures.

An independent body should enforce nuclear safety and radiological protection, as it is the case in most countries. Such a requirement is not new. IAEA's Convention on Nuclear Safety of 1994 recommended that "each contracting party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilization of nuclear energy" [IAEA1994]. More than 20 years later, it is still not the case in India. Therefore, it is not a surprise that IAEA's Integrated Regulatory Review Service (IRRS) team recommends that Indian Government should embed the AERB's regulatory independence in law, separated from other entities having responsibilities or interests that could unduly influence its decision-making. It also notes that the AERB should develop and implement its own internal emergency arrangements including detailed procedures to fulfil its emergency response role [IRRS2015].

The Nuclear Energy Agency of OECD also stresses that in order to ensure that the regulatory body is effectively independent from undue influence in its decision-making; several elements are of utmost importance. These elements include: Political independence, financial independence and technical independence [NEA2014].

On this issue, the Fukushima Nuclear Accident Independent Investigation Commission of the National Diet of Japan [IICANPS2012] stresses: "The TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties. They effectively betrayed the nation's right to be safe from nuclear accidents. Therefore, we conclude that the accident was clearly "manmade." We believe that the root causes were the organisational and regulatory systems that supported faulty rationales for decisions and actions, rather than issues relating to the competency of any specific individual."

Then, the recommendation 5 of the final report regarding "criteria for the new regulatory body" is clear:

The new regulatory organization must adhere to the following conditions. It must be:

1. INDEPENDENT:

The chain of command, responsible authority and work processes must be:

(i) Independent from organizations promoted by the government

(ii) Independent from the operators

(iii) Independent from politics.

2. TRANSPARENT:

(i) The decision-making process should exclude the involvement of electric power operator stakeholders.

(ii) Disclosure of the decision-making process to the National Diet is a must.

(iii) The committee must keep minutes of all other negotiations and meetings with promotional organizations, operators and other political organizations and disclose them to the public.

(iv) The National Diet shall make the final selection of the commissioners after receiving third-party advice.

3. PROFESSIONAL:

(i) The personnel must meet global standards. Exchange programs with overseas regulatory bodies must be promoted, and interaction and exchange of human resources must be increased.

(ii) An advisory organization including knowledgeable personnel must be established.

(iii) The no-return rule should be applied without exception.

4. CONSOLIDATED:

The functions of the organizations, especially emergency communications, decision-making and control, should be consolidated.

5. PROACTIVE:

The organizations should keep up with the latest knowledge and technology, and undergo continuous reform activities under the supervision of the Diet.

Indian government should separate the protection of the population from the nuclear industry by creating an independent organisation in charge of safety, radiation protection and expertise.

8. Conclusions

As pointed out in the emergency manual of the Kaiga NPP, the scope of the emergency preparedness plans is to "prevent deterministic health effects in individuals and limit the probability of stochastic effects in the population" [DAE2011]. IAEA mentions "mitigation of radiological consequences of significant releases of radioactive materials" [IAEA1996]. But Japanese disaster has proven that populations require "protection".

NDMA claims that "it may be noted that for Indian NPPs, exhaustive preparedness plans are in place to cope with situations arising out of eventualities of accidents, if any" [NDMA2009]. This study shows that it is not the case. Indian radioprotection rules in case of nuclear emergency are based on obsolete international recommendations. Many intervention levels are far too high with respect to international standards and will not be accepted by the population in case of emergency. DAE's statement[32] that "nuclear facilities in India adopt internationally accepted guidelines for ensuring their safe operations and safety to the public and the environment" is not correct. The sovereign duty of the State to protect the population cannot be fulfilled in such conditions.

Using more stringent levels would mean to extend the protection zone. Millions of people could then require protection in case of a severe accident. As it is impossible to manage such a disaster, Indian authorities prefer to consider that an INES-7 accident is not probable enough to be considered and keep high intervention levels to avoid intervention.

The new Japanese Nuclear Regulation Authority writes in its interim report on emergency preparedness [NRA2012]: "One of the lessons learned from the accident at the Fukushima Dai-ichi Nuclear Power Plant is that the arrangements for emergency preparedness for the nuclear power plants were not adequate, because it had been assumed that "severe accidents will not happen actually" as in the case of past nuclear or radiological emergencies. The Emergency Preparedness Guide was issued in 1980 after the nuclear power plant accident at Three Miles Island (TMI) in the USA. Subsequently several revisions were made based on experience of domestic or overseas accidents and international considerations. However, since the occurrence of such an accident at the Chernobyl nuclear power plant in the former Soviet Union was considered to be hardly conceivable, the Emergency Preparedness Guide does not adequately address any severe accidents which practically require protective measures outside nuclear power plant sites. […]

As shown in the accident at the Fukushima Dai-ichi Nuclear Power Plant, a nuclear power plant has a potential hazard resulting in a severe accident. The operator, relevant ministries and agencies, and local governments should realize the potential risk of nuclear power plants and perform arrangements for preparedness and response for a nuclear or radiological emergency."

The same remarks apply to the Indian situation.

Indian authorities should openly acknowledge that a severe nuclear accident could happen in Indian like in any other country and trigger a complete reorganisation of EP&R to cope with such a possibility. The new regulatory body should be independent and the new plan should take into account the most recent international recommendations that would lead to rescale the geographical extension of emergency plans. We cannot over-emphasize that these news nuclear emergency plans should be prepared in a transparent way with the people surrounding nuclear facilities who might be affected by an accident. A special attention should be drawn on the most vulnerable people.

If such conditions are not possible, it cannot be considered that defence in depth is guaranteed and nuclear power plants should be stopped.

