NUCLEAR DISASTER MANAGEMENT

INDEX

APPLICATIONS OF RADIOACTIVE MATERIAL AND CONCERNS

Nuclear Power Reactor and Research Reactor

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INTRODUCTION

India has traditionally been vulnerable to natural disasters on account of its unique geoclimatic conditions like all other countries in the world, become equally vulnerable to various man-made disasters.

Nuclear and radiological emergencies as one such facet of man-made disasters are of relevance and concern to us.

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 .

With the advancement in scientific research , several countries has acquired the technology of Nuclear arms which are more destructive and harmful than atomic bombs. Theft to nuclear materials has also lead to creation of 'dirty bombs' leading to terrorism.

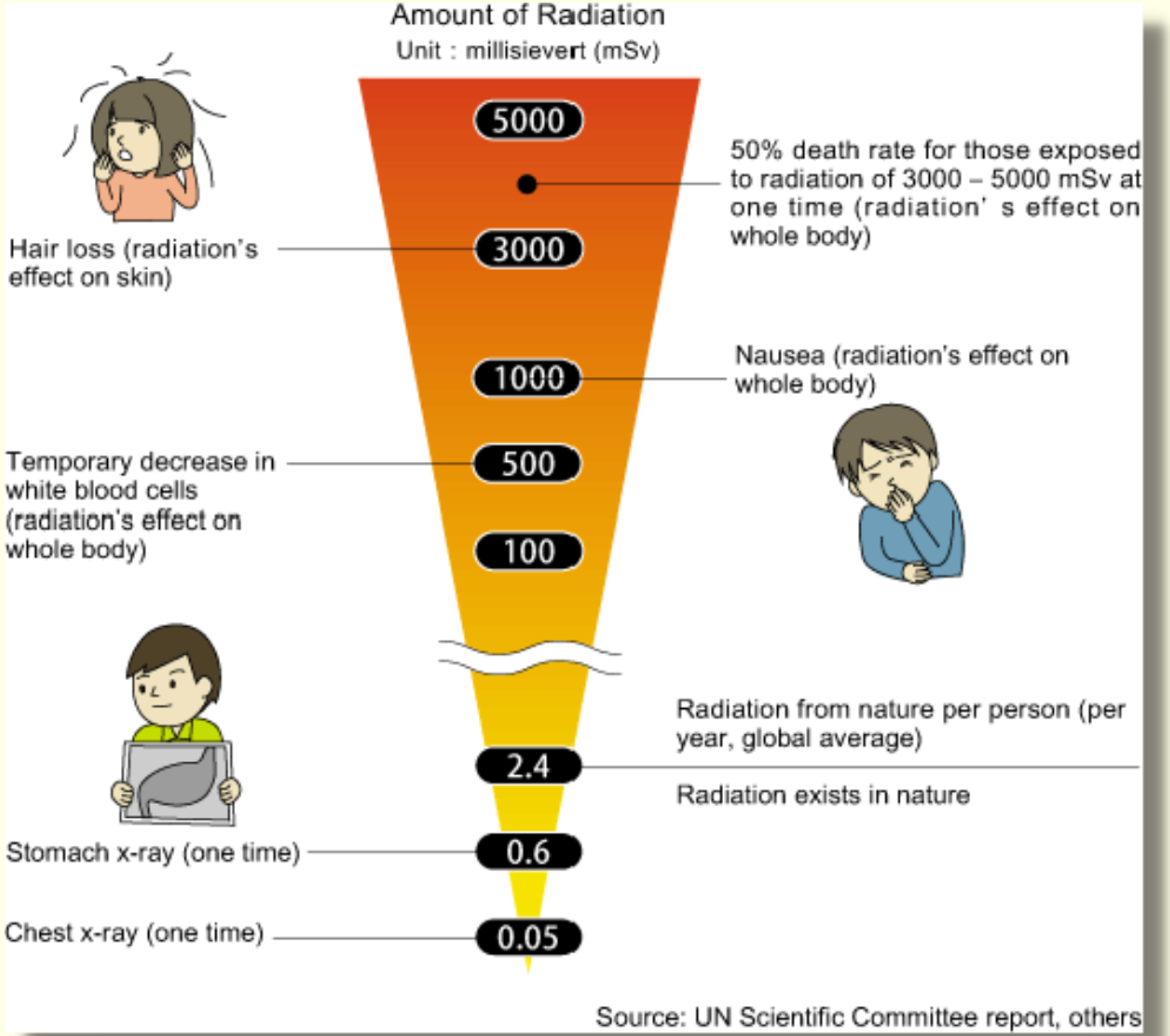
Nuclear emergencies can still arise due to factors beyond the control of the operating agencies; e.g., human error, system failure, sabotage, earthquake, cyclone, flood, etc.
Such failures, even though of very low probability, may lead to an on-site or off-site emergency.

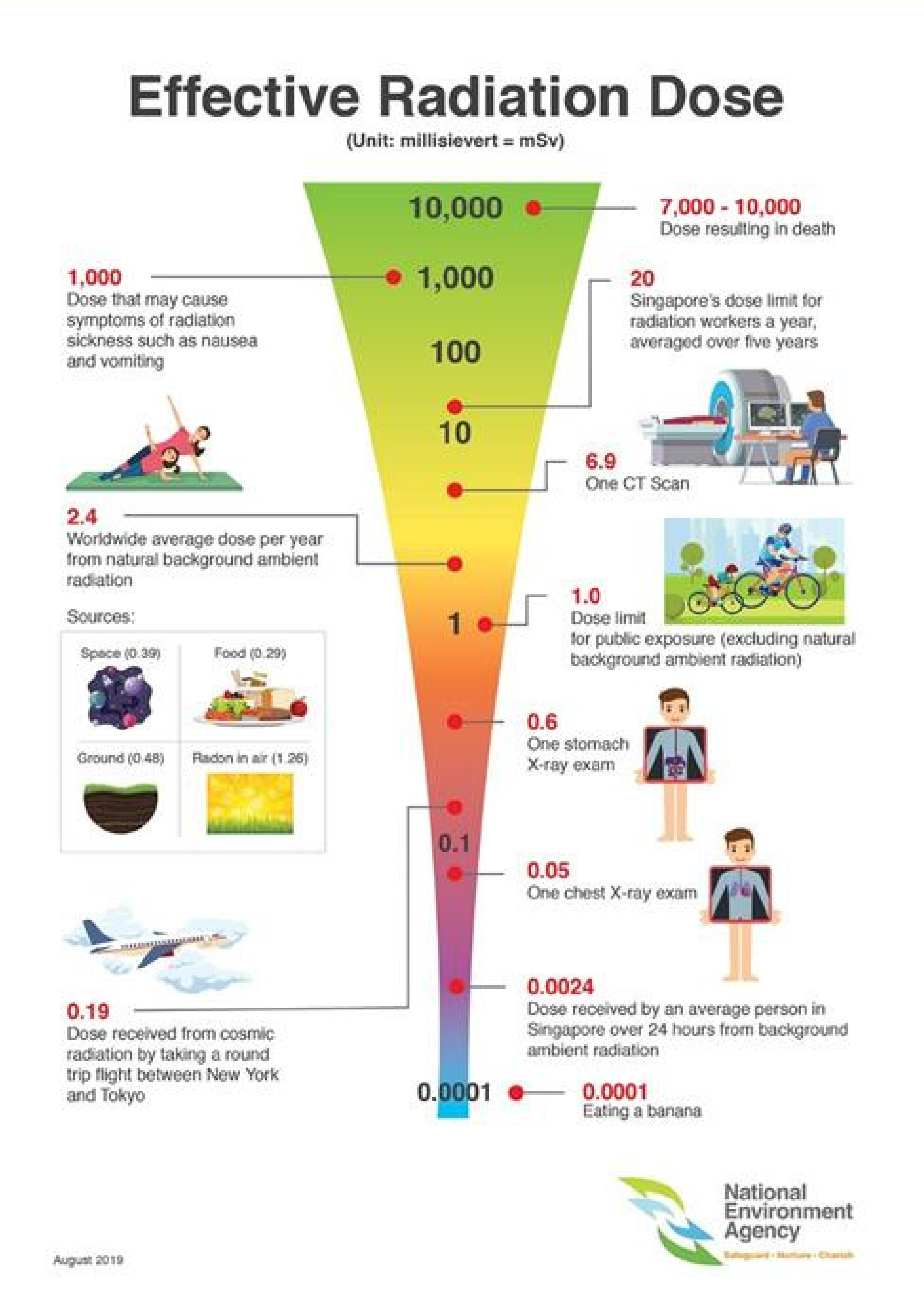
To combat this, proper emergency preparedness plans must be in place so that there is minimum avoidable loss of life, livelihood, property and impact on the environment.

