

**GUJARAT STATE DISASTER  
MANAGEMENT AUTHORITY**



# **Action Plan for Nuclear & Radiological Disaster**

**2011**

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**ACTION PLAN  
FOR  
NUCLEAR AND RADIOLOGICAL  
DISASTER**



**GUJARAT STATE DISASTER MANAGEMENT AUTHORITY  
JANUARY 2011**





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## **MESSAGE**

*Gujarat is one of the highly Prosperous state in the country. Gujarat's economy is increasing day by day so the energy consumption. To fulfil this need Nuclear Atomic Power Station is the best option. But, we all are aware about the potential devastation caused by nuclear disaster in the past. Gujarat has an Atomic power Station at Kakrapar and couple of Heavy Water plants too which makes it vulnerable to nuclear and radiological disasters.*

*It is very important to prepare ourselves to respond to nuclear disaster, though it is not common. In this context an Action Plan for Nuclear and Radiological Disaster has been prepared by GSDMA. I appreciate the work done by GSDMA and urge upon all the departments to make use of this plan to ensure a disaster free Gujarat.*

**(ANANDIBEN PATEL)**



# Content

	Page No.
<b>Abbreviation</b>	<b>1</b>
<b>Glossary of Key Terms</b>	<b>3</b>
<b>Introduction</b>	<b>5</b>
<b>Emergency Preparedness</b>	<b>8</b>
<b>Trigger Mechanism</b>	<b>16</b>
<b>Response Mechanism</b>	<b>18</b>
<b>Annexure</b>	<b>25</b>



# Abbreviation

AERB	Atomic Energy Regulatory Board
AERC	Additional Emergency response Centre
ATI	Administrative Training Institute
A&H Dept.	Animal & Husbandry Department
BARC	Bhabha Atomic Research Centre
CBDM	Community Based Disaster Management
CBRN	Chemical, Biological, Radiological and Nuclear
CMG	Crisis Management Group
COR	Commissioner of Relief
COH	Commissioner of Health
CP	Commissioner of Police
DAE	Department of Atomic Energy
DCG	District Crisis Group
DDMA	District Disaster Management Authority
DEOC	District Emergency Operations Centre
DM	Disaster Magistrate
DPL	District Police Line
DPCR	District Police Control Room
DP & S	Directorate of Purchase & Stores
DRDO	Defence Research and Development Organisation
EOC	Emergency Operations Centre
ERC	Emergency Response Centre
ERT	Emergency Response Team
GEB	Gujarat Electricity Board
GSDMA	Gujarat State Disaster Management Authority
GWSSB	Gujarat Water Supply & Sewerage Board
HWB	Heavy Water Board
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IERMON	Indian Environmental Radiation Monitoring Network
IMD	India Meteorological Department
IND	Improvised Nuclear Device
LCG	Local Crisis Group

KAPS	Kakrapar Atomic Power Station
MFR	Medical First Responder
MoD	Ministry of Defence
MHA	Ministry of Home Affairs
MHRD	Ministry of Human Resource Development
MoH&FW	Ministry of Health and Family Welfare
NCMC	National Crisis Management Committee
NDCN	National Disaster Communication Network
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NEC	National Executive Committee
NEOC	National Emergency Operations Centre
NGO	Non-Governmental Organisation
NIDM	National Institute of Disaster Management
NPCIL	Nuclear Power Corporation of India Limited
NPP	Nuclear Power Plant
OED	Off-site Emergency Director
PPG	Personal Protective Gear
QRMT	Quick Reaction Medical Team
QRT	Quick Reaction Team
RAD	Radiation Absorbed Dose
R&D	Research and Development
RDD	Radiological Dispersal Device
RED	Radiation Exposure Device
RSO	Radiological Safety Officer
SCG	State Crisis Group
SDRF	State Disaster Response Force
SEC	State Executive Committee
SEC <sup>1</sup>	State Emergency Centre
SEOC	State Emergency Operations Centre
SED	Site Emergency Director
SOP	Standard Operating Procedure
TREMCARD	Transport Emergency Card
UT	Union Territory

# Glossary of Key Terms

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## **Absorbed Dose (D)**

Absorbed dose, is defined as the mean energy imparted by ionising radiation to the matter in a volume element divided by the mass of the matter in that element.

## **Contamination**

Radioactive substances (in the form of dust, dirt, liquid) deposited on surfaces (e.g., skin, walls, etc.), or within solids, liquids or gases where their presence is normally neither expected nor desirable.

## **Dose**

Amount of energy delivered to a unit mass of material by the radiation travelling through it.

## **Half-Life**

The time taken by a sample of radioactive material to decay down to half the number of its original atoms.

## **Moderator**

A substance that reduces the energy of fast neutrons through the process of collisions (without any significant capture or absorption) with its atoms/molecules.

## **Nuclear/Radiological Emergency**

Any radiation incident resulting in or having a potential to result in exposure and/or contamination of the workers or the public in excess of the respective permissible limits can lead to a nuclear/radiological emergency.

## **Off-Site**

Outside the site area of the nuclear/radiological source.

## **On-Site**

Within the site area of the nuclear/radiological source.

## **Prophylaxis**

A measure taken for the prevention of a disease or condition.

## **Radiation**

Energy emitted from a radioactive atom/source is known as radiation. The three main types of radiations emitted by radioactive substances are alpha ( $\alpha$ ), beta ( $\beta$ ) rays and photons (x-ray and gamma ( $\gamma$ ) rays). There is yet another type of radiation, known as neutron radiation, which is emitted during a nuclear fission process. The radioactive substances are both natural as well as man-made. The magnitude of this radiation decays with time. Exposure to radiation can be reduced by applying the principles of Time, Distance and Shielding.

