EMERGENCY RESPONSE PLAN FOR ACCIDENTS IN SAUDI ARABIA

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Abstract

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This paper presents a brief description of the general emergency plan for accidents involving radioactive materials in the Kingdom of Saudi Arabia. Uses of radioactive materials and radiation sources and their associated potential accident are specified. Most general accident scenarios of various levels have been determined. Protective measures have been specified to reduce individual and collective doses arising during accident situations.

Intervention levels for temporary exposure situations, as established in the IAEA's basic safety standards for protection against ionising radiation and for the safety of radiation sources, are adopted as national intervention levels. General procedures for implementation of the response plan, including notification and radiological monitoring instrumentation and equipment, are described and radiation monitoring teams are nominated. Training programs for the different parties which may be called upon to respond are studied and will be started.

1. SOURCES OF HAZARDS AND POTENTIAL ACCIDENTS

Radioactive materials are manufactured, exported, imported, transported and used in industry, medicine, research and teaching in the Kingdom of Saudi Arabia. Some radioisotopes and radiopharmaceuticals are produced at the research center of the King Faisal Specialist Hospital at Riyadh using a 28 MeV variable energy cyclotron. Some of these radioisotopes are used locally and some are exported abroad. Moreover, different radiation sources are imported from abroad and are widely used in different techniques. The main techniques involving the use of radioactive sources in the Kingdom, together with the maximum activity used by a single user, are summarised in Table I. All possible accident scenarios with different radiation sources can be grouped as follows:

(1) Human or technical errors that may lead to a situation where the radioactive source becomes unshielded and it becomes impossible to retract it into its containe
(2) A transport accident involving radioactive sources or material which leads to a situation where the radioactive source becomes unshielded or to spillage of the radioactive material and its dispersion.
(3) Conventional fire or explosion in which the container and shield of source may melt and consequently the source becomes unshielded, and spillage of radioactive material and dispersion may occur.
(4) A radioactive source may be misplaced, lost or stolen, or it may have ended up in the possession of those who are unaware and may interfere with it.
(5) A spillage of a radioactive material due to a human or a technical error, causing contamination inside an installation which also may extend to off-site.

The aforementioned scenarios of accidents involving radiation sources and materials may be grouped into three characteristic groups as follows:

Loss of the radioactive source shielding, leading to external exposure of the workers, as well as of the general public.

(1) Loss of containment of the radioactive material, leading to its spillage, dispersion and contamination of people and environment in on-site locations with a possibility of extending to the off-site locations.
(2) Loss or theft of a source or a radioactive material, leading to contamination of people and the environment.

For the purpose of this emergency plan, radiological accidents are classified according to the geographical extent of the consequences as follows:

I. Level 1: Consequences of the accident are limited to a single room or building.
II. Level 2: Consequences of the accident are limited to the perimeter of the installation.
III. Level 3: Consequences of the accident are of significance outside the installation.

2. THE EMERGENCY RESPONSE PLAN

2.1. Objectives of the Plan

The objectives of responding to emergency situations depend to a large extent on the accident type. However, since the emergency response plan should have an adequate degree of flexibility to cope with accidents of different natures and different levels of severity, the common objectives for different emergency situations should be outlined. When responding to accidents of the first group, the objectives should be as follows: Keeping individual and public doses as low as reasonably achievable by introducing the proper protective measures, assessing the doses accurately, arranging for medical assistance of the injured personnel, if there are any and restoring control over the source, by returning it inside its shield or placing it in a safe shielded position. When responding to accidents of the second group, accidents caused by loss of the containment of a radioactive material, the objectives of the response are as follows: Keeping the doses as low as reasonably achievable, controlling, contamination and keeping the contaminated areas as low as possible, assessing the contamination levels and doses, arranging for medical assistance and decontamination of injured personnel, if any, decontamination and clean-up of the contaminated objects, collecting and disposing of the radioactive waste. Accidents caused by misplacement, loss or stealing of the radioactive source, the objectives of the response are as follows: Locating the source, effecting the recovery of the source and bringing it under control, keeping doses as low as practically possible, assessing doses accurately, arranging for medical assistance of injured personnel, if any.

