IAEA

Emergency Preparedness Review

EPREV

# PEER APPRAISAL OF THE ARRANGEMENTS IN THE REPUBLIC OF GHANA REGARDING THE PREPAREDNESS FOR RESPONDING TO A RADIATION EMERGENCY

2015-05-31 to 2015-06-09

International Atomic Energy Agency

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# FOREWORD

Within the United Nations system, the International Atomic Energy Agency (IAEA) has the statutory functions of establishing standards of safety for the protection of health against exposure to ionizing radiation, and of providing for the application of these standards. In addition, under the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention) the IAEA has a function, if requested, to assist Member States in preparing emergency arrangements for responding to nuclear accidents and radiological emergencies.

In response to a request from the Government of Ghana, the IAEA fielded an Emergency Preparedness Review (EPREV) mission to conduct, in accordance with Article III of the IAEA Statute, a peer review of Ghana's radiation emergency preparedness and response arrangements vis-à-vis the relevant IAEA standards.

The number of recommendations, suggestions and good practices is in no way a measure of the status of the emergency preparedness and response system. Comparisons of such numbers between EPREV reports from different countries should not be attempted.

**Contents**

## Executive Summary

This report provides the results of the Emergency Preparedness Review (EPREV) mission to Ghana from 31 May to 9 June 2015. The mission was undertaken by the International Atomic Energy Agency (IAEA) based on a request from the National Disaster Management Organization (NADMO) and the Ghana Atomic Energy Commission (GAEC). EPREV missions are designed to provide a peer review of emergency preparedness and response (EPR) arrangements in a country based on the IAEA Safety Standards. The team for the EPREV mission consisted of international EPR experts from IAEA Member States as well as a team coordinator from the IAEA Secretariat.

This report includes recommendations and suggestions for improvements based on safety requirements and good practices that are considered as models for other Member States. In some cases, improvements in line with the detailed findings are already being undertaken. In other cases, the Government of Ghana should adopt an action plan to implement the recommendations and suggestions.

The EPREV team considers it the highest priority for Ghana to increase the depth of understanding of the current plans and procedures by response organizations. There are well-established plans, including the National Nuclear and Radiological Emergency Response Plan (NNRERP) and National Emergency Response Procedures in the Event of a Nuclear or Radiological Accident, but the knowledge of these plans is limited to a small number of individuals. In many cases, staff and experts interviewed stated that they knew of the plans and procedures, but in the event of an emergency, they would call the individual responsible for drafting that plan.

The plans and procedures represent only the core of an EPR capability. Organizations identified in the documents, including operating organizations and response organizations, should carry out an analysis of their needs in order to fulfil their responsibilities identified in the plans. This should include skills sets needed for the various positions, training programs for those positions, depth of personnel needed to fill the positions, and equipment that may be needed. In particular, additional training is needed for first responders.

There is a significant amount of specialized equipment for emergency response available in the country. This is mostly concentrated at GAEC in the Nuclear Security Support Centre (NSSC). There are areas of need, most notably in equipment such as alarming dosimeters and radiation pagers, which could help protect first responders and front line officers.

Response organizations would benefit from conducting emergency drills and exercises to test the effectiveness of the training and reinforce the use of specialized equipment that is not often used. These exercises should include a combination of exercises at category III facilities such as the Ghana Research Reactor 1 (GHARR-1) and also at other locations where radioactive material can be encountered, such as at border crossings. The exercise programme should be coordinated at the national level and should periodically include senior government officials as participants.

GAEC has a unique combination of roles under the current government structure, including those of promoter, regulator, operating organization, and technical support organization. This has created a significant challenge for GAEC to implement the necessary EPR arrangements in each of these roles. The GAEC compound, including the GHARR-1, the Waste Management Centre (WMC), an irradiation facility, and storage areas for other radioactive

materials, do not have in place adequate EPR plans and procedures. In the case where plans exist, such as for GHARR-1, the plans exist in isolation and don't fully recognize the possibility for emergencies at another institute on the GAEC site to affect the facility. GAEC also needs to conduct further analysis and training for its role to support an emergency response elsewhere in the country. In every interview and site visit, the counterparts noted the expertise available in GAEC and emphasized their reliance on receiving technical advice from GAEC during an emergency. GAEC should focus training and exercise efforts on establishing a capability to integrate into the Incident Command System (ICS) and the mechanisms by which such advice can be provided.