## **Stochastic Effects**

Effects resulting in the damage of the cells of living bodies leading to cancer and hereditary defects. The frequency of the event, but not its severity, increases with an increase in the dose. For protection purposes, it is assumed that there is no threshold dose (unlike deterministic effect) for stochastic effect. Protective actions in terms of rescue and relief operations to minimise the stochastic effect in case of a nuclear/radiological emergency are not always advisable, especially when doses are of a very low level.

## **Triage**

A rapid method utilising simple procedures to sort affected persons into groups, based on the severity of their injury and/or disease, for the purpose of expediting clinical care to maximise the use of available clinical services and facilities.

## **Yield**

The energy released in a nuclear weapon explosion is called 'yield', which is usually measured in kilotons or megatons of TNT equivalent. One ton of TNT releases 4.2 billion joules of energy on detonation.

# Chapter 1 - Introduction

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## 1.1 Introduction

The growth in the application of nuclear science and technology in the fields of power generation, medicine, industry, agriculture, research and defence has led to an increase in the risk of occurrence of Nuclear and Radiological emergencies.

As on date, 17 power reactors and five research reactors are in operation in India, six power reactors are under construction, and plans exist to set up thorium-based reactors to meet the ever-increasing energy needs. Further, India is also one amongst the seven declared nuclear weapon states which uses nuclear technology for strategic purposes.

### ***Kakrapar Atomic Power Station***

The Kakrapar Atomic Power Station (KAPS) is a nuclear power station in India, which lies in the proximity of the Surat city in the State of Gujarat. It consists of two 220 MW pressurized water reactors with heavy water as moderator and another two power station with the capacity of 700MW each is under construction. KAPS-1 went critical on 3 September 1992 and began commercial electricity production a few months later on 6 May 1993. KAPS-2 went critical on 8 January 1995 and began commercial production in September 1995. KAPS-3 and KAPS-4 are expected to begin for commercial operation in June 2015 and December 2015 respectively.

In addition, there are two heavy water plants in Gujarat (at Vadodara and Hazira).

## 1.2 Aims

The aim to develop and maintain the Action Plan for Gujarat State is to working towards minimum risk to human health, life and environment, in case of an occurrence of a nuclear or radiological disaster.

## 1.3 Objectives

- To provide, in a concise and convenient form, a list of major executive actions involved in responding to Nuclear and radiological emergencies and necessary measures for preparedness, response/relief required to be taken.
- To ensure that all concerned Ministries, Departments and Organisations of the Gujarat Government and District Administrations know the precise measures required of them at each stage of the process and also to ensure that all actions are closely and continuously coordinated.
- To indicate various actions which would be required by the Gujarat Government within their sphere of responsibilities so that they may prepare and review the Contingency Action Plans accordingly.

## **1.4 Scope of the Action Plan**

The scope of this document is from receiving of emergency intimation to the immediate response actions.

## **1.5 Nuclear and Radiological Emergency/Disaster Scenarios**

- An accident taking place in any nuclear facility of the nuclear fuel cycle including the nuclear reactor, or in a facility using radioactive sources, leading to a large-scale release of radioactivity in the environment.
- A 'criticality' accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place inadvertently leading to bursts of neutrons and gamma radiation (as had happened at Tokaimura, Japan).
- An accident during the transportation of radioactive material.
- The malevolent use of radioactive material as Radiological Dispersal Device (RDD) by terrorists for dispersing radioactive material in the environment.
- A large-scale nuclear disaster resulting from a nuclear weapon attack (as had happened at Hiroshima and Nagasaki in Japan) which would lead to mass casualties and destruction of large areas and properties.

## **1.6 Authority**

- The Department of Atomic Energy (DAE) has been identified as the nodal agency in the country for providing the necessary technical inputs to the national or local authorities for responding to any nuclear or radiological emergency in the public domain.
- The Ministry of Home Affairs (MHA) is the nodal ministry in such emergencies. For this purpose, a Crisis Management Group (CMG) has been functioning since 1987 at DAE.
- In the event of any radiological or nuclear emergency in the public domain, the CMG is immediately activated and will co-ordinate between the local authority in the affected area and the National Crisis Management Committee (NCMC). The CMG comprises of senior officials drawn from various units of DAE like the Nuclear Power Corporation of India Ltd. (NPCIL), Bhabha Atomic Research Centre (BARC), Heavy Water Board (HWB) and the Directorate of Purchase and Stores (DP&S). It also includes a senior official from the regulatory authority, the Atomic Energy Regulatory Board (AERB). Each member is backed by an alternate member, so that the CMG can be activated at a very short notice. Several Resource Agencies from BARC

also back up the CMG. They can provide advice and assistance in the areas of radiation measurement and protection and medical assistance to radiation affected personnel.

- For an effective response to any major nuclear emergency, an immediate communication 18 Emergency Response Centres (ERCs) have been established across the country, by BARC and DAE which is shown in Annex 1. For Gujarat Kakrapar is the ERC.
- In case of Gujarat, the ERC at Gujarat and other national resources such as the Armed Forces etc. shall deal with the situation. The role of the State Government and its agencies such as the Gujarat State Disaster Management Authority (GSDMA) will only be supportive and be at the directions of the CMG.

## **1.7 Regulatory Body**

- AERB is the nuclear regulatory authority in India which, as per the legal framework of Atomic Energy Act, 1962, has the mandate for issuance of licenses to nuclear and radiation facilities upon ensuring compliance with the applicable standards and codes.
- It is emphasised that the AERB, which oversees nuclear and radiological safety in the country, has the powers to not only licence the operation of a facility but also the power to order partial or full shutdown of any facility that violates its guidelines.
- The AERB has been playing a very crucial role in the prevention of nuclear/radiological accidents by ensuring that proper safety design features and operating procedures in all nuclear and radiation facilities are in place.