CAUSES

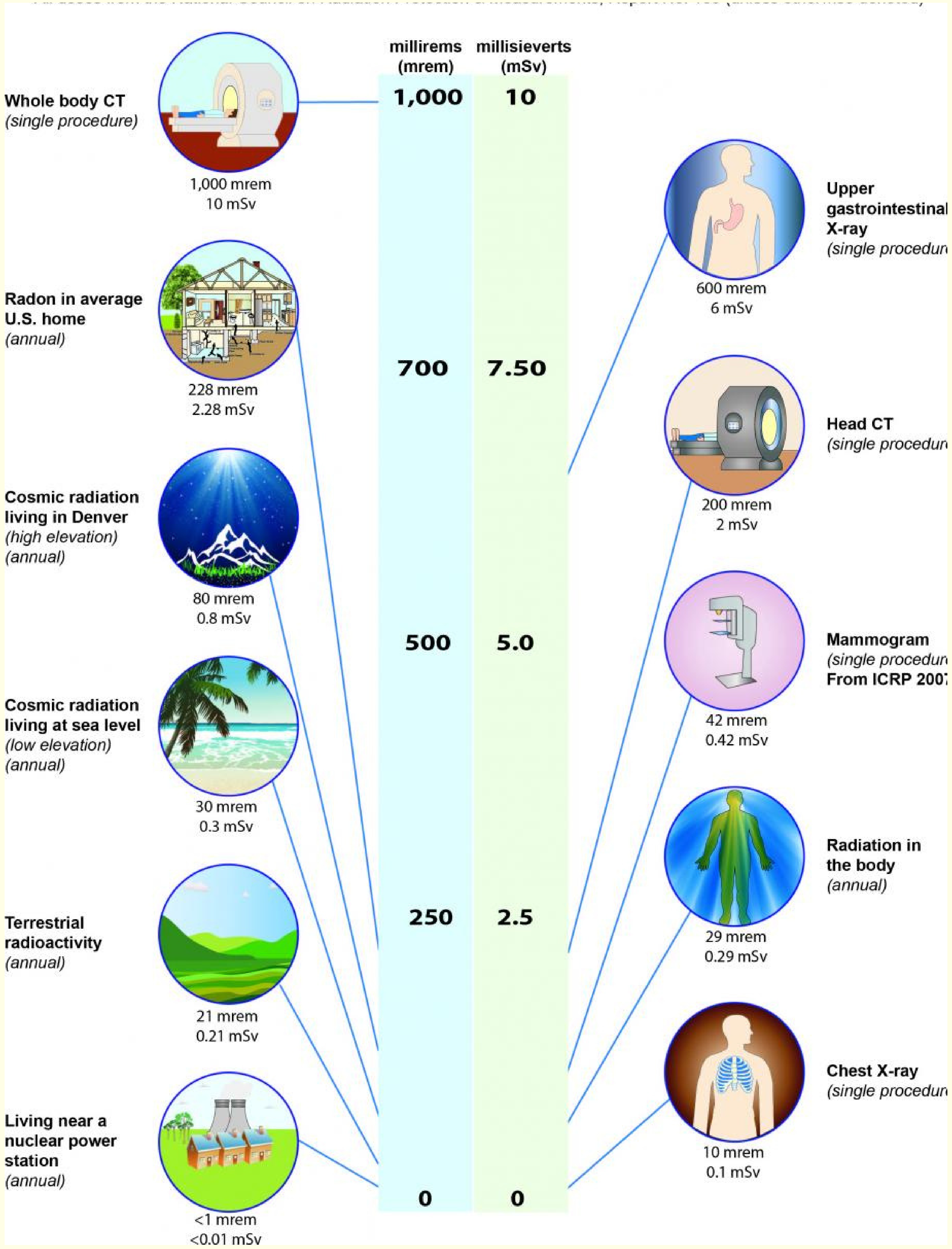
NUCLEAR FACILITY	NUCLEAR CHAIN REACTION	RADIOACTIVE MATERIAL	MALEVOLENT PRACTICES	NUCLEAR ATTACK
An accident in any nuclear facility of the nuclear fuel cycle, leading to a large scale release of radioactivity in the environment.	A ‘criticality’ accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place leading to bursts of neutrons and gamma radiation.	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 which would lead to mass casualties and destruction of large areas and properties. (Hiroshima and Nagasaki in Japan)

RADIATION EFFECTS





Effective Radiation Dose
(Unit: millisievert = mSv)
10,000
1,000
100
10
1
0.1
0.0001
7,000 - 10,000
Dose resulting in death
1,000
Dose that may cause symptoms of radiation sickness such as nausea and vomiting
20
Singapore's dose limit for radiation workers a year, averaged over five years
6.9
One CT Scan
2.4
Worldwide average dose per year from natural background ambient radiation
Sources:
Space (0.39)
Food (0.29)
Ground (0.48)
Radon in air (1.26)
1.0
Dose limit for public exposure (excluding natural background ambient radiation)
0.6
One stomach X-ray exam
0.05
One chest X-ray exam
0.0024
Dose received by an average person in Singapore over 24 hours from background ambient radiation
0.19
Dose received from cosmic radiation by taking a round trip flight between New York and Tokyo
0.0001
Eating a banana
National Environment Agency
August 2019