The EPREV team noted positively the new bills under review by Parliament, including new legal authorities for NADMO and GAEC. Most notably, the new bill for GAEC would establish a new, effectively independent regulatory body. These bills represent significant accomplishments for both organizations and their adoption would create a strong legal basis for future activities. In the interim, NADMO and GAEC should prepare diligently for the transition period to ensure that capabilities and resources are not lost in the re-organization.

The EPREV team noted the excellent cooperation between NADMO, GAEC, and all the stakeholders and response organizations during the mission and in detailed discussions regarding the EPR arrangements in the country.

This report serves as the final record of the EPREV mission. The IAEA will continue to work with Ghana through existing projects to continue to improve EPR arrangements. It is expected that Ghana will develop an Action Plan to implement the recommendations and suggestions in the report, and will invite the IAEA for an EPREV Follow-Up Mission to review the implementation.

# 1. Introduction

## 1.1. Objective and Scope

The purpose of this EPREV mission was to conduct a review of Ghana emergency preparedness and response arrangements and capabilities. The EPREV focused on emergency preparedness categories III and IV. The review was carried out by comparison of existing arrangements against the IAEA safety standards.

It is expected that the EPREV mission will facilitate improvements in Ghana's emergency preparedness and response arrangements, and those of other Member States, from the knowledge gained and experiences shared between Ghana and the EPREV team and through the evaluation of the effectiveness of the Ghanaian arrangements, its capabilities and its good practices.

The key objectives of this mission were to enhance nuclear and radiation safety, emergency preparedness and response:

- Providing Ghana with an opportunity for self-assessment of its activities against IAEA safety standards;
- Providing Ghana with an objective review of its emergency preparedness and response arrangements with respect to IAEA safety standards and guidelines;
- Contributing to the harmonization of emergency prepradeness and response approaches among IAEA Member States;
- Promoting the sharing of experience and exchange of lessons learned;
- Providing reviewers from IAEA Member States and the IAEA staff with opportunities to broaden their experience and knowledge of EPR;
- Providing key staff with an opportunity to discuss their practices with reviewers who have experience with different practices in the same field;
- Providing Ghana with recommendations and suggestions for improvement; and
- Providing other States with information regarding good practices identified in the course of the review.

## 1.2. Preparatory Work and Review Team

At the request of the Government of Ghana, a preparatory meeting for EPREV was conducted from 13-14 January 2015. The preparatory meeting was carried out by the appointed Team Leader Mr Peter ZOMBORI and with the counterparts from Ghana.

The EPREV preparatory team had discussions regarding EPR (and policy issues) with the Liasion Officer Mr Joseph Ofei ANKRAH and key organisations in the host country. The discussions resulted in agreement of the scope of the EPREV mission.

Mr ANKRAH made presentations on the national context, the current status of EPR in Ghana and the self-assessment results to date. Mr Razak AWUDU from GAEC gave a presentation on the nuclear and radiological emergency preparedness and response arrangements in the country.

IAEA staff presented the EPREV principles, process and methodology. This was followed by a discussion on the tentative work plan for the implementation of the EPREV Mission in June 2015.

The proposed EPREV Review team composition (experts from Member States to be involved in the review) was discussed and the size of the EPREV Review team was tentatively confirmed. Logistics including meeting and work space, counterparts and Liaison Officer identification, proposed site visits, lodging and transportation arrangements were also addressed. All relevant aspects were included in the agreed Terms of Reference (TOR).

Mr ANKRAH provided IAEA (and the review team) with the advance reference material for the review including the self-assessment results. In preparation for the mission, the IAEA review team members conducted a review of the advance reference material and provided their initial review comments to the IAEA Team Coordinator prior to the commencement of the EPREV mission.

### 1.3 Reference for the Review

The primary reference for the review is IAEA Safety Standards Series draft Safety Requirement GSR Part 7 *Preparedness and Response for a Nuclear or Radiological Emergency* [1]. GSR Part 7 was approved by the Board of Governors in March 2015 and is awaiting publication at the time of the mission.

In addition, Safety Guides GSG-2 *Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency* [2], and GS-G-2.1 *Arrangements for Preparedness for a Nuclear or Radiological Emergency* [3] were used as review criteria.

The terms used in this report are consistent with those found in the IAEA standards referred in the above paragraphs.