## Chapter 2 - Emergency Preparedness

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Preparedness is 'getting ready' to respond to an emergency and it encompasses all DM activities, viz., planning, developing, training, exercising, maintaining capacity, etc., prior to the emergency that are essential to ensure a fast and effective response capability in the event of an actual emergency situation. It envisages the development and maintenance of such a capability in a well-structured and well rehearsed fashion with seamless coordination among the various agencies involved. It does not have the pressure of time and stress associated with responding in an actual emergency.

The handling of nuclear emergency requires coordination among different service groups of the nuclear facility. In the event of the potential radiological consequences in the public domain, all three levels, i.e., district, state and central, will play a vital role.

### 2.1 Preparedness for Nuclear Power Plan

The response actions within the site boundary of the nuclear facility are the responsibility of the management of the nuclear facility whereas the implementation of the emergency response plan in the public domain (beyond the site boundary) is the responsibility of the concerned district authority. As the off-site emergency response plan has already been drawn up by the local administration in consultation with the concern plan authority, the District Collector of the affected area will take a charge as the incident commander. In the event an off-site emergency having the potential for trans-boundary effects, necessary action is taken by DAE in accordance with the country's international obligations.

The operating authorities of nuclear facilities in India already have an emergency response plan in place to be invoked in the event of an emergency, which is tested during periodic exercises as per international practice.

## Preparedness for Nuclear Power Plan

Responsibility	Activities
District Magistrate	<ul style="list-style-type: none"> <li>Establish/Activate an off-site emergency committee which is headed by the District Magistrate and supported by the district subcommittee, which include chiefs of all public service departments relevant to emergency management in the district and also the Head of the Site Emergency Committee of the nuclear facility for technical advice. (This committee takes decisions pertaining to the handling of a nuclear emergency outside the site boundary and ensures implementation of countermeasures such as sheltering, prophylaxis and evacuation and resettlement, including maintenance of law and order and civil amenities).</li> </ul>
ERC	<ul style="list-style-type: none"> <li>Ensure that all the activities pertaining to the handling of an off-site emergency are guided and coordinated.</li> </ul>
COR/GSDMA	<ul style="list-style-type: none"> <li>It is desirable to have a mechanism to continuously monitor background radiation levels in the public domain by GSDMA, with assistance from MHA and in consultation with DAE, which will help in detecting and locating the orphan sources.</li> </ul>
DDMA, GSDMA, Local Municipalities, NPCIL	<ul style="list-style-type: none"> <li>Ensure awareness generation, education and training of the community.</li> </ul>
MHRD, MHA, Education Dept.	<ul style="list-style-type: none"> <li>Ensure the student community is imparted proper education on the relevant topics by schools/colleges.</li> </ul>

Responsibility	Activities
<p>NPCIL, KAPS, District Authority, Municipalities, COR, AERB, CMG, DAE</p>	<ul style="list-style-type: none"> <li>• Conduct drills for plant, on-site, and off-site emergencies every quarterly, annually and once in two years, respectively (The preparation, conduct and evaluation of these exercises shall involve the coordination of all functionaries within the facility, the district authorities and the CMG of DAE).</li> <li>• The training of all the stakeholders will include information on: <ul style="list-style-type: none"> <li>○ Radiation sources and nuclear/ radiological accidents.</li> <li>○ Health and safety aspects of radiation emergency and the effect on human beings.</li> <li>○ Possible scenarios of nuclear/radiological emergencies.</li> <li>○ Preparedness of the facilities' operators and other stakeholders to cope with such emergency scenarios.</li> <li>○ Relevant technical information for appropriate integration into risk assessment and associated decision making.</li> <li>○ Information pertaining to the provisions of liability, insurance, relief and compensation.</li> <li>○ Dissemination of the training materials in local languages by making full use of, inter alia, the print and audio visual media.</li> <li>○ Testing the training programmes for quality assurance through regular mock drills/exercises.</li> </ul> </li> <li>• Check an evaluation report after an exercise and ensure implementation of the corrective measures recommended by the evaluators.</li> <li>• Ensure proper media management to minimise possible negative impacts of the exercise on the public psyche.</li> <li>• Update and revise the emergency response plan based on the lesson learnt as an outcome of the various exercises and mock drills.</li> </ul>
<p>DAE, DRDO, ATI</p>	<ul style="list-style-type: none"> <li>• Organise training programme on the management of nuclear emergencies/ disasters with the assistance from DAE and DRDO, for all administrative personnel of Gujarat State.</li> </ul>

Responsibility	Activities
NDMA, GSDMA, COR, DDMA, Municipal Commissioner, MHA, DAE, District Health Authority	<ul style="list-style-type: none"> <li>• Identify hospitals in the off-site emergency plan of nuclear facilities or in the vulnerable cities will be the focal point for managing the affected victims.</li> <li>• Ensure an availability of trained and equipped medical professionals for the management of radiation injuries and maintain an up-to-date database of them.</li> <li>• Prepare a network of medical facilities and medical professionals to handle large-scale radiation injury cases. (MoH&amp;FW will work in close coordination with NDMA, GSDMA, MHA, DAE and MoD to foresee medical preparedness in specific areas)</li> <li>• Ensure that there is at least one mobile radiological laboratory unit in each district and at least two units in each metropolis to support detection, protection and decontamination procedures. (Presently, only a few mobile radiological laboratories are available with DAE and DRDO)</li> <li>• Establish CBRN research and treatment centre in major hospitals, with sufficient number of beds to take care of any type of nuclear emergency/disaster.</li> </ul>
Chief Medical Officer (District)	<ul style="list-style-type: none"> <li>• Prepare medical preparedness plan to manage the medical aspects of the incidents at nuclear facility.</li> <li>• Ensure that the district health authorities constitute QRMts for pre-hospital care and the team consisting of RSOs, medical doctors, nurses and paramedical staff is well equipped.</li> </ul>
NDMA, COR, GSDMA, Home Dept.	<ul style="list-style-type: none"> <li>• In addition to the ERC (presently 1 at Kakrapar in Gujarat) established by BARC, establish additional ERCs at the District Police Control Rooms (DPCRs)/District Police Lines (DPLs) with the necessary trained personnel and equipped with appropriate radiation detection instruments and Personal Protective Gear (PPG) in all the major cities and other vulnerable locations. (The police being the automatic first responders, these additional ERCs will be located at the District Police Control Rooms (DPCRs)/District Police Lines (DPLs). Immediately on the occurrence of any major/hear major explosion, personnel from the nearest ERC will move in a police vehicle along with radiation detection devices and PPG for inspecting the site).</li> </ul>