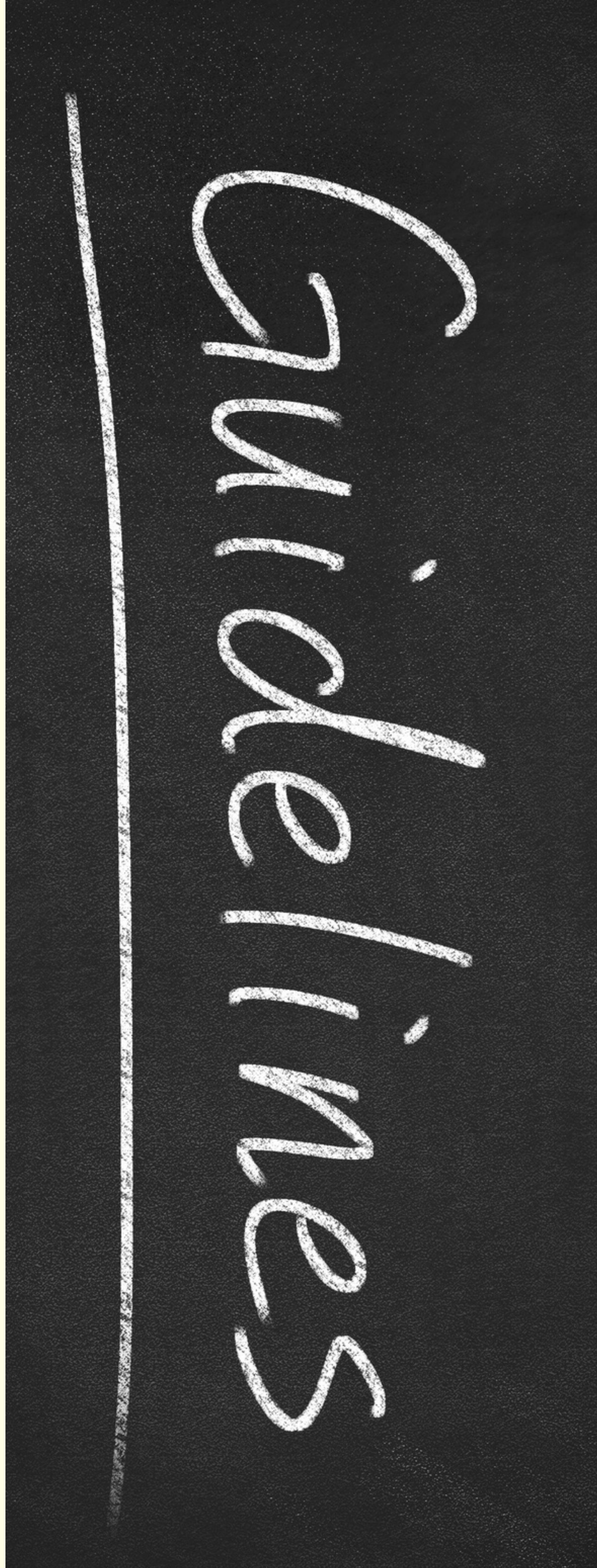


millirems (mrem)
millisieverts (mSv)
1,000 10
700 7.50
500 5.0
250 2.5
0 0
Whole body CT (single procedure)
1,000 mrem
10 mSv
Radon in average U.S. home (annual)
228 mrem
2.28 mSv
Cosmic radiation living in Denver (high elevation) (annual)
80 mrem
0.8 mSv
Cosmic radiation living at sea level (low elevation) (annual)
30 mrem
0.3 mSv
Terrestrial radioactivity (annual)
21 mrem
0.21 mSv
Living near a nuclear power station (annual)
<1 mrem
<0.01 mSv
Upper gastrointestinal X-ray
600 mrem
6 mSv
Head CT
200 mrem
2 mSv
Mammogram
42 mrem
0.42 mSv
Radiation in the body (annual)
29 mrem
0.29 mSv
Chest X-ray
10 mrem
0.1 mSv