## 2. DETAILED FINDINGS ON GENERAL REQUIREMENTS

### 2.1. Emergency management system

The legal basis for the emergency management system in Ghana is provided through the Disaster Management Organization Act no. 517, 1996. This act establishes the National Disaster Management Organization (NADMO) of Ghana reporting to the National Security Council. A National Coordinator leads the organization and is charged with carrying out the responsibilities and functions of disaster management. The Act focuses on response and recovery aspects of disaster management but does not empower NADMO for prevention and preparedness efforts. To codify the roles and responsibilities, a new Act has been drafted (National Disaster Management Organization Bill 2014) and is now with Parliament for review. Approval is expected in 2015. Despite the limited legal basis for preparedness efforts, NADMO has been successful in establishing strong technical committees for the identified hazards in the country, including a committee for nuclear and radiological emergencies, which has been in continuous existence since 2004 and includes participants from all stakeholders and response organizations.

NADMO developed and published a National Disaster Management Plan (NDMP) in 2010, which defines the all-hazards emergency management system and includes nuclear and radiological emergencies. The plan covers all required elements and establishes a strong foundation for emergency preparedness and response in the country. Also in 2010, NADMO and the Ghana Atomic Energy Commission (GAEC) jointly developed and published a National Nuclear and Radiological Emergency Response Plan (NNRERP). The NNRERP is entirely consistent with the NDMP, includes all the required elements, and is consistent with international arrangements. These plans are well understood by a limited number of key individuals in all stakeholder organizations; however, there is a need for more training and staffing related to the plans. This is discussed in detail in Chapter 4 under the infrastructure requirements.

The Atomic Act, 2000 establishes GAEC and identifies a legal basis for the peaceful use of nuclear technology in the country, but it does not address emergency preparedness and response. Critically, the Act does not establish an effectively independent regulator. While the structure of the regulator is not the purview of this report, this has a significant impact on the emergency preparedness and response (EPR) arrangements. This issue has been well identified by Ghana and other IAEA review missions, and a new bill has been drafted to restructure GAEC, establish a new, effectively independent regulator, and provide a more complete legal basis (including emergency preparedness and response). Like the new disaster management bill, the new nuclear technology act is with Parliament for review and it is expected to become law in 2015.

The team acknowledges and recognizes the significant efforts undertaken to draft these new laws and the improvements they include. However, the revised legal structure – in particular as it relates to the structure and responsibilities of GAEC – raises the need to review the NDMP and NNRERP to reflect the important changes.

| **Suggestion 1.** |
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| **Observation:** The current emergency management system is well defined for all hazards, including nuclear and radiological emergencies. However, the new bills under review by Parliament will necessitate a revision to existing national plans. |

| Suggestion 1. |
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| **Basis for suggestion:** GSR Part 7, paragraph 4.1 states: "The government shall ensure that an emergency management system is established and maintained on the territories and within the jurisdiction of the State for the purposes of emergency response to protect human life, health, property and the environment in the event of a nuclear or radiological emergency." |
| **Suggestion:** NADMO and GAEC should consider reviewing and revising the NDMP and NNRERP in anticipation of the new legal basis, so that the arrangements can be in place as soon as practical after approval of the new bills. |

### 2.2. Roles and responsibilities

*General*

The distribution of roles and responsibilities for nuclear or radiological emergencies is clearly defined in the NNRERP. This document gives a detailed listing of all the national organizations that may have a role in responding to an emergency. The NNRERP assigns the major coordination functions to NADMO, which begin at the initial notification of a nuclear or radiological emergency and end when all government agencies have terminated their response activities. GAEC has the responsibility of coordinating the radiological aspects (e.g., monitoring, measurements) during the emergency.

The NNRERP describes the roles and responsibilities of the other government agencies. The plan covers preparedness, response and recovery. Appendix 2 lists the allocation of the critical tasks. The newly created National Ambulance Service (NAS) is not considered in the NNRERP, although emergency medical services are addressed under the previous government structure.

Chapter 5 of the NNRERP defines the responsibilities for emergency preparedness. This requests all organizations identified in the plan to develop and maintain their own emergency plans and procedures, to review and revise them every year, and to conduct training and exercises for their implementation. However, these supporting plans and implementing procedures do not exist for most of the defined response organizations, with the few exceptions being category III facilities such as the research reactor at GAEC.

*Coordinating mechanism*

By virtue of the NADMO Act 517 of 1996 each government agency should develop and maintain its own emergency response plan and detailed operating procedures to carry out the response described in this plan. The co-ordination of all planning efforts between ministries, regional and local governments and users is ensured through NADMO and the Radiation Protection Board (RPB), the regulatory body within GAEC. The most efficient forum for this coordination effort is the Technical Committee on Nuclear and Radiological Disaster, established by the NDMP and continuously operational since 2004.