Responsibility	Activities
BARC, DAE	<ul style="list-style-type: none"> <li>• BARC has established Indian Environmental Radiation Monitoring Network (IERMN) to monitor radiation on 24 x 7 basis.</li> <li>• All major cities and other vulnerable areas are presently not covered by this network, and this will be taken up on priority by the State Government and assisted by DAE and MHA. NEC will monitor the timely implementation of the network.</li> </ul>
COR, ERC, State EOC, GSDMA, Local authorities, Local Municipalities/ Corporations	<ul style="list-style-type: none"> <li>• Establish reliable, efficient and dedicated communication network (based on HF, wireless, Polhet and satellite links) within the facility with ERCs of nuclear facilities, medical facilities, district authorities, the CMG of DAE, NCMC and NEC for sharing of information on priority issues and actions, among all functionaries who have a role in handling the emergency on a priority basis.</li> <li>• Ensure periodic functional checks of the communication links.</li> <li>• Ensure the planned last-mile coverage to the community and provide the facility to pass the communication in simple regional languages.</li> <li>• The specific requirements of a nuclear emergency communication system include: <ul style="list-style-type: none"> <li>○ Civil defence communication (siren/ signals) to communicate stay-in and evacuation warnings in the event of an off-site emergency or a large-scale nuclear disaster is to be ensured for all major target sites and will be periodically tested.</li> <li>○ The public will be made aware of the nature of the signals and their implications.</li> <li>○ Reliable and diverse communication systems will be ensured for Emergency Operations Centres (EOCs) as envisaged in the NDCN of NDMA.</li> <li>○ All possible communication channels will be explored, including ham radio operators, as per the vulnerability profile of the State/District.</li> <li>○ Mock drills will be periodically carried out to test the communication links.</li> <li>○ A nodal officer (District Information Officer) will be identified for briefing the media.</li> </ul> </li> </ul>

Responsibility	Activities
District Collector, COR, GSDMA, Municipal Commissioner, Transport Dept.	<ul style="list-style-type: none"> <li>Identify and ensured the availability of access routes and transport vehicles for evacuation of the affected population as a part of the preparedness programme in an all hazards approach, in consultation with all the stakeholders including DAE.</li> <li>Ensure that the identified roads are improved. In addition, carry out regular repairs of the existing ones.</li> </ul>
District Collector, Municipal Commissioner, COR, GSDMA	<ul style="list-style-type: none"> <li>Assess the number of shelters required during a nuclear/radiation emergency and make plans to make them available. (DRDO has developed a variety of shelters which could be considered as an additional resource for large-scale sheltering of people)</li> </ul>
District Collector, Municipal Commissioner, COR, Civil Supply Dept.	<ul style="list-style-type: none"> <li>Make arrangements for supplying uncontaminated food to the residents in shelters.</li> <li>Make sure the availability of alternate sources of food, water and hygiene facilities for the effected community.</li> </ul>
Police, Revenue Dept, Health Dept, A.H Dept., Local Authority	<ul style="list-style-type: none"> <li>Necessary arrangements for disposal of human dead bodies and animal carcasses.</li> <li>Stock essential medicines to control cattle epidemic.</li> </ul>

## **2.2 Preparedness for Radiological Emergency**

- Any unusual event relating to the loss of source or excessive exposure to a person or contamination will be informed to AERB and CMG, and the nearest ERC.
- The user industry/facility, along with experts/professionals from DAE units/AERB, will promptly provide expert services in radiation protection to assist the local officials and first responders in mitigating an emergency from a radioactive source or for searching and sealing of the lost source.
- It is desirable to have a mechanism to continuously monitor background radiation levels in the public domain by GSDMA with assistance from MHA and in consultation with DAE which will help in detecting and locating orphan sources. Such a mechanism will be implemented in all major cities that are hubs of important business activities or other important installations which could be potential targets for such threats.
- BARC and DRDO have developed a vehicle monitoring system that can check any inadvertent movement of any radioactive source or material in a moving vehicle.
- In order to detect unauthorised/illicit trafficking, sensitive portal radiation monitors and other radiation detection devices are to be installed by MHA in consultation with the DAE and AERB at border entry points, sea ports and airports.
- To enhance security at facilities handling radioactive materials and during the transportation of such sources, the AERB has laid down its requirement/guidelines for the security of the sources during handling and transportation. These guidelines will be strictly adhered to by the users of the radiation sources. Wherever required, physical protection measures will also need to be implemented/strengthened.

## **2.3 Preparedness for 'Criticality' Accidents**

- Install 'Criticality monitors' at appropriate locations in the concerned nuclear facilities to sense the release of bursts of neutrons and gamma rays from the 'criticality' reactions.
- Assessor needs to be aware of all the factors which have the potential to result in an inadvertent 'criticality'.

## **2.4 Preparedness for Transport Accidents**

- The AERB has published its requirement/guidelines for the security of sources during handling and transportation. These guidelines must be strictly adhered by users of the radiation sources.

## **2.5 Preparedness for Radiological Dispersal Device**

The tasks to be undertaken by GSDMA, SEC and DDMA's, in consultation DAE, DRDO and AERB and with assistance from MHA, involve inter alia, preparedness in the following main areas, viz.:

1. The affected persons and area will have to be monitored for contamination levels.
2. The first responders have to be suitably equipped to measure the radiation levels and have the necessary kit to protect themselves.
3. There will also be a need to monitor a large number of persons after an RDD explosion and handle large amounts of radioactive wastes arising out of change of clothing, showering or washing.
4. A list of the agencies to be contacted by the public in case of a suspected presence of radioactivity will be made available to all citizens.
5. Expertise has to be developed for remotely defusing unexploded RDDs and other methods of reducing exposure of the experts need to be planned and worked out.