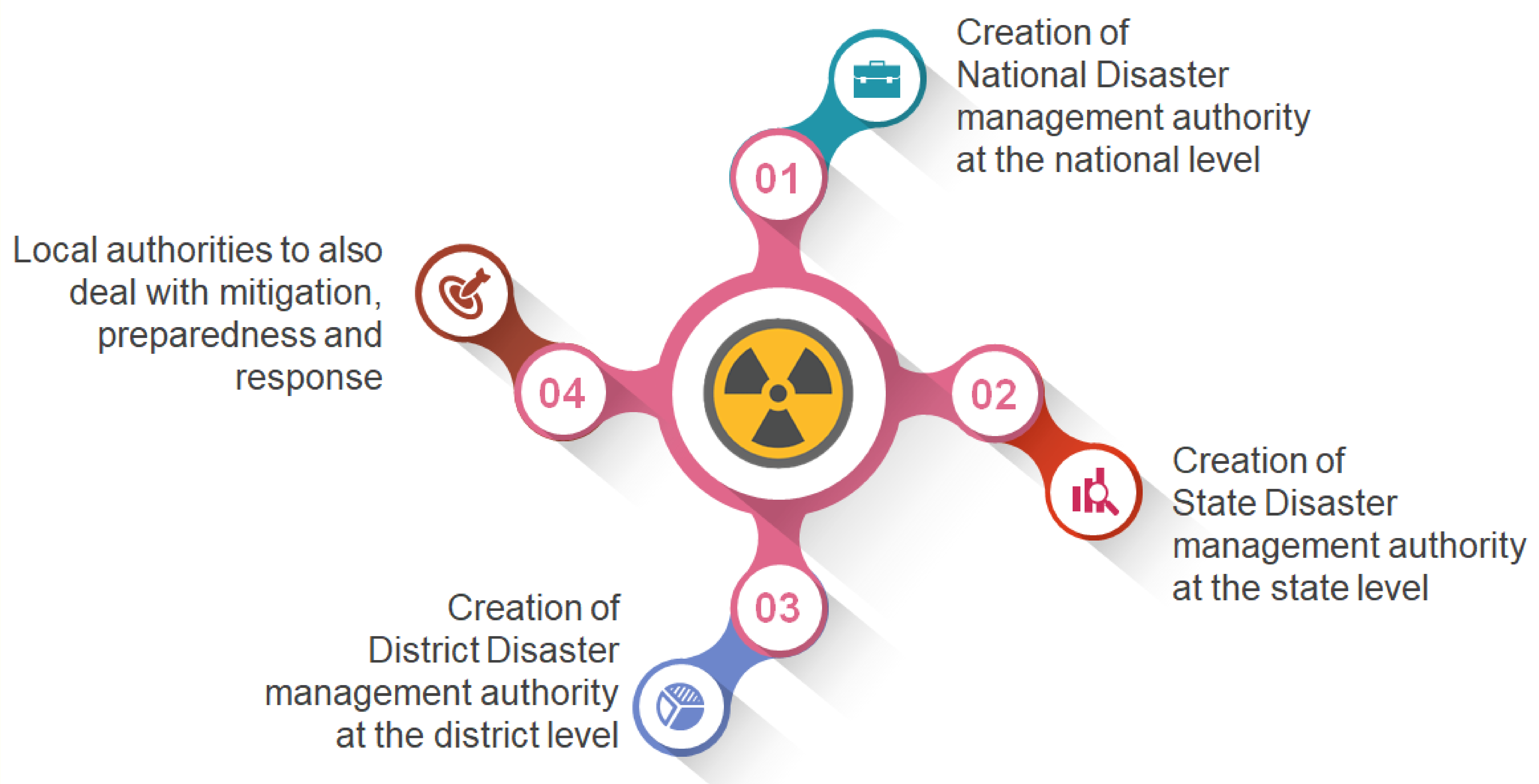
GUIDELINES

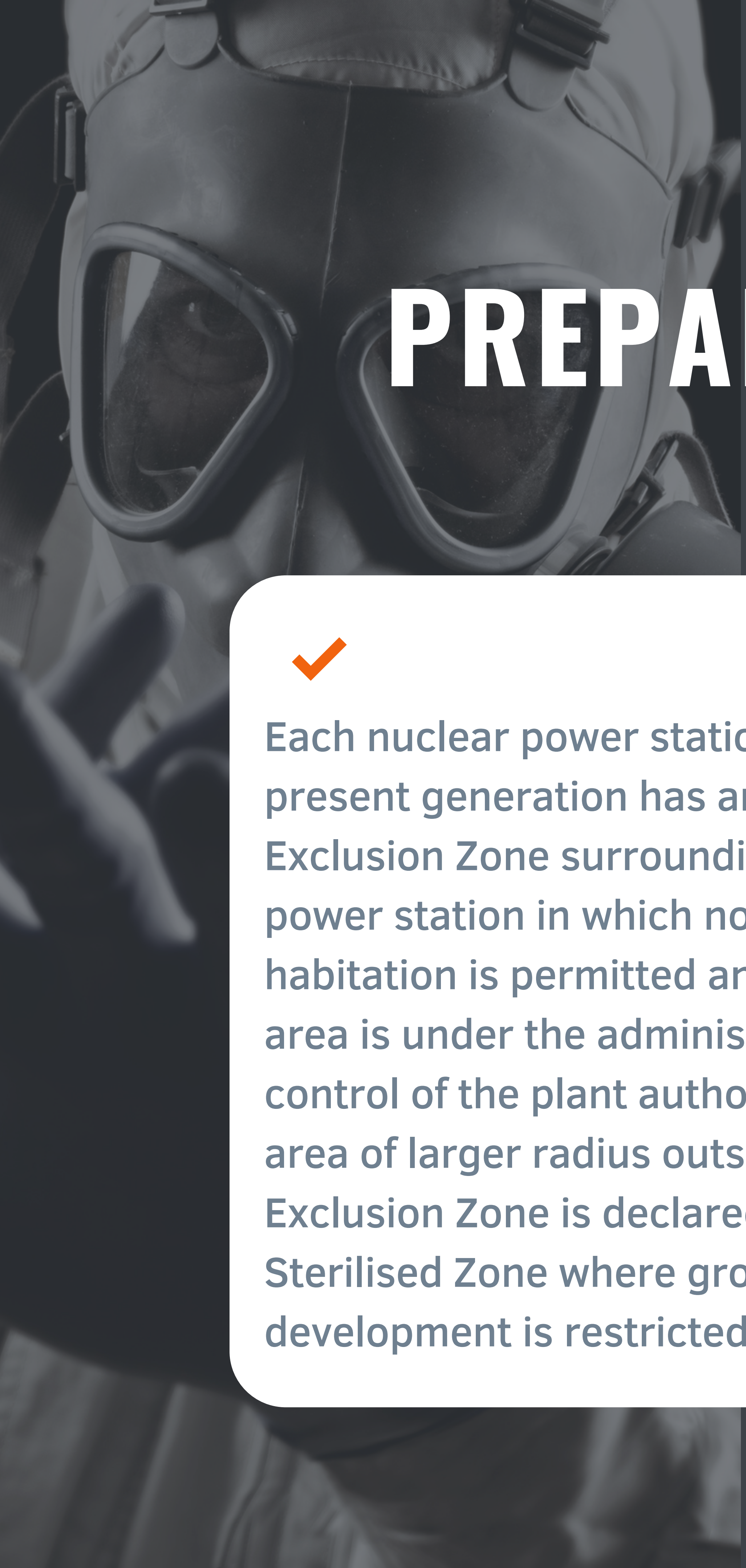
The main focus of these Guidelines is to institutionalise a holistic and integrated approach to the management of disasters at all levels and covering all components of the disaster continuum — **prevention, mitigation, preparedness, response, relief, rehabilitation, reconstruction, recovery**, etc.

These also take into account the need to have a community which is well informed, resilient and geared up to face nuclear and radiological emergencies, if and when encountered.