2.2. Time scale and phases of the accidents

Radiological accidents involving radioactive materials and sources may last minutes or a few hours and severe ones might continue for several days. Nevertheless, in all circumstances three distinct phases may be identified; these are the recognition phase, initial phase and the recovery phase. The recognition phase starts from the moment loss of control over the source takes place until the recognition that an accident has occurred. The initial phase is the time between the moment of recognition of the accident until exposure to the source has been brought to a certain degree of control, but before restoration of the situation is normal.

The immediate steps for responding to the emergency, after the recognition phase, depend on the accident type. In case of loss of shielding, the accident is considered under a certain degree of control once people are evacuated from the high dose rate area, and the initial phase is terminated. In the case of a contamination accident, the initial phase is over when the spreading of the radioactive contamination is stopped. In the case or theft of a

radioactive source the initial phase ends when the source has been found or located. The recovery phase is the period between achieving a certain degree of control over the source up to the moment of reinstatement of normal conditions. Restoration of the situation to normal conditions during the recovery phase is considered urgent in cases where the effects of the accident involve people or areas outside the facility, but in cases where these effects are confined, restoration should be carried out only after detailed planning.

2.3. Responsibilities and Responding Organization

(1) **The Licensee:** The licensee has the primary responsibility for the safe use and control of the licensed radioactive materials and sources. It is his responsibility to prepare detailed response plans to all credible scenarios of accidents that can be anticipated with the licensed sources and materials. These plans should include parts dealing with identification of accidents, immediate steps needed to control exposures, assessments, protective actions, notifications of the local Civil Defence authorities and the competent radiological authority.

(2) **The Consignor and the Carrier:** In transport accidents, although the consignor has the primary responsibility, the carrier also bears safety responsibilities during transport. The consignor is responsible for complying with the national regulations related to the transport of radioactive materials. He should supply the carrier with all appropriate emergency instructions and schedules, be ready to offer all needed assistance in an emergency involving the consignment, and send emergency crews to the accident site if needed. The carrier is responsible for complying with the national regulations, being informed of different response procedures along the route, and getting the proper emergency instructions on board the vehicle.

(3) **The Local Authorities:** The intervening local civil defence authorities (police, fire brigade, ambulance and medical services) have the responsibility to protect the public. These authorities should rely on their general procedures and normal methods of operations supplemented with specific advice and recommendations given to them when notified of the accident. The licensee must be prepared to give advice and instructions to the local defence personnel.

(4) **The Competent Authority:** King Abdulaziz City for Science and Technology (KACST) is the National Competent Authority in the Kingdom of Saudi Arabia. The Institute of Atomic Energy Research (IAER) being the arm of KACST is responsible for discharging the day to day functions. KACST is responsible for the approval, review and periodic test of the emergency response plans prepared by the licensees and for ensuring the preparedness of these plans. It should be notified about all types of accidents to assess all undertaken protective actions, and to offer the needed assistance for all on-site accidents. For all accidents having off-site consequences KACST should be notified by the licensee immediately to take the off-site assessments and to ensure compliance of the licensee in mitigating the consequences. KACST is prepared to respond to accidents of different levels through communication and notification systems, equipping of radiological monitoring teams with adequate instruments and equipment's, as well as a decontamination team. It carries the necessary training to immediately respond to different types of accidents.

2.4. Communication and Notification

(1) Access to the KACST has been made available at any time. Capability to receive notifications and reports from licensees and users has been secured through four telephone lines, two of them are connected to the Director of the Institute of Atomic Energy Research (IAER) (one at day time and the other at night) and the other two are connected to the head of the radiation protection department of IAER. The licensee, user, radiation protection officer

(RSO) or qualified expert should immediately notify the IAER of the fact an emergency situation exists, unless the accident is considered a minor one. In the later case, a detailed report should be sent to IAER. In general, the accidents which are considered minor ones have been defined for all licensees.
(2) The notification should be done accurately and in accordance with the form defined in the national basic safety standard, and should include complete information on notified, accident, sources, and injuries.
(3) When the emergency situation is terminated, a written report should be provided to IAER. It should include detailed information and reasons of the accident, response procedures and methods, all assessments of exposure among occupational workers and the general public, and all corrective actions to avoid repetition of the accident.