## Chapter 3 - Trigger Mechanism

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The Trigger Mechanism prescribes the manner in which the disaster response system shall be automatically activated after receiving early warning signals of a disaster happening or likely to happen or on receipt of information of an incident.

As a basic regulatory requirement, emergency preparedness exists at KAPS to respond to any on-site emergency in their areas. But to handle radiological emergencies arising from a transport accident or from movement/handling of “orphan sources” (radioactive sources that have lost regulatory control) or due to malevolent acts like explosion of a Radiological Dispersal Device (RDD), Radiation Exposure Device (RED) or Improvised Nuclear Device (IND) any time or anywhere in the State, a network of 18 number of Emergency Response Centres (ERCs) has been established by Bhabha Atomic Research Center (BRAC) (for Gujarat the ERC is Kakrapar) and Department of Atomic Energy (DAE). This network is basically meant for responding to such emergencies and also for providing timely advice and guidance to the first responder at the State and National level. The Kakrapar ERC is equipped with radiation monitoring instruments, protective gear and other supporting infrastructures. Various units of Nuclear Emergency Response Teams (ERTs), consisting of personnel from different DAE units are also being raised. The centralised agency, called the management activities not only by activating these ERC and ERTs but also by mobilising the resources from all DAE facilities, at the time of crisis.

The proposed National Policy on CBRN lays down that in each metropolitan area with population of over 20 lakhs, 25 Additional Emergency Response Centers (AERCs) will be set up under the Commissioner of Police of that city. In Gujarat, 50 AERCs in Ahmedabad, 25 AERCs Surat and 25 AERCs in Vadodra will be set up, equipped with basic detection equipments and protective gears supplied by the NDMA (Annex –3).

Other AERCs will be set up in cities with a population of over 10 lakhs, and each such city shall have 15 AERCs, similarly equipped.

In addition, the 5 Emergency Response Centers, constructed by GSDMA, and operated under Commissioner of Relief shall also have the capacity to detect, contain radioactive material.

### 3.1 Line of Communication and Responsibility for the State

Nuclear Disaster is a situation, where chances of receiving any early warning are very low. In such a situation where no early warning signals are available, the primary objective of the trigger mechanism shall be to mount immediate isolation. The following procedure shall be followed in such situations :

- For metropolitan areas, the Incident Commander for all nuclear hazards shall be the Commissioner of Police. For other areas it will be the District Magistrate (DM).

- The field functionary at ground zero shall inform the District Emergency Operation Centre (DEOC), the Commissioner of Police in a metropolitan area and the District Magistrate of the incident. DEOC / District Magistrate/ Commissioner of Police shall inform the State Emergency Operation Center (SEOC), Emergency Response Centers (ERCs), the Commissioner of Relief (COR) and GSDMA.
- Immediately thereafter, personnel from the AERC will determine the source of the radioactive emission and its strength (Annex 2, IAEA-EPR-FIRST RESPONDERS 2006) and report the same to the Commissioner of Police. In non-Metropolitan Area, the District Collector will inform the GSDMA, Emergency Response Centers for carrying out the function.
- The COR or GSDMA shall convene an immediate meeting of the Crisis Management Group under the Chief Secretary.
- COR shall inform National Emergency Operation Center (NEOC) and if required coordinate with Bhabha Atomic Research Center (BARC) for specialised support team from the 18 ERCs.
- The Commissioner of Police in a metropolitan area and the District Magistrate in others shall review the situation and activate coordination, command and control.
- Commissioner of Health (COH) shall place medical and para-medical teams if required at the disposal of the Incident Commander.
- The Fire Brigade as well as personnel/vehicles/equipments from GSDMA's Emergency Response Centers (ERCs) will report to the Incident Commander.
- Commissioner of Relief (COR) shall also coordinate immediate evacuation of potentially affected civilians with the CP, Municipal Commissioner and Collector.
- Team for Rapid Assessment of damage shall be deployed
- Chemical Biological Nuclear and Radiological team (CBRN) shall be formed and deployed to ground zero by the incident commander, i.e. Commissioner of Police in metropolitan areas and by the District Magistrate (DM) in other areas.

**Note :** *Chemical Biological Nuclear and Radiological team (CBRN), teams requires to be set up in the State*

## Chapter 4 - Response Mechanism

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Response measures are those which are taken instantly prior to, and following, a Nuclear & Radiological emergency aimed at limiting injuries, loss of life and damage to property and the environment and rescuing those who are affected or likely to be affected by it.

NEC will ensure that the functions and responsibilities of the nuclear facility operators and response organisations are clearly defined and understood by all stakeholders. The MHA and the NEC will also determine the actions that need to be performed by each organisation during an emergency and whether it has the necessary resources and capabilities needed for the purpose. The advice of NCMC will also be sought in this matter.

### 4.1 Emergency at Nuclear Facility

In plant emergency, the consequences of the accident are expected to be limited to the plant facility only.

The Site Emergency, wherein the consequences of an accident are not expected to cross the site boundary, that is, the Exclusion Zone - which means that even under this condition, there is no radiological emergency in the public domain.