ADMINISTRATIVE BODIES



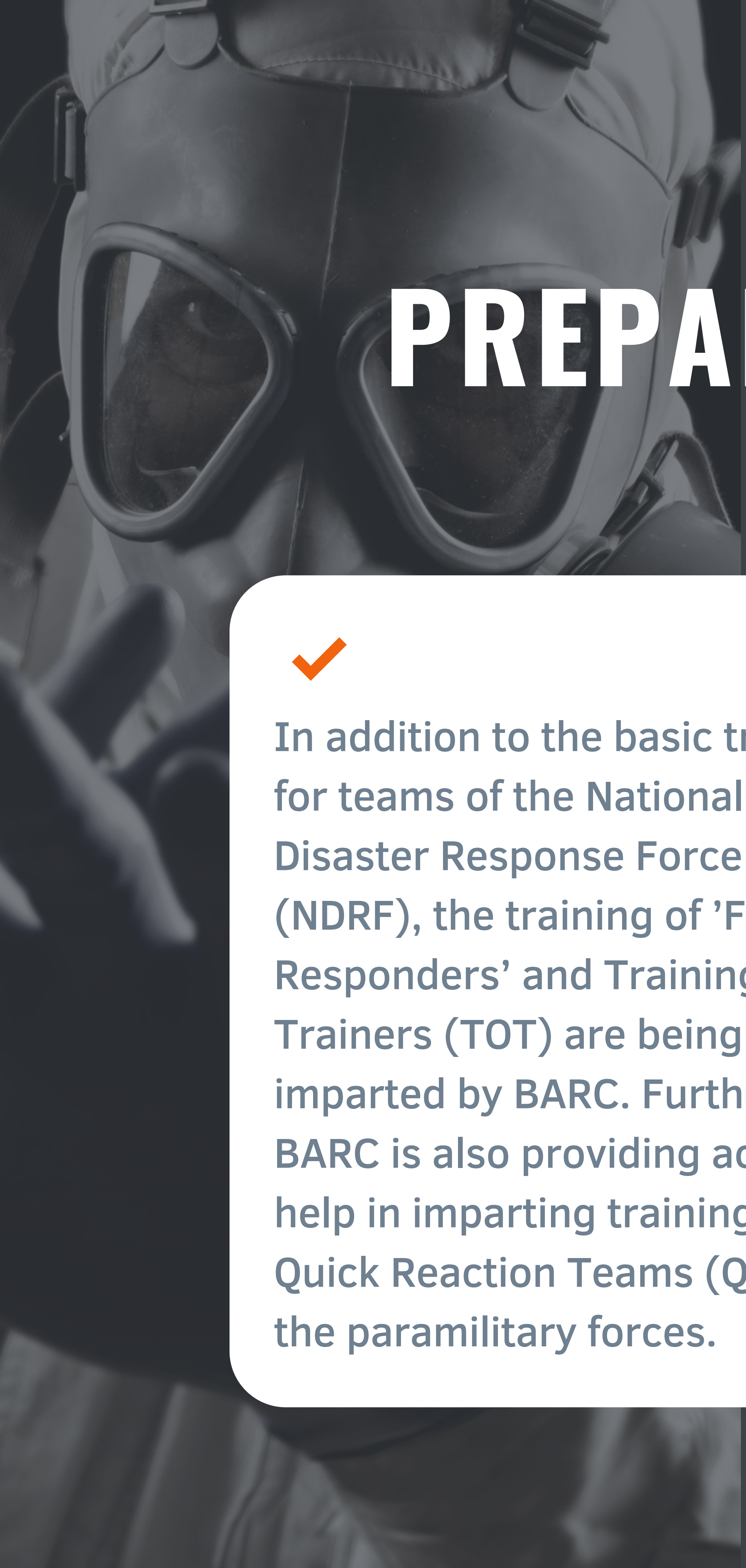


PREPAREDNESS AND RESPONSE PLANS

✔ Each nuclear power station of the present generation has an Exclusion Zone surrounding the power station in which no habitation is permitted and this area is under the administrative control of the plant authority. An area of larger radius outside the Exclusion Zone is declared as the Sterilised Zone where growth and development is restricted.

✔ The AERB's safety code for transportation covers the design of the transport container, its handling and loading, procedures for transporting and unloading, including the procedures to handle any accident en-route.

✔ All nuclear power plants and the Bhabha Atomic Research Centre (BARC) are equipped with radiation monitoring instruments, have personnel decontamination centres and the necessary stock of antidote medicines and specific de-corporation agents for typical radioisotopes.

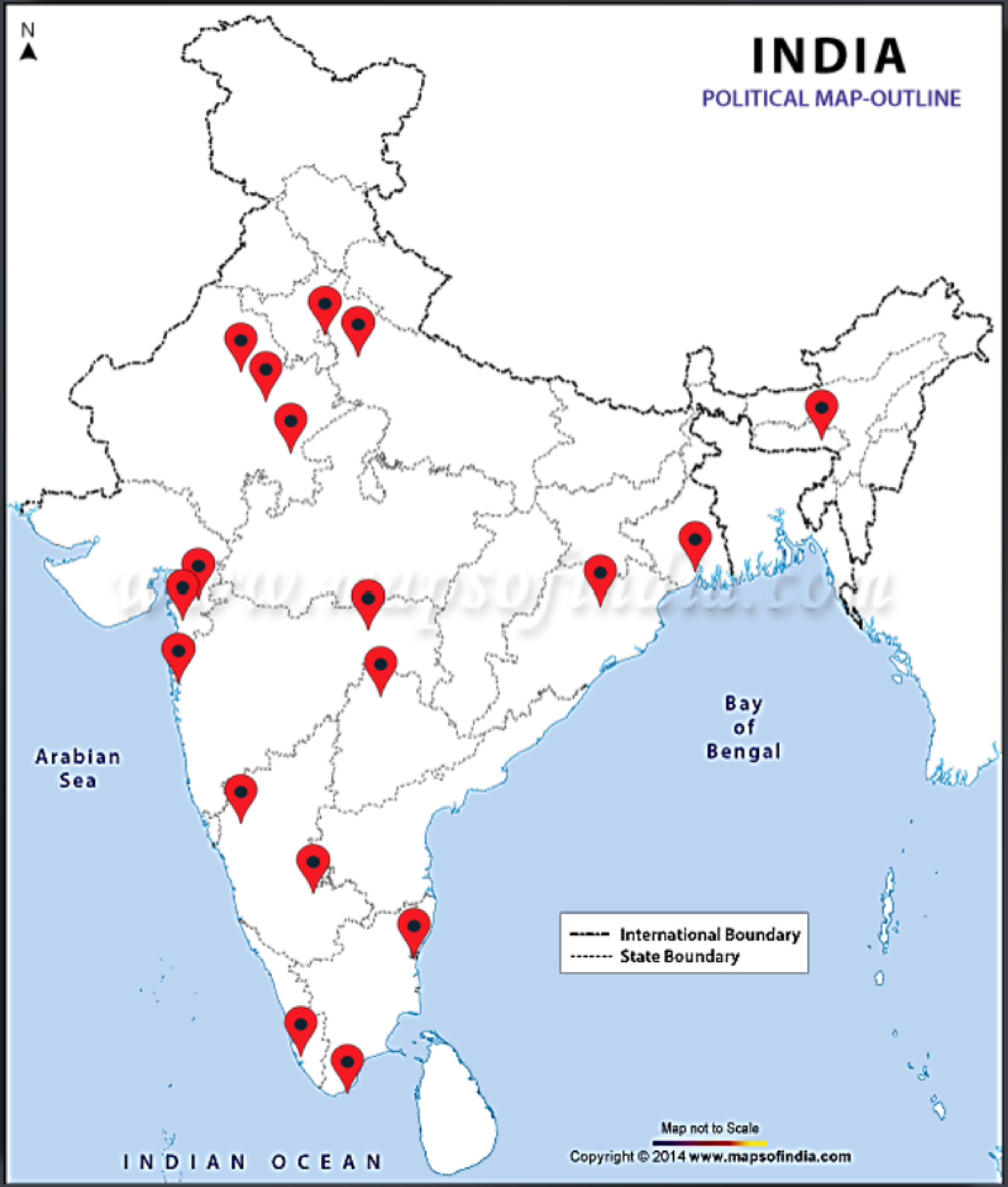


PREPAREDNESS AND RESPONSE PLANS

In addition to the basic training for teams of the National Disaster Response Force (NDRF), the training of 'First Responders' and Training of the Trainers (TOT) are being imparted by BARC. Further, BARC is also providing active help in imparting training to Quick Reaction Teams (QRTs) of the paramilitary forces.

Off site emergency zones and distances 5km radius area from a nuclear facility for initiation of provisional protective actions before the start of a release warranting protective actions off the site depend on Emergency Action Level (EAL, nuclear facility condition) in order to prevent and mitigate stochastic effect.

A network of 18 units of ERCs by BARC, DAE is meant for quick response to emergencies arising from a transport accident or from the movement/handling of "orphan sources" or due to malevolent acts. They also provide timely advice and guidance to first responders at the state and national levels. ERCs are fully equipped.