Figure 5 of the NNRERP describes the structure of the full-scale national emergency organization for a nuclear or radiological emergency. NADMO is put in the position of the National Coordinator. The coordination mechanism during response is described in Chapter 4 of the NNRERP (Concept of Operations) for the main government functions in a nuclear or radiological emergency including details of possible emergency conditions and immediate emergency actions, notifications, protective action recommendations, control and

coordination of information, monitoring and assessment. The plan covers preparedness, response and recovery.

*Regulatory Body*

The RPB is established as part of GAEC to provide technical and scientific services (e.g., dosimetry, laboratory services) to all GAEC institutes. RPB also serves as the national regulatory body. On a day-to-day basis, the work of the Board is carried out by the staff of the Radiation Protection Institute (RPI), which is identified in the NNRERP as the main GAEC point of contact for emergencies.

Visits to operating organizations, including hospitals and port facilities, clearly demonstrate that RPI staff has the technical knowledge to give advice and assist in all aspects of nuclear and radiation safety, including EPR. They provide dosimetry services as part of their support to licensees. RPI also inspects the safety arrangements during both scheduled and unannounced visits.

However, as the regulatory body, RPI does not have clearly defined regulations and guidance to specify the principles, requirements and criteria for emergency preparedness and response upon which its regulatory judgments, decisions and actions are based. Additionally, the regulatory oversight of EPR arrangements at GAEC operated facilities is not applied in a consistent manner to those at external operating organizations.

| **Recommendation 1.** |
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| **Observation:** RPI, in the role of the regulator, does not have clear criteria or guidance on which to base its regulatory findings when reviewing the arrangements of operating organizations. |
| **Basis for recommendation:** GSR Part 7 paragraph 4.12 states: "The regulatory body is required to establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based. These principles, requirements and associated criteria shall include principles, requirements and associated criteria for emergency preparedness and response of the operating organization." |
| **Recommendation**: RPI, as the regulatory body, should develop criteria and guidance on which its regulatory judgements for operating organization EPR arrangements are based. |

Due to the same reason of not having clear separation of promotional and regulatory functions within GAEC, the enforcement power and tools of the regulator are limited. This deficiency, together with the previously mentioned lack of regulatory criteria and guidance, is expected to be solved during the process of establishing the effectively independent regulatory body.

| **Recommendation 2.** |
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| **Observation:** RPB, as regulator, does not consistently enforce the need for operating organizations to have emergency plans and procedures, including at facilities also operated by GAEC. |
| **Basis for recommendation:** GSR Part 7 paragraph 4.13 states: "The regulatory body shall require that arrangements for preparedness and response for a nuclear or radiological emergency be in place for the on-site area for any regulated facility or activity that could necessitate emergency response actions. Appropriate emergency arrangements shall be established by the time the source is brought to |

| Recommendation 2. |
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| the site, and complete emergency arrangements shall be in place before the commencement of operation of the facility or commencement of the activity. The regulatory body shall verify compliance with the required arrangements." |
| **Recommendation**: RPB, as the regulatory body, should require and enforce that operating organizations develop and maintain emergency arrangements for any facility or practice that could necessitate emergency response actions. |

*Operating organization*

Some operating organizations have emergency plans and procedures which have been developed during the licensing process and are regularly inspected by the regulatory body. The team visited Nick TC Scan Ltd. in the Tema Port area, where the company operates a container scanner using a 37 TBq $^{60}$Co source. The management of the company showed the emergency arrangements (e.g., procedures, active and passive safety systems, dosimeters, and survey meters) that are in place for emergency response. As with other operating organizations, dosimetry service is provided by RPI, which uses the time to collect and exchange dosimeters to also inspect the safety arrangements, including the emergency related ones. At the Nick TC Scan, all staff receives training on emergency arrangements but drills and exercises are done infrequently.

However, other facilities, such as Korle Bu Teaching Hospital, the GAEC WMC, and the GAEC GHARR-1 research reactor, do not have emergency arrangements in place. In some cases specific procedures do exist for the unit/machine operator. This is address in Section 4.4 on Plans and Procedures.

### 2.3. Hazard assessment

The hazard assessment has been conducted by GAEC, in coordination with NADMO, which resulted in the identification of potential hazards in the country. Ghana includes facilities and practices in emergency preparedness categories III and IV. The primary category III facilities are the GHARR-1, with an output of 30 kW, and a number of irradiation facilities at hospitals and ports. The location of all category III facilities is mapped and included as part of the planning basis in the NNRERP.