The off-site Emergency, which assumes the highly unlikely possibility of radiological releases in the public domain, and detailed response plans have been drawn up even for this hypothetical scenario at each site. The initial safe distances suggested in Radiological Emergencies (IAEA 2006) are given in Annex 2. **The local District Administration, the Crisis Management Group, DAE and the National Crisis Management Committee (NCMC) get involved in this type of Emergency**

Sr. No.	Emergency	Responsibility	Activity
1	Off-Site Emergency	OED (District Collector)	<ul style="list-style-type: none"> <li>• Declare an off-site emergency in consultation with SED.</li> <li>• Activate an offsite emergency control centre.</li> <li>• Establish immediate communication with ERC, State Government and the CMG, DEA.</li> <li>• Arrange an immediate deployment of various ERTs in affected sector(s).</li> <li>• Based on the emergency monitoring teams from off-site areas initiate countermeasures (such as sheltering and prophylaxis) of different grades.</li> </ul>
		Dist. Collector, Municipal Commissioner, ERC, Home Dept., Health Dept.,	<ul style="list-style-type: none"> <li>• Arrange an evacuation of the public to safer places.</li> <li>• Activate systems of the State machinery to meet the necessary requirements of the public in the camp till the people are in a position to go back to their homes after the affected areas are cleared and declared safe.</li> <li>• Deploy QRMTs/MFRs consisting of physicians, triage officer, RSO, nurses and paramedical staff.</li> </ul>
		COR, Civil Supply Dept., Collectors, Municipal Commissioner, Water Supply Dept., Health Dept., GEB, Power & Energy Dept., GWSSB & Local Authorities, Home Dept.	<ul style="list-style-type: none"> <li>• To ensure that necessary arrangements at evacuation/relief centers is made with sufficient availability of: <ul style="list-style-type: none"> <li>○ Food,</li> <li>○ Water,</li> <li>○ Blankets/Clothing</li> <li>○ Medicines</li> <li>○ Lighting</li> <li>○ Sanitation and hygiene etc.</li> </ul> </li> <li>• To ensure necessary security arrangements for the personals (Emergency responders/relief teams) who are working at Relief Centers and involved in distribution of Relief Materials.</li> <li>• To ensure that law and order is maintained at evacuation/relief centers and in the affected areas as well.</li> </ul>

Sr. No.	Emergency	Responsibility	Activity
		OED, COR, Info. Dept., Municipal Commissioner,	<ul style="list-style-type: none"> <li>• Make an arrangement for providing useful, timely, correct, consistent, and appropriate information to the public in the event of a nuclear or radiological emergency.</li> <li>• Ensure that the information to media/general public about the coordinated response is released in an organized manner.</li> </ul>
		CMG	<ul style="list-style-type: none"> <li>• Immediately activate and co-ordinate between the local authority in the affected area and the NCMC.</li> </ul>
2	<b>Nuclear/Radiation emergency</b>	ERC, DEA, AERB, CMG, Dist. Collector, CP, Municipal Commissioner,	<ul style="list-style-type: none"> <li>• Recognise the existence of an abnormal situation.</li> <li>• Identify and characterise the source and its origin.</li> <li>• Initiate a quick and reliable monitoring methodology to detect the onset of an accident/emergency condition and assess its magnitude.</li> <li>• Communicate the situation to fire fighting and medical services, police, civil defence, transport, and other agencies.</li> <li>• Estimate the dose via the relevant pathways. (Dose Limits for exposures to ionising radiations for occupational workers given in Annex 4)</li> </ul>
		Dist. Collector, Municipal Commissioner, Health dept., ERC, COR,	<ul style="list-style-type: none"> <li>• Support decision making on protective measures for the population and the environment.</li> <li>• If required, distribute iodine tablets at the earliest (iodine prophylaxis).</li> <li>• Respond quickly to the situation and mobilise resources at short notice.</li> <li>• Initiate countermeasures at the earliest (for relief and rescue operations on the basis of actual radiation dose levels prevailing in different zones).</li> <li>• Make sure an immediate measures need to be taken as the situation develops.</li> <li>• Ensure that the actions taken by the various agencies are well coordinated.</li> </ul>

Sr. No.	Emergency	Responsibility	Activity
		COR, Home Dept., State EOC, Civil Supply Dept., Animal and Husbandry dept., Information dept.	<ul style="list-style-type: none"> <li>• Send prior information (in respect of dos and don'ts) to those likely to be affected by the accident/emergency. These include: <ul style="list-style-type: none"> <li>◦ Evacuation/temporary relocation of the affected population, if required.</li> <li>◦ Withdrawal and substitution of supplies of food and drinking water (based on actual measurement of contamination found in food and drinking water).</li> <li>◦ Animal husbandry and agriculture department personnel to ensure radiological protection following a nuclear emergency.</li> <li>◦ Initiation of the recovery phase at an appropriate time.</li> </ul> </li> </ul>
3	<b>'Criticality' Accidents</b>	ERC, CMG, NEC, DEA	<ul style="list-style-type: none"> <li>• Critical Situation in a nuclear facility is a situation of national emergency. In case of Gujarat, the ERC at Gujarat and other national resources such as the Armed Forces etc. shall deal with the situation. The role of the State Government and its agencies such as the Gujarat State Disaster Management Authority will only be supportive and be at the directions of the Crisis Management Group set up by the Union /Central Government.</li> </ul>
4	<b>Transportation of Radioactive Materials</b>	DM or CP	<ul style="list-style-type: none"> <li>• On discovery of any such accident, the District Magistrate in a district or the Commissioner of Police in a metropolitan area, shall inform the following – <ul style="list-style-type: none"> <li>◦ The ERC at Kakrapar</li> <li>◦ The SEOC at Gandhinagar</li> <li>◦ The Commissioner of Relief</li> </ul> </li> </ul>
5	<b>Radiological Dispersal Device Emergency</b>	CMG, Dist. Collector, DM, Municipal Commissioner, CP, ERC, EOC, COR, Info. Dept., Home Dept., local authority, Health Dept. Civil supply Dept.,	<ul style="list-style-type: none"> <li>• Mobilise and operate incident command</li> <li>• Oversee victims triage</li> <li>• Make sure that the site is cordoned and the perimeters are controlled and managed</li> <li>• Ensure notification and activation of special teams</li> <li>• Ensure traffic and access control</li> <li>• Ensure protection to at risk and vulnerable population</li> <li>• Provide resources support and requests for assistance</li> </ul>