Location of ERCs by BARC

- MUMBAI
- TARAPUR
- KAKRAPAR
- INDORE
- KOTA
- JAIPUR
- DELHI
- NARORA
- SHILLONG
- KOLKATA
- JADUGUDA
- NAGPUR
- HYDERABAD
- KAIGA
- BENGALURU
- KALPAKKAM
- ALWAYE
- KUDANKULAM

MEDICAL PREPAREDNESS

1. Creation of Decontamination Room
2. Nuclear Ward fitted with Dust-Filter
3. Radioactive Bio-Waste Disposal Facilities
4. Radio Bio-Dosimetry Laboratory having Facilities like Fluorescence InSitu Hybridization (FISH) to Study Chromosomal Aberration
5. Haematology Laboratory with Cell Separator for Granulocyte Concentrate
6. Genetic Laboratory
7. Molecular Laboratory
8. Immunology Laboratory
9. Bone Marrow Bank, Bone Marrow Transfusion and Stem Cell Harvesting Facilities

MEDICAL RESPONSE

IODINE PROPHYLAXIS

The thyroid gland is the most vulnerable organ in the body that is likely to be damaged by radiation.
If exposure to radioiodine is anticipated, like in the case of radioactive releases following a major reactor accident. For high-risk individuals, this will protect the thyroid gland from the effects of radiation.

CASUALTY DECONTAMIN-ATION

Identified hospitals will establish a decontamination station near the entrance,
solated from patients and visitors. For such purpose, the hospitals concerned will deploy QRMTs/MFRs consisting of physicians, triage officer, RSO, nurses and paramedical staff.

TRIAGE & EVACUATION

- Maps clearly indicating the entry and exit routes for ambulances and walk-in patients will be laid down.
- The reception area will be expanded to accommodate a large number of expected patients with trauma and burns.
- The hospital functionaries will be trained in triage.

SANITATION & TEMPORARY SHELTERS

Presentations are communication tools that can be used as demonstrations, lectures, speeches, reports, and more. Most of the time, they're presented before an audience.

MITIGATION

Siting: The site for a nuclear power plant is selected through a detailed study of the site to ensure that its operation has no adverse impact on the environment.

Design and Construction: To prevent accidents caused by faulty design, it is ensured that the technologies incorporated are state-of-the-art and proven and the man-machine interface is considered in all stages of designing.

Commissioning Program: The commissioning program confirms that the installation, as constructed, is consistent with design and safety requirements. Operating procedures are validated as part of the commissioning program.

Operation: During operation, it is ensured that the plant is always operated within the safe boundaries as identified by safety analyses. Further, all the important functions, viz., operations, inspection, testing, maintenance and support functions are conducted by a sufficient number of properly trained and authorised personnel in accordance with the approved procedures.

ALARA Principle: During all the stages of the life of a nuclear plant, starting from design to decommissioning, radiation exposure to both the occupational workers as well as members of the public are kept As Low As Reasonably Achievable (ALARA).

Management: The managing authority assigns the highest priority to safety standards and ensures that safety policies are implemented with a clear division of responsibility and a well defined protocol of communication.

Decommissioning: The radioactive wastes generated during decommissioning must be handled with extreme care. It must be ensured that (i) it does not add to excessive exposure of the plant's personnel and members of the public after decommissioning and (ii) even after a long period of time, it does not get into the local environment or get mixed up with the water table.

Protocols: The safety provisions include a series of physical barriers between the radioactive reactor core and the environment, the provision of multiple safety systems, each with backup and designed to accommodate human error.

SAFETY PRECAUTIONS

Levels	Objectives	Essential means	Category
Level 1	Prevention of abnormal operations and failures	Conservative and high quality in ❑ design ❑ construction ❑ operation	PREVENTION
Level 2	Control of abnormal operations and detection of failures	❑ Control systems ❑ Protection systems ❑ Associated surveillance programme	
Level 3	Control of accidents	❑ Engineered safety features	MITIGATION
Level 4	Control of severe plant condition (accident progression) and mitigation of consequences	❑ Procedures for accident management • Complementary measures • Accident management	
Level 5	Mitigation of radiological consequences 'on release of radioactive material'	❑ Off-site emergency response	EMERGENCY PREPAREDNESS


CALLING
URGENCY
HANDLING
EMERGENCY
SOS
EXIT
FIREFIGHTERS
HOSPITAL

HANDLING PLANT EMERGENCIES

- Emergency operating procedures for the assessment of an emergency condition and its mitigation.
- Nuclear emergency response plans specifying the jobs of all the functionaries who have assigned roles during the emergency.
- Alerting the plant personnel by sounding the emergency siren and making an emergency announcement.
- Adequate means for communicating a notification to the emergency response organisations at the facility, the district and state authorities, CMG of DAE and the central government authorities.

- Identified assembly locations for plant personnel and casual visitors for their accounting, and assessment of persons trapped in the radiological areas.
- Formation of rescue teams and activation of a treatment area and decontamination centre.
- Radiation survey around the plant and outside the plant and site boundaries.
- Assessment of wind speed, wind direction and the affected sector around the nuclear facility.
- Mobilisation of the services of the ambulance and paramedical staff at its site.
- Equipment and materials for handling a nuclear emergency are kept at a designated place of the nuclear facility and ERC.

HANDLING ON-SITE EMERGENCIES

- Extensive radiological survey for an assessment of the radiological conditions within the site boundary of the nuclear facility.
- Suitable prophylaxis(treatment) to be made available at all assembly areas for administration to plant personnel.
- Identification of temporary shelters within the facility/site for shifting plant personnel.
- Provision of a fleet of vehicles for evacuation of plant personnel from the site to a safer place.

- Provision of fixed and portable contamination monitors to check contaminated personnel/vehicles leaving the site.
- On sensing the potential of release of radioactivity which can transgress into the public domain, the concerned district authorities are alerted to be on standby for emergency operations in the public domain.
- Radiological monitoring of the environment in the EPZ (16 km radius around the plant).

HANDLING OFF-SITE EMERGENCIES

- It identifies the role of each response agency in a clear and unambiguous manner with local Administration.

- There is an off-site emergency committee headed by the district magistrate which include chiefs of all public service departments relevant to emergency management.

- All the activities are guided and coordinated from a pre-designated emergency response centre located outside the boundary of the nuclear facility.

- The information and broadcasting department ensures the smooth flow of information to the media to avoid panic and spreading of rumours.

REGULATORY FRAMEWORK

The **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.

The AERB issues a large number of standards, codes and guides for various practices (during different nuclear and radiation applications) which must be strictly adhered to, for the prevention or mitigation of the impacts of any nuclear/radiological emergency. The codes issued by the AERB for various applications provide for a graded approach for regulatory control of a facility depending on the level of radiological hazard involved.

SHORT TERM PLANS

(0-2 years plan)

R&D FOR DEV & ADVANCEMENT

MEDICAL PREPAREDNESS

- Hospital Disaster Management Plans
- Emergency Medical response.
- Upgradation and Networking.
- Pyschosocial Care

PREVENTIONS

- Intelligence Mechanism
- Survelliance at Vulnerable Locations
- Detection od unsual events
- Early Warning System.

CAPACITIVE DEVELOPMENT

- Education and awaremess Geneartion
- Training and Community Participation.
- Knowledge Management.
- Critical Infrastructures

RISK REDUCTION FRAMEWORK

MIDDLE TERM PLANS

(0-5 YEARS PLAN)

- FURTHER UPGRADATION OF REGULATION AND ENFORCEMENT
- ENHANCEMENT OF RISK REDUCTION FRAMEWORK
- PREPAREDNESS WITH COMMUNITY PARTICIPATION
- UPGRADATION OF RESPONSE CAPABILITIES
- ENHANCEMENT OF CAPACITY DEVELOPMENT

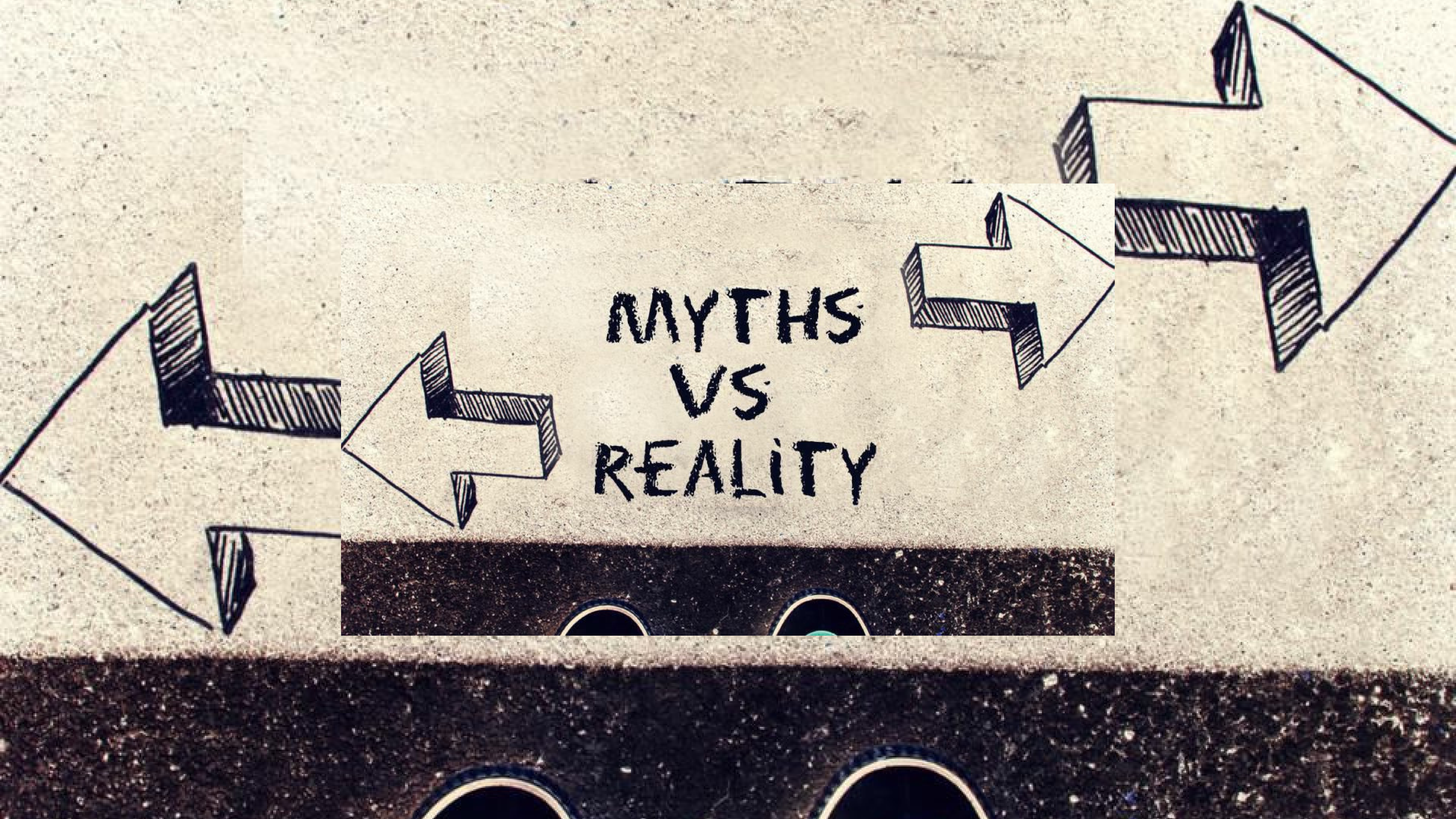
LONG TERM PLANS

(0-8 YEARS PLAN)

- TOTAL REGULATION AND ENFORCEMENT
- COMPLETE RISK REDUCTION
- OPTINUM LEVEL OF PREPAREDNESS
- OPTINUM RESPONSE CAPABILITIES
- TOTAL CAPACITY DEVELOPMENT IN TERMS OF COMMUNITY AND INFRASTRUCTURE .

CAPACITY DEVELOPMENT

- RELIABLE COMMUNICATION
- SPECIALISED RESPONSE TEAM
- STRENGTHENED TRANSPORT
- REHABILATION
- REGULATORY CENTRES
- EDUCATION AND AWARENESS
- RADIOLOGICAL LABS
- SECURITY 101


MYTHS
VS
REALITY

MYTH - 01

ALL IRRADIATED FOOD PRODUCTS BECOME RADIOACTIVE AND MAKE THEM UNFIT FOR HUMAN CONSUMPTION.

REALITY -01

THE SHELF-LIFE OF IRRADIATED FOOD PRODUCTS INCREASES BECAUSE IRRADIATION KILLS THE PATHOGENS WHILE RETAINING THE FOOD VALUE. FOOD PRODUCTS DO NOT BECOME RADIOACTIVE DUE TO IRRADIATION.

MYTH - 02

ANY REACTOR ACCIDENT WILL LEAD TO A SITUATION LIKE CHERNOBYL.

REALITY -02

BECAUSE OF THE BEST PRACTICES FOLLOWED IN DESIGN (WITH DEFENCE-IN-DEPTH APPROACH), DEVELOPMENT, CONSTRUCTION AND OPERATION OF THE NUCLEAR POWER PLANT OF THE PRESENT GENERATION, CHANCES OF ANY NUCLEAR ACCIDENT LEADING TO A CHERNOBYL LIKE SITUATION ARE EXTREMELY REMOTE.

MYTH - 03

IN A MAJOR ACCIDENT, A NUCLEAR POWER REACTOR CAN EXPLODE LIKE AN ATOM BOMB.

REALITY -03

DUE TO THE DESIGN PHILOSOPHY ADOPTED AND VARIOUS BUILT-IN SAFETY SYSTEMS IN A NUCLEAR POWER REACTOR, IT CANNOT EXPLODE LIKE A BOMB, BECAUSE OF THE INHERENT DESIGN FEATURES AND BUILTIN SAFETY SYSTEMS THAT PRACTICALLY ELIMINATES THE CHANCES OF ANY RADIOACTIVITY GOING TO PUBLIC DOMAIN.

MYTH - 04

THE GENETIC EFFECT IS OBSERVED IN THE OFFSPRING OF ALL THOSE WHO ARE EXPOSED TO RADIATION DURING THEIR OCCUPATION.

REALITY -04

THERE IS NO CONCLUSIVE EVIDENCE OF ANY GENETIC EFFECT, EVEN IN THOSE PERSONS WHO BELONG TO THE REPRODUCTIVE AGE GROUP, AND WERE EXPOSED TO HIGH DOSES TO RADIATION IN ACCIDENTS OR DURING MEDICAL TREATMENT.


CHERNOBYL
1986


RadioFreeEurope
RadioLiberty
BYELORUSSIAN S.S.R.
POLAND
CHERNOBYL
U.S.S.R.
UKRAINIAN S.S.R.
CZECHOSLOVAKIA
HUNGARY
ROMANIA

26 - APRIL -1986

WHAT HAPPENED ?

The Chernobyl nuclear disaster took place on 26 April 1986 at 1.23am.

The plant was in the midst of a shutdown when there was a power surge, caused by control rods being inserted into the reactor. The mix of the overly hot fuel with the cooling water caused increased pressure and steam production, which spread through the entire core and caused an explosion. This was followed by a second explosion possibly caused by a build-up of hydrogen from zirconium steam explosions.

26 - APRIL -1986

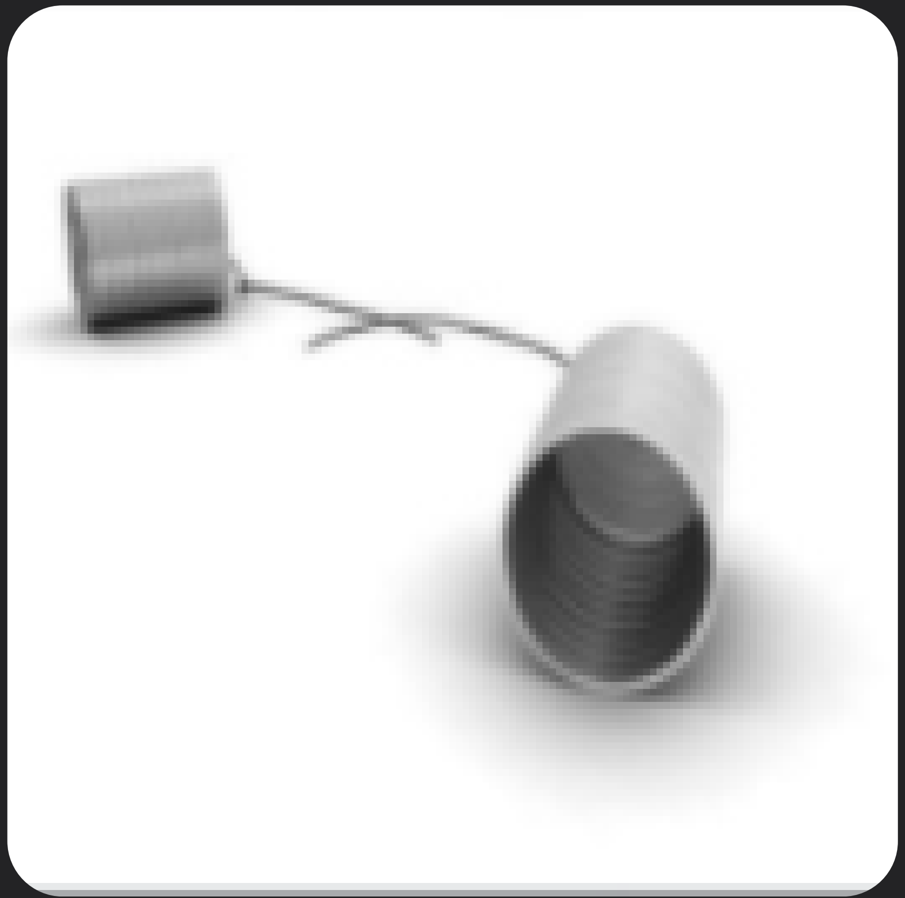
' A SECURITY TEST '

- The accident is produced effecting a security test.
- The test consisted on a simulation of a power failure.
- Objective : Determine how much time the turbines generate energy despite the power failure

26 - APRIL -1986

ERROR ON POWER DECREASE

- The power of the reactors decreased to reduce risks.
- All elapse well the first minutes, a problem makes drastic decrease to 30MW.
- With this power, the reactor can shut down.



26 - APRIL -1986

LACK OF COMMUNICATION

- There are a users in diferent rooms, responsible of the reactor number 4
- The user on the reactor climbed up several control rods to recover the power
- The user that controls the water introduce more water than necessary .

26 - APRIL -1986

FINAL EXPOLSION

- To achieve a balance of steam and water, more rods than allowed are climbed up.
- The responsible of the water realize his error, and remove the excess of water
- Power excess and water absence resulted on an excess of heat that melt the reactor core and resulted on a explosion

CAUSES

- The Chernobyl explosion was the result of a “flawed Soviet reactor design”, operated by “inadequately trained personnel”, according to the World Nuclear Association.
- The Chernobyl plant used four Soviet-designed RBMK-1000 nuclear reactors — a design that’s now universally recognised as inherently flawed.
- The nuclear plant operators made serious mistakes - a consequence of “Cold War isolation and the resulting lack of any safety culture”, the association adds.

Effects

The rate of suicides, post-traumatic stress, and depression increased in the population around the area.

Direct killing of 31 people.

At least 20,000 children got thyroid cancer from the radiation

200,000 dead indirectly due to Radiation Exposure.

400,000 people were evacuted in a single Day

160,000 sq km was contaminated within 3 hrs.

EFFECTS

COMMITTED ERRORS & SOLUTIONS

HUMAN ERROR

Lack of Communication and Errornomous Decisions

Solution : It is necessary to give them sufficient Instructions and communication device for every action taken

DESIGN ERROR

Unstable Reactor and Separation of responsible Users

Solution : Close the reactor of such type and design must have controller in the same room.

AUTOMATION ERROR

The system allows action that endanger the security of Centrals.

Solution : System can't afford to take dangerous actions.

PREPAREDNESS PLANS

Stringent emergency preparedness plans

Even with the Chernobyl reactor's poor design, officials could have averted many radioactive exposures to the population with an effective emergency response. Key personnel at all U.S. power reactors work with surrounding populations on an ongoing basis to prepare for an orderly and speedy evacuation in the unlikely event of an accident.

Alert and notification

Chernobyl plant operators concealed the accident from authorities and the local population, and thus the government did not even begin limited evacuations until about 36 hours after the accident. In the United States, nuclear power plant operators are required to alert local authorities and make recommendations for protecting the public within 15 minutes of identifying conditions that might lead to a significant release—even if such a release has not occurred. The U.S. Nuclear Regulatory Commission posts resident inspectors at every nuclear power plant site to ensure the plants are following federal safety requirements.

Protecting the food chain

Since authorities did not promptly disclose details of the Chernobyl accident, many people unknowingly consumed contaminated milk and food. This would not be the case in the United States. As it did following the Three Mile Island nuclear accident in 1979, the federal government would carefully monitor and test food and water supplies that potentially could become contaminated. Under existing federal programs and regulations, the government would quarantine and remove from public consumption any unsafe food or water. In addition, after the accident at the Fukushima Daiichi reactors in Japan in March 2011, the U.S. strengthened protections of the public from contaminated milk and food by conducting specialized training and drills with farmers and agricultural producers.

Thank you!

U18EC002
MALHAR YADAV

U18EC022
AMAN SAH

U18EC147
BHAVIKA TAMBI