The hazard associated with category IV practices and with other sources that may be present in the country or enter the country through the borders is also considered in the NNRERP. However, the exact location of these sources and the nature of their use in industry are not well known outside of a small number of individuals within GAEC. A detailed inventory of the sources has been conducted in the Greater Accra and Eastern regions within the country, but has not been expanded to the other 8 regions.

The graded approach has been applied to some facilities in category III, mainly Tema Port and GHARR-1 facilities, but does not include events off the site that could affect the site. Other category III facilities, as identified in the NNRERP section 2.2, do not have hazard assessments.

| Recommendation 3. |
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| **Observation:** The national hazard assessment does not include the location of all radioactive sources in the country, and is not updated on a regular basis. |
| **Basis for recommendation:** GSR Part 7 paragraph 4.25 states: "The government shall |

| Recommendation 3. |
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| ensure that a review of the hazard assessment is performed periodically with the aims of: (a) ensuring that all facilities and activities, on-site areas, off-site areas and locations where events could occur that would necessitate protective actions and other response actions are identified, and (b) taking into account any changes to the hazards within the State and beyond its borders, any change in assessments of threats for nuclear security purposes, the experience and lessons from research, operation and emergency exercises, and technological developments (see paragraphs 6.30, 6.36 and 6.38). The results of this review shall be used to revise the emergency arrangements as necessary." |
| **Recommendation**: The government should update the national hazard assessment to include all sources in the country and locations at which there is a significant likelihood of encountering a dangerous source (e.g., border crossing). |

### 2.4. Protection strategy for an emergency

The requirement to develop a protection strategy is new in GSR Part 7 (2015) and it is not reflected in the Ghana national planning documents, specifically in the NNRERP. Some elements of a protection strategy can be found in Chapter 4 (Concept of Operation) of the NNRERP, but a thorough and consistent protection strategy at the national, regional, district and facility level is still to be performed. This will need to be considered at the national level and should include the input of NADMO and GAEC.

| Recommendation 4. |
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| **Observation:** There is no protection strategy developed for taking protective actions and other response actions effectively in a nuclear or radiological emergency. |
| **Basis for recommendation:** GSR Part 7 paragraph 4.27 states: "The government shall ensure that, on the basis of the hazards identified and the potential consequences of a nuclear or radiological emergency, protection strategies are developed, justified and optimized at the emergency preparedness stage for taking protective actions and other response actions effectively in a nuclear or radiological emergency to achieve the goals of emergency response." |
| **Recommendation**: GAEC and NADMO should coordinate the development of protection strategies for taking protective actions and other response actions effectively in a nuclear or radiological emergency. |

## 3. DETAILED FINDINGS ON FUNCTIONAL REQUIREMENTS

### 3.1. Managing emergency response operations

NADMO has designated the Incident Command System (ICS) as the command and control system for emergency response in the country. It is used frequently for conventional emergencies throughout the country. The NNRERP builds on the concepts of ICS for command and control of nuclear or radiological emergencies and defines the responsibilities of the On-Scene Controller for overall management at the emergency site. The plan is not clear on who would be expected to fill the role of On-Scene Controller or what their qualifications should be. None of the counterparts interviewed knew of anyone who is qualified to be an On-Scene Controller. The On-Scene Controller reports to the Emergency Manager, who is responsible for the "overall strategic management" of the emergency response. It is not clear where the Emergency Manager would be located or who would fill this position.

GAEC, although designated as having key responsibilities during an emergency response, has not yet conducted any training on ICS to allow them to integrate into a response structure. This would hinder the ability of GAEC to be able to provide technical advice and assessments during an emergency.

| **Recommendation 5.** |
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| **Observation:** The command and control system designated in the country, the Incident Command System, is not implemented by all response organizations and operating organizations who would respond to a nuclear or radiological emergency. |
| **Basis for recommendation:** GSR Part 7 paragraph 5.7 states: "Arrangements shall be made for the establishment and use of a clearly specified and unified command and control system for emergency response under the all-hazards approach as part of the emergency management system." |
| **Recommendation**: NADMO should ensure that all organizations, including GAEC (especially RPI), receive training and conduct exercises to be able to use the Incident Command System during the response to a nuclear or radiological emergency. |

### 3.2. Identifying, notifying and activating

The primary method for the public to notify the authorities of an emergency is through phone to the local police or fire station. These local officials know that they should contact NADMO in the event of any nuclear or radiological emergency and have the contact information for the NADMO crisis center, which operates 24/7. There is also an emergency call number to the NADMO crisis center which is available to the public. This number reaches the headquarters in Accra and if necessary headquarters will contact officials in the region or district to respond and provide an initial assessment of the emergency. NADMO is able to contact GAEC and other response organizations as defined in the NNRERP. This is done mostly through personal relationships and a combination of official and personal phones.