2.5. Control of Access

Control of access to hazardous areas depends on the type of accident and its magnitude. In the case when a source is missed or stolen, control of access is not applicable. However, in the case of loss of shielding, contamination or transport accidents it is a must. The limits of the restricted areas depend on nature and activity of the exposed source, degree of release or contamination, and on weather and wind direction. These limits should be defined immediately after the occurrence of the accident by the operator. The RSO should define the limits of the restricted areas so that the exposure outside them is normal after careful assessment of the situation. The Competent Authority should evaluate the extent of the restricted area. Control of access will be carried out using physical barriers (walls, doors, windows), affixing warning labels and signs, stopping local ventilation and air conditioning system since they may affect dispersion of radioactive material, using civil defence or traffic barriers, and cordoning the area by police brigades. Access to cordoned areas will be made only through a check point which should be used as a radiological control station for people, equipment and material and as an assembly point for responding and for emergency crews.

2.6. Equipment and Emergency Teams

During all stages of management of the accident, radiation measuring instruments are required. The user should have only those instruments that are necessary for his own specific source or material, while the competent authority has all instruments that may be necessary to respond and monitor radiation or contamination in all situations. Sets of different personnel dosimeters are maintained, calibrated and regularly checked and are ready for use at any time. A set of survey meters, radiation and contamination monitors, needed for an appropriate response to different accidents, radiation, energy ranges and radiation intensities, are maintained in good working condition. Moreover, a mobile intervention laboratory provided with radiological monitoring instruments, sampling equipment and other accessories is ready to respond to any emergency situation. This laboratory (8.0 x 2.2 x 2.1 m. vehicle) contains a whole body scanner based on a hyper-pure germanium spectrometer, a high resolution germanium spectrometer with the associated electronics, computer and software, and a proper lead shield, separate counting facilities for alpha and beta gross counting and NaI (Tl) gamma-ray spectrometer with the associated electronics and lead shield.

At present there are two teams (3 members each) engaged in the emergency response plan. They are all working in the IAER and have good experience in radiation and spectroscopic measurements, and they are headed by an experienced senior nuclear physicist. Soon a third team will be prepared to meet the requirements for covering 24 hour monitoring. A decontamination group headed by a senior radiochemist is also ready to carry out any

decontamination activities and to give needed advice to users or to the Civil Defence personnel in this matter.

2.7. Medical Care

Severe accidents may result in external doses which exceed thresholds for the deterministic effects of radiation. For that case, it has been arranged that King Faisal Specialist Hospital and Research Center at Riyadh (Capital of KSA), where medical practitioners with some experience in radiation effects are available, will be responsible for the medical treatment of radiologically injured individuals. In case of internal exposure, it is now being discussed with the hospital to prepare the special facilities, equipment, materials and expertise to cope with personnel decontamination and to limit the spread of contamination.

TABLE I. TECHNIQUES INVOLVING THE USE OF RADIOACTIVE SOURCES IN SAUDI ARABIA TOGETHER WITH MAXIMUM ACTIVITY USED BY A SINGLE USER

No.	Used technique and sources	Max. Activity
1.	**Radiography techniques (industrial non-destructive testing)**	
	Ir-192	250 Ci
	Co-60	30 Ci
	Cs-137	30 Ci
	Neutron sources -(Am+Be) and Cf-252	-<1 Ci
	Beta radiography	-<1 Ci
2.	**Gauging techniques Transmission gauges ,Backscattering gauges**	
	Level gauge (gamma)	-<1 Ci
	Neutron thermalization (humidity measurement)	-<1 Ci
	Neutron transmission	-<1 Ci
3.	**Irradiation techniques**	
	Radiation beam therapy	14 kCi
	Brachytherapy	
	Radiation sterilization (Co-60)	250 kCi
	Polymerization (Co-60)	24 kCi
	Blood sterilization (Cs-137)	1403 Ci
	Research	24 kCi
4.	**Techniques involving unsealed radioactive materials**	
	Isotope production (^{99m}Tc, ^{125}I, ^{131}I...)	1 Ci
	Medical applications and diagnostic use	-<1 Ci
	Tracer techniques	-<1 Ci

2.8. Training

A training program is now planned for all personnel and bodies that will participate in the emergency response. The training program will include general radiation protection, radiation measurements and dose evaluation, use of different equipment and devices for radiological assessment, emergency procedures, organizations, communications and responsibilities.

The training program for the IAER personnel will take into consideration the roles that its personnel must play in responding to accidents. It will include accident assessment techniques, implementation of protective measures, and use of protective clothing. Moreover, users of radioactive materials and sources are instructed to provide training for their personnel in accordance with the potential hazards of the materials they are using.

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