[32] http://dae.nic.in/?q=node/37

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Abbreviations

AERB	Atomic Energy Regulatory Board of India
CMG	Crisis Management Group
DAE	Department of Atomic Energy, Government of India
DM	Disaster Management
DMA	Disaster Management Authority
DRDO	Defence Research and Development Organisation of India
EP&R	Emergency Preparedness and Response
EPZ	Emergency Planning Zone
ETE	Evacuation Time Estimate
HERCA	Heads of the European Radiological Protection Competent Authorities
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IRRS	Integrated Regulatory Review Service
LIC	Local Information Committee (France)
NAIIC	Nuclear Accident Independent Investigation Commission of the National Diet of Japan
NDMA	National Disaster Management Authorities, Government of India
NPCIL	Nuclear Power Corporation of India Limited
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission in the United States of America
TMI	Three-Mile-Island
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiations
WENRA	Western European Nuclear Regulators Association

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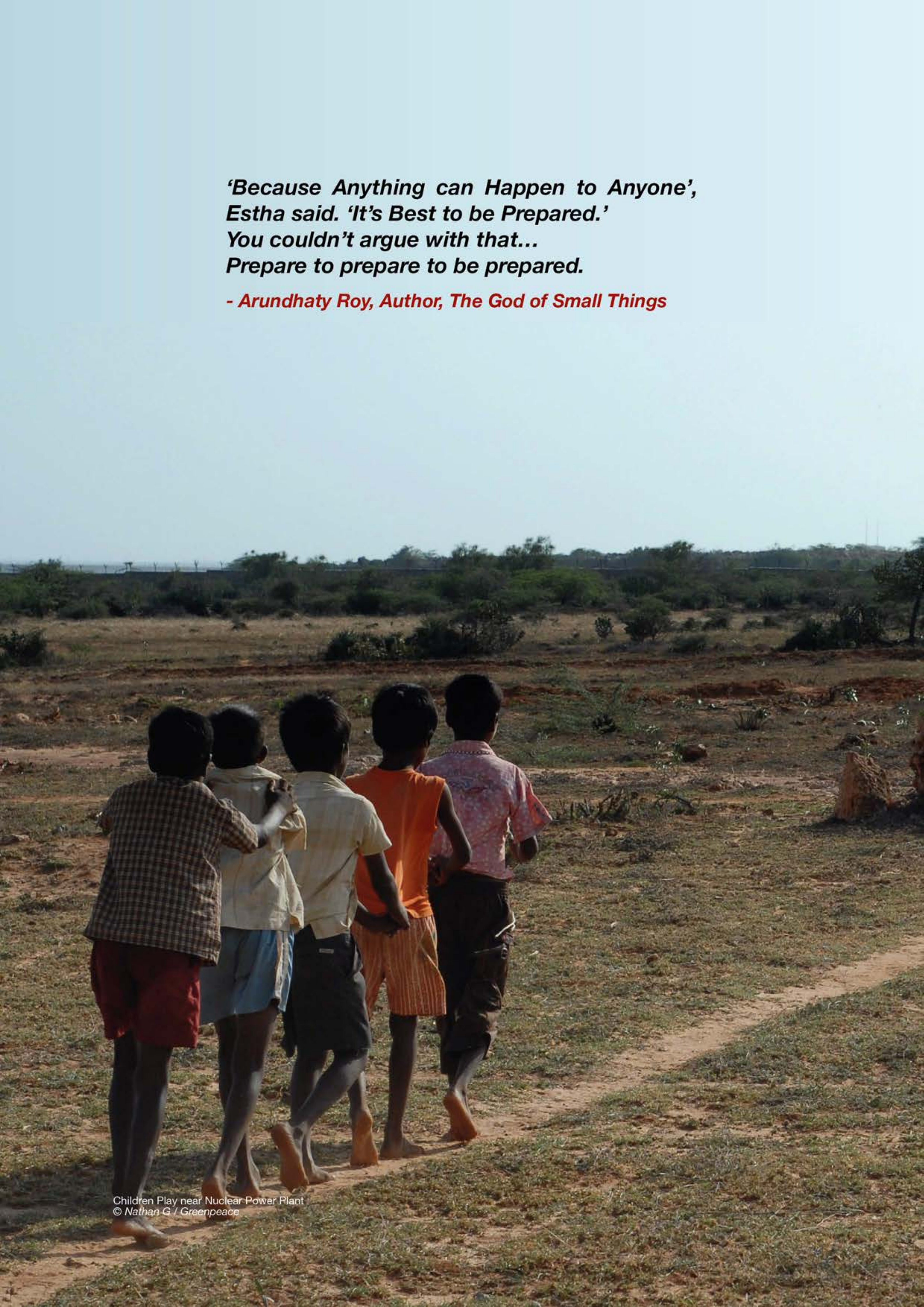
'Because Anything can Happen to Anyone', Estha said. 'It's Best to be Prepared.' You couldn't argue with that... Prepare to prepare to be prepared.

- Arundhaty Roy, Author, The God of Small Things



Children Play near Nuclear Power Plant
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GREENPEACE
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Greenpeace is a global organisation that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment. Greenpeace is a non-profit organisation, present in 40 countries across Europe, The Americas, Asia and the Pacific.

It speaks for 2.8 million supporters worldwide, and inspires many millions more to take action every day. To maintain its independence, Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants.

Greenpeace has been campaigning against environmental degradation since 1971 when a small boat of volunteers and journalists sailed into Amchitka, an area north of Alaska, where the US Government was conducting underground nuclear tests.This tradition of 'bearing witness' in a non-violent manner continues today, and ships are an important part of all its campaign work.

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