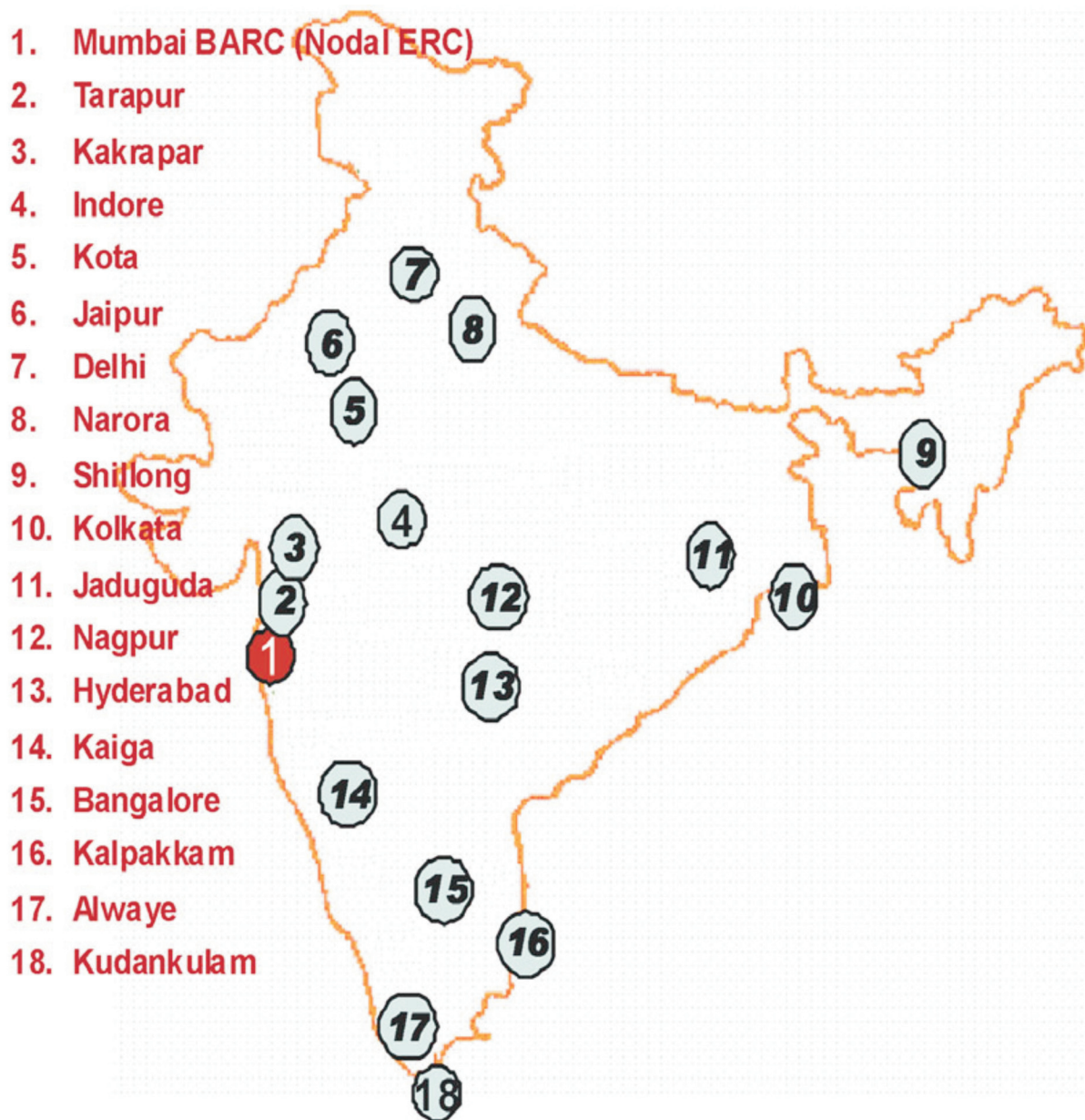
Sr. No.	Emergency	Responsibility	Activity
			<ul style="list-style-type: none"> <li>• Ensure public works coordination</li> <li>• Ensure public information, outreach, and communication activities.</li> <li>• Seal off the inner zone of 400m radius from the blast point as 'no entry area' except for emergency measures.</li> <li>• Perform life-saving rescue and emergency first aid for seriously injured. <ul style="list-style-type: none"> <li>○ Remove injured persons as far away as practical from the incident scene, especially in case of fire.</li> <li>○ If medical attention is needed, assist in arrangements for medical assistance.</li> <li>○ The medical personnel will be informed that radioactive contamination might exist on the victims and/or their clothing.</li> </ul> </li> <li>• Identify all those who may have been exposed to a possible release of radioactive material.</li> <li>• Identify those involved with the incident or potentially contaminated by the incident at the scene, except those requiring emergency medical evacuation.</li> <li>• All individuals will be monitored and decontaminated, if necessary, and cleared after further medical treatment and discharged.</li> <li>• Record names, addresses, destinations, and telephone numbers of those individuals who cannot be persuaded to stay at the incident scene.</li> <li>• Prohibit eating, drinking and smoking in the incident area</li> <li>• Use a handy evaluation tool when demonstrating countermeasures.</li> <li>• Advice to the Local Public following a Radiological Dispersal Device Explosion</li> </ul> <p><i>The public living in approximately twice the radius of the inner cordoned area are advised the following:</i></p> <ul style="list-style-type: none"> <li>○ If present in the inner zone, to get monitored at the earliest.</li> <li>○ Avoid inadvertent ingestion.</li> <li>○ Move away from the immediate area, at least several tens of metres from the explosion site and get inside a closed building. This will reduce exposure to both radiation and radioactive airborne dust.</li> </ul>