At category III facilities there is a wide variation in the process for notification of an emergency. Tema Port has a staffed central station able to receive notifications and contact the local off-site officials. GAEC has a Central Alarm Station (CAS) but it does not have redundant power. During the mission when the team attempted to visit the CAS but the

facility was locked and not staffed because of a power outage. This is discussed in more detail in Chapter 4.5 on Logistical Support and Facilities.

Operating organizations in category IV lack detailed notification procedures for response organizations but are aware that they could contact the police or fire services, and should notify GAEC in an emergency.

There is no national classification system in place in Ghana, although the NNRERP does designate the Facility Manager as being responsible for classifying the emergency. GHARR-1 has a classification system in its plan, although the counterparts interviewed were unaware of it until they saw it during the mission. The GHARR-1 classification system is based on the United States Nuclear Regulatory Commission (NRC) classification system. No other facilities or practices have an emergency classification system.

| **Recommendation 6.** |
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| **Observation:** There is no classification system in place to ensure an appropriate response to a nuclear or radiological emergency. |
| **Basis for recommendation:** GSR Part 7 paragraph 5.14 states: "The operating organization of a facility or activity in category I, II, III or IV shall make arrangements for promptly classifying, on the basis of the hazard assessment, a nuclear or radiological emergency warranting protective actions and other response actions to protect workers, emergency workers, members of the public and, as relevant, patients and helpers in an emergency in accordance with the protection strategy." |
| **Recommendation**: GAEC, in coordination with NADMO and the operating organizations, should establish a classification system for nuclear or radiological emergencies. |

GAEC is responsible for the sending and receiving notification between Ghana and the IAEA (although Ghana is not yet a party to either the *Convention on Early Notification of a Nuclear Accident* or the *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*). However, Ghana has not designated any National Warning Point (NWP), participated in any IAEA convention exercises, or registered any users on the Unified System for Information Exchange in Incidents and Emergencies (USIE). Test messages sent by the IAEA in September 2013, May 2014, and October 2014 were either not answered or the designated phone/fax number was continuously busy (automated systems attempt delivery for extended periods of time).

| **Recommendation 7.** |
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| **Observation:** Ghana does not have a warning point available for international notification, and does not have any users registered for the available international systems. |
| **Basis for recommendation:** GSR Part 7 paragraph 5.19 states: "The State shall make known to the IAEA and to other States, directly or through the IAEA, its single warning point responsible for receiving emergency notifications and information from other States and information from the IAEA. This warning point shall be maintained continuously available to receive any notification, request for assistance or request for verification and to initiate promptly a response or verification." |
| **Recommendation**: The government should designate a single warning point for |

| Recommendation 7. |
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| emergency notifications, which is able to send and receive information from other states and the IAEA. |

First responders receive training on basic radiation hazards and how to identify possible radioactive materials (e.g., placards, warning signs/symbols) as part of the initial training. First responders know how to contact NADMO in case of any indications of a radiological emergency.

### 3.3. Taking mitigatory actions

At GAEC, there are limited procedures and equipment available to control an emergency. The Ghana National Fire Service has two fire stations nearby and is aware they may be needed during an emergency, although no arrangements are in place and no drills or exercise have ben conducted. Off site events that may affect the emergency or the emergency response are not considered.

Other Category III and IV facilities and practices do not have procedures or equipment available for mitigatory actions. This is addressed in Chapter 4.4 on Plans and Procedures.

First responders are generally aware of the indicators of a radiological emergency and their initial response would be to establish a cordon area and call for NADMO and GAEC. There are no arrangements for reach back advice in the time it takes NADMO and GAEC to deploy to the scene (as is discussed further in Chapter 4 and the requirement for Organization and Staffing).

### 3.4. Taking urgent protective actions and other response actions

At Category III facilities including GAEC, Tema Port, and Korle Bu Teaching Hospital, the arrangements do not include procedures for taking urgent protective actions. At GAEