Are We Prepared Against Nuclear Disasters?

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On 8 December 2004, two persons were detained by Izzatnagar Police, Bareilley, Uttar Pradesh (UP) on suspicion of being small time drug peddlers. They were carrying a sophisticated metal box, which when examined by Bhabha Atomic Research Centre, turned out to be containing 253.6 gms of 99 per cent enriched uranium. Natural uranium contains 0.7 per cent uranium 235 (U 235). To convert it into a form suitable for nuclear weapons it must be enriched by increasing the concentration of U 235 to about 90 per cent. The amount of enriched uranium needed to make a nuclear weapon varies with the degree of enrichment and the sophistication of the weapon. A 'dirty bomb', however, does not require such enriched uranium.

Technology for making atom bomb is readily available. However, enriched uranium can only be processed in state owned sophisticated facilities. Although, a highly sophisticated implosion nuclear weapon can be made from just nine to twelve kilograms (kgs) of highly enriched uranium (90 per cent), for a 'dirty bomb', the requirement is much less. Similarly, a number of thefts of Cobalt 60 have reportedly taken place from the cancer hospitals in the capital. Cobalt 60 can be used for making 'dirty bomb' easily. One does not require technical knowledge to make one.

All this leads to the conclusion that there is a likelihood of nuclear material being used by terrorists to achieve their nefarious designs. Are we prepared to face such an eventuality? Probably not. Where are the pitfalls and how can we minimise their effects?

India has been grappling with low intensity conflict and terrorism in Jammu and Kashmir and insurgencies in the North East for several years now. The Mumbai blasts of 1993, the Coimbatore explosions of 1997 and numerous events of civil unrest and strife are the other manifestations of human induced disasters.

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The 11 September 2001 incident in the USA was a grim reminder to the world of the worst possibilities of terrorism. It also made the West, especially the USA, realise the practical nuances of terrorism.

The likelihood of nuclear weapons, (may be of crude variety), falling into the hands of terrorists and militants cannot be ruled out. For whom were the uranium plates heading for on 8 December 2004? This is a question our intelligence agencies are grappling with. Although steps in the right direction are being taken in capacity upgrading preparedness and response mechanism for tackling natural and human induced disasters, not much has been achieved to counter nuclear disasters. This is a grey area which needs to be addressed.

Nuclear disasters, by their very nature invoke a great deal of emotions, ranging from command over unlimited power to that of utmost horror and revulsion. At the same time, in spite of detailed accounts available about the effects and repercussions of nuclear disasters, the magnitude of the tragedy and the challenge implicit in their existence does not easily sink in.

Nuclear disasters may also mean nothing to the population since they are under the perception that it may never happen in their lifetime and more so since the chances of worldwide nuclear war have receded after the break up of the former Soviet Union. But with the proliferation of the nuclear technology, the chances of it taking place nearer home have multiplied. With easy availability of nuclear know-how, a crude variety of radiological dispersal device or 'dirty bomb' with terrorists and militants is a reality. Thus terrorism and spread of nuclear weapons have enlarged the scope of human induced disasters.

Nuclear Hazards

Disasters occur when a trigger event, a hazard (earthquake, cyclone, flood, industrial accident, act of terrorism, nuclear explosion, spill and so on) drastically affects human population. Most disasters have common characteristics – they lead to disruption of normal activity pattern of societies,.they result in a degree of loss (human, material, economic and environmental)

and they often outstrip the ability of the affected societies to deal with the problem themselves without resorting to external help.

Nuclear Attack Defined

The detonation of nuclear weapons gives rise to the phenomenon of flash, blast wave, thermal wave, massive fires (fire storms), initial radiation (neutrons and gamma rays), radioactive fall out, electromagnetic pulse and climatic changes. The extent of damage caused by a nuclear bomb depends not only on the type and size of the bomb but also on the height at which it is detonated, the atmospheric conditions, the time of the detonation and other variable factors. However, height of detonation is the main factor determining whether there will be local radioactive fallout or not. If the fire ball, the size of which depends on explosive yield of bomb, touches the ground, i.e. in case of a ground or low air burst, it sucks up huge quantities of earth and debris with the radioactive products of the bomb. These form part of the characteristic mushroom cloud that is carried aloft with the wind. When the fireball cools, some of the radioactive particles descend by force of gravity, the others are deflected downwind from the site of the explosion. In the case of an air burst, there is no local fallout.

Any explosion involves release of a large amount of energy in a very short time. In a nuclear explosion, the energy is produced by redistribution of protons and neutrons, among the interacting nuclei. Thus the energy released in a nuclear reaction is of the order of nuclear binding energies, which are much larger than chemical binding energies. This difference in energies released is the cause for immense destructiveness of nuclear weapons. The redistribution of nuclei is observed to happen in one of the two ways: a heavy nucleus can split into two lighter nuclei or two light nuclei can combine to form a heavier nucleus. The former is called 'fission' and the latter, 'fusion'. These different processes form the basis of the 'fission weapon' and the 'fusion weapon', also known as the 'atom bomb' and the 'hydrogen bomb' respectively. The energy released when a nuclear weapon explodes is called the yield of the weapon. This is usually measured in kilotons or mega tons of TNT equivalent.

Types of Nuclear Disaster

Nuclear disasters can be of three kinds as follows:-

(a) **Type 1.** During nuclear attack in a war scenario.

(b) **Type 2.** Nuclear leaks in nuclear reactors during normal functioning.

(c) **Type 3.** Nuclear weapons falling in the hands of anti-national elements or sabotage or militant threat to strategic targets like seat of power, national symbol (like the Parliament), military establishments, densely populated areas, nuclear establishments, reactors and so on.

Type 1 Disasters.

Nuclear disasters can be caused as a result of full fledged nuclear war between two warring nations possessing nuclear weapons. Civil defence in rear areas, in such an eventuality, is probably not all that prepared. Director General, Civil Defence should become the nodal agency for responding to all types of disasters, including nuclear ones. Mock drills should be conducted regularly.

Type 2 Disasters.

As regards Type 2 nuclear disasters, these occur due to the following:-

(a) Human error.

(b) Carelessness during routine working.

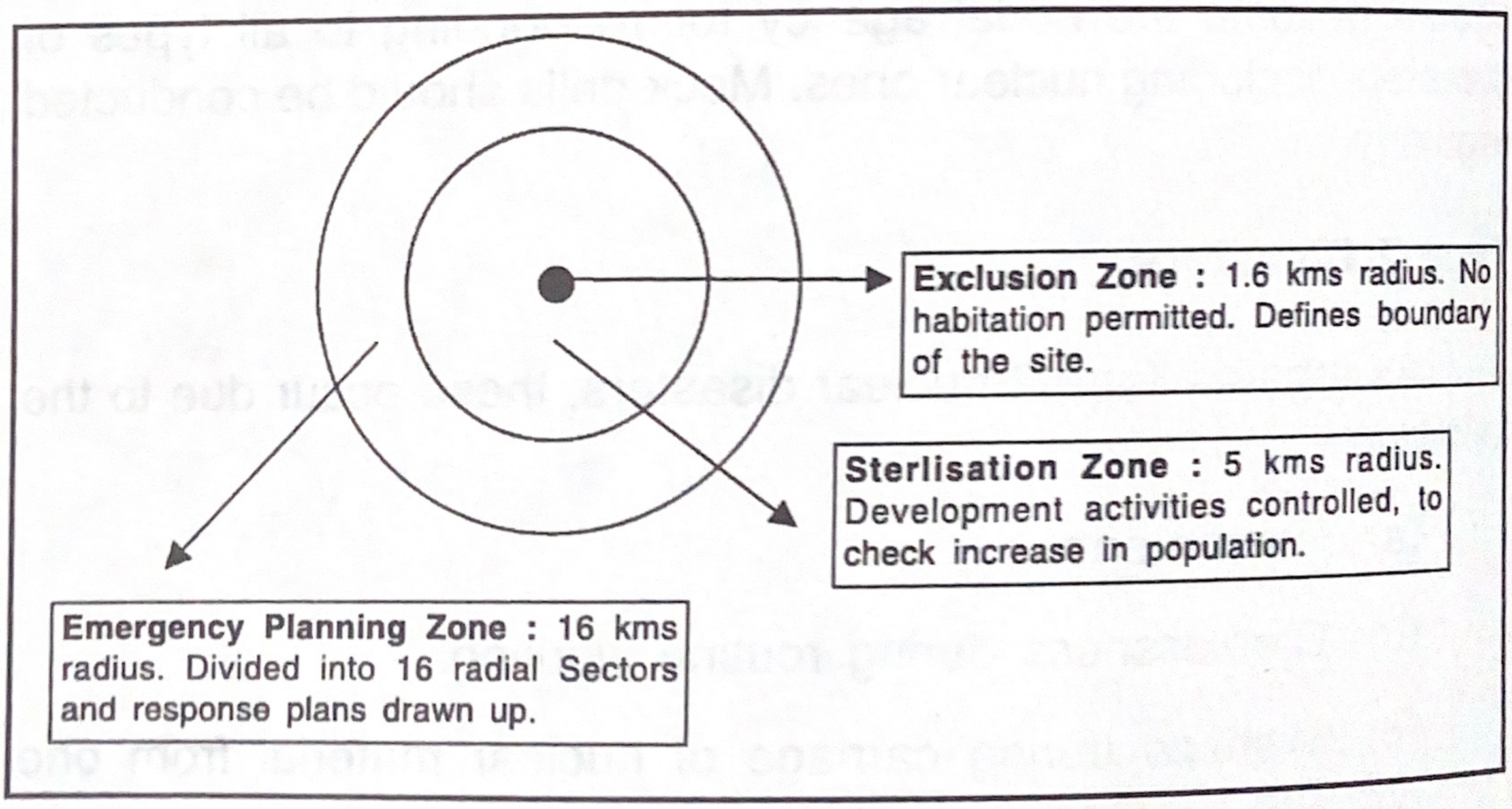
(c) Mishaps during carriage of nuclear material from one place to another.

Commercial nuclear reactor uses low grade nuclear enriched Uranium (four per cent U235) which can not explode like an atom bomb. Melt down may take place when a reactor 'melts' i.e. uranium fuel rods start to liquify. In a commercial nuclear reactor, the chain reaction generated is controlled and there are stringent checks and counter checks, to prevent leaks. Elaborate arrangements

exist to take remedial measures within the complex, including immediate, short and long term. The responses are checked periodically to test the standard operating procedures. But errors do occur. In its long history of 67 years since 1938 when fission was first discovered, the problem of controlling this technology has been of central importance to the human race. Nuclear technology should be used for development and not for destruction. In its peaceful use, there have been a few disasters, two of which have been documented, namely Three Mile Island, Pennsylvania, USA (28 March 1979) and Chernoboyl in Ukraine (26 April 1986). Both nuclear accidents started as a result of minor technical failures, which were accentuated into disasters due to human errors or wrong perception and reading of the situation. The one in India at Kalpakkam Nuclear Reprocessing Plant (KARP), Tamil Nadu on 21 January 2003 was reportedly successfully contained and a major disaster averted.

Emergency Response Plans for Nuclear Facility. Figure 1 is one schematic of emergency response zones.

FIGURE 1 : EMERGENCY RESPONSE ZONES



Note : Generally, all emergency response plans are finalised two years before the plant is commissioned. An off site emergency exercise is also supposed to be conducted before commissioning.

Each nuclear power station facility has an 'Exclusion Zone' of 1.6 km, surrounding the power station, in which no habitation is permitted. The entire area is fenced or walled off and defines the boundary of the site. Next comes the five km radius, known as

'Sterilisation Zone' in which all developmental activities are controlled, to check the increase in population. Beyond this is the public domain and an area of 16 km radius around the plant site which is called off site 'Emergency Planning Zone' (EPZ).

There are three types of emergencies for which emergency response plans are made as under:-

(a) Plant Facility Emergency (Emergency Standby, Personnel Emergency and Plant Emergency).

(b) Site Emergency.

(c) Off Site Emergency.

In the 'Plant Facility Emergency', the accidents are expected to be limited to the plant facility only. Adequate safety measures have to be taken to save workers and machinery. The second type, the 'Site Emergency', wherein the consequences of an accident are not expected to cross the site boundary i.e. 'Exclusion Zone', which means that there will be no radiological emergency in public domain. The response plans are approved by highest nuclear authority. They are tested during exercises and drills and corrective measures taken. As part of trigger mechanism, the Crises Management Group in Department of Atomic Energy (DAE) is automatically alerted even when a 'Plant Emergency' exercise takes place. This is repeated even in a 'Site Emergency' exercise. For the last type of emergency (Off Site Emergency), which is highly unlikely, detailed response plans are drawn up. The local district administration and the Crises Management Committee at the Cabinet Secretariat are expected to get involved only in this last type of Emergency. It is local district administration which is responsible for drawing up and testing 'Off Site Emergency Plans'. These plans are tested at least once every two years. DAE has an Emergency Control Room (ECR) which is manned and operated round the clock all year round.

Preparedness for nuclear fall out includes a system for notifying the public in 16 km Emergency Planning Zone. The public might be advised to stay indoors or evacuate the area.

The other type of radiological emergency envisaged in the public domain is during the transportation of radioactive material. Mandatory design specifications for the packaging, systems and procedures for handling and transport have to be in place, to ensure that there is no release of radioactivity in the public domain, in the unlikely event of such an accident. However, even if such an event were to occur, the ECR at the DAE Secretariat gets an alert, which in turn, immediately activates the Crises Management Group. It is, however, recommended that for monitoring the movement of radioactive material, global positioning system (GPS) or equivalent gadget should be used by the transporting vehicle as well as sending and receiving agencies and the ECR.

Type 3 Emergency.

The third type of emergency is when the nuclear weapons fall in the hands of terrorists. Terrorist use of a radiological dispersion device (RDD) often called "dirty nuke" or "dirty bomb" – is considered far more likely than use of a nuclear device in a war. These radiological weapons are a combination of conventional explosives and radioactive material designed to scatter dangerous and sub-lethal amounts of radioactive material over a general area. Such radiological weapons appeal to terrorists because they require very little technical knowledge to build and deploy, compared to a nuclear device. Also, radioactive materials, used widely in medicine, agriculture, industry and research, are readily available and easy to obtain, compared to weapon grade uranium or plutonium. Use of a nuclear device would probably be limited to a single smaller "suitcase" weapon.

There is no way of knowing how much warning time there would be before an attack by a terrorist using a nuclear or radiological weapon. A surprise attack remains a possibility. If intelligence reports envisage threat of a nuclear bomb strike by terrorists, people living near potential targets could be advised to evacuate or they could decide on their own to evacuate to an area not considered a likely target. Protection from radioactive fallout would require taking shelter in an underground area, or in the middle of a large reinforced concrete building. But with the 'dirty bomb' in the hands of anti- national elements, no area in the country is safe. Some examples of the potential targets for the terrorists

could include:-

(a) Strategic missile sites and military bases.

(b) Nuclear reactors and nuclear establishments.

(c) Centres of government and state capitals.

(e) Important transportation and communication centres.

(f) Manufacturing, industrial, technology and financial centres.

(g) Petroleum refineries, electrical power stations and chemical plants.

(h) Major ports, airfields and large railway yards.

(j) Military headquarters, ammunition depots and so on.

Protection Against Nuclear Detonation

Best protection against nuclear detonation is spreading general awareness among the population. When early warning of nuclear detonation is received or when it has already taken place, try and take shelter underground in subways or underground portion of Metro rail. While underground, lie in one corner near the wall. If caught over ground, rush to nearby house and lie face down in the centre of the room or under heavy furniture. If in the open, drop on the ground, face down, crawl to a nearby cover, with no portion of your body exposed directly, lower sleeves of your shirt, curl your face with your arms, lie face down. If traveling, close windows and stop air conditioning and other vents. Move out of the contaminated area as fast as possible.

At present, we are neither prepared nor have taken steps in educating the masses. The right place to start in educating the public about nuclear disasters is to make it a part of study curriculum from VIII standard onwards. For educating adult population, following steps are recommended:-

(a) Include a chapter in undergraduate courses in all disciplines.

(b) Include study of nuclear study material as part of basic courses at Lal Bahadur Shastri Academy of Administration Mussorie, Sardar Vallabbhai Patel National Police Academy Hyderabad, Para Military and State Police Academies, Armed Forces Training Academies, schools of instruction and so on.

(c) In-service courses of all government and Non-Government Organisations (NGOs).

(d) Workshops, seminars, discussions on TV, radio and print media are also important mediums.

Director General, Civil Defence, should be nominated as a nodal response agency for all nuclear disasters, except in the war zone. He should coordinate plans and organise mock drills periodically.

CONCLUSION

The chances of these 'dirty bombs' falling into the hands of terrorists cannot be ruled out. Nations have to evolve their strategies, plan tactics and set standard operating procedures against such eventualities as a precautionary measure before they cause catastrophic damage to the country and its people. Presently we are not prepared for this type of a disaster. Unfortunately, India has been learning only after a disaster has struck. Super cyclone of 1999, Bhuj earthquake of 2001 and Tsunami of 2004 bear testimony to this stark reality. Recovery of radioactive uranium and thefts of Cobalt 60 are pointers to the larger threat in the offing. We know that the South Asian region is a nuclear flashpoint. Let us prepare ourselves accordingly.

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