Sr. No.	Emergency	Responsibility	Activity
			<ul style="list-style-type: none"> <li>○ Not to eat food until certified free from contamination.</li> <li>○ Avoid any smoke/dust.</li> <li>○ Turn on local radio/TV channels for advice from emergency response centres/health authorities.</li> <li>○ Remove contaminated clothes and place these in a sealed plastic bag;</li> <li>○ Take a shower to wash off dust and dirt. This will reduce total radiation exposure.</li> <li>○ If radioactive material was released, local news broadcasts will advise people where to report for radiation monitoring and for blood and other tests to determine whether they were in fact exposed and steps to be taken to protect their health</li> </ul>
6	<b>Loss or Theft of Radioisotopes/ Radioactive Material</b>	Home Dept., Dist. Collector /DM	<ul style="list-style-type: none"> <li>● It is the user's responsibility to maintain an inventory of all sources at all times so in case of loss or theft of a radioactive source, the matter needs to be reported to the police, CMG and AERB immediately.</li> <li>● Theft of sources should be dealt jointly by law and order enforcement agencies and radiation protection experts.</li> </ul>



# ANNEXURE

**Annex 1** : Location of the Emergency Response Centres (ERCs) established by BARC





**Annex 2** : Suggested Radius of Inner Cordoned Area (Safety Perimeter) for Radiological Emergencies (IAEA-EPR-FIRST RESPONDERS 2006)

Situation	Initial Inner Cordoned Area (Safety Perimeter)
<b>Initial Determination (Radiological Emergency in Open Area)</b>	
Unshielded or damaged potentially dangerous source	30m around
Major spill from a potentially dangerous source	100m around
Fire, explosion or fumes involving a potentially dangerous source	300m radius
<b>Suspected bomb (potential RDD), exploded or unexploded</b>	<b>400m radius or more to protect against an explosion</b>
<b>Initial Determination (Radiological Emergency Inside a Building)</b>	
Damage, loss of shielding or spill involving a potentially dangerous source	Affected and adjacent areas (including floors above and below)
Fire or other event involving a potentially dangerous source that can spread materials throughout the building (e.g. through the ventilation system)	Entire building and appropriate outside distance as indicated above
<b>Expansion Based on Radiological Monitoring</b>	
Ambient dose rate of 100 $\mu$ Sv/h	Wherever these levels are measured

### **Annex 3 : Technical Specifications of Instruments**

- I. For the purpose of surveillance, it is proposed to equip fairly good number of vehicles patrolling on road in all metropolitan cities and other district headquarter – town, that have high potential of radiological hazards with **Go/No-Go type of Survey Instrument**. It will give an audio – visual alarm at dose rate exceeding 1mR/hr (.01mSv/hr). (**@ 1 no. For each AERC**)
- II. Portable Survey Meter with maximum dose range (Gamma Rays) of 5 R/hr (50 m Sv/hr). It will read the radiation field in an affected area. (**@ 1 no. for each AERC**)
- III. Digital Dosimeters to provide digital display of cumulative dose received and to trigger an alarm when the cumulative dose exceeds a set value (**@ 5 nos for each AERC**)
- IV. **Comfo – Respirators** to prevent particulate radioactivity from inhalation and/or exposure to the face and eye. It is like a helmet to protect face, eye and nose. (**@ 5 nos. For each AERC**)
- V. **Radiation Symbols** to be utilised for cordoning off the suspected/affected area of radiological contamination. (**@ 10 nos. For each AERC**)
- VI. **Oro- Nasal Surgical Masks** for preventing inhalation of particulate radioactive material. (**@ 50 nos. for each AERC**)
- VII. **Centralised Laboratory Facility** at each town/metro to ensure workability of all the instruments. It will have facility for calibration, maintenance etc. This will house one radioactive source (Cs- 137/Co-60) for calibration, a high range survey meter and some instruments for maintenance. (**@ 1no. per town/metro**). The room required for this laboratory will be provided by the concerned State Government.

## **Annex 4 : Dose Limits**

AERB has prescribed the following dose limits for exposures to ionising radiations for occupational workers.

### A) Effective dose<sup>1</sup> (whole body)

1. 20 mSv averaged over five consecutive years, calculated on a sliding scale of five years<sup>2</sup>; (The cumulative effective dose in the same five year period shall not exceed 100 mSv)
2. a maximum of 30 mSv in any year.

### B) Equivalent dose (Individual Organs)

- |   |                      |
|---|----------------------|
| 1. i) Eye lens                          | 150 mSv per year and |
| 2. ii) Skin <sup>3</sup>                | 500 mSv per year     |
| 3. iii) Extremities<br>(hands and feet) | 500 mSv per year     |

### C) Pregnant woman

- |   |          |
|---|----------|
| 1. Equivalent dose limit to the surface of the woman's lower abdomen<br>(for the remaining period of pregnancy) | 2 mSv    |
| 2. Annual Limit on Intake (ALI) for radionuclides<br>(for the remaining period of pregnancy)                    | 0.05 ALI |

### D) Apprentices and students (above the age of 16 years)

- |                                     |                 |
|-------------------------------------|-----------------|
| Effective dose ((whole body):       | 6 mSv per year  |
| Equivalent dose (Individual Organs) |                 |
| 1. Eye lens                         | 15 mSv per year |
| 2. Skin                             | 50 mSv per year |
| 3. Extremities<br>(hands and feet)  | 50 mSv per year |

In addition, investigation limits are also prescribed by AERB at which investigation of exposure cases exceeding these limits are carried out by an AERB committee.

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<sup>1</sup> Effective dose means summation of the tissue equivalent doses, each multiplied by the appropriate tissue- weighting factor.

<sup>2</sup> Sliding scale of five years means current year and previous four years.

<sup>3</sup> Average dose over 1cm<sup>2</sup> of the most highly irradiated area of the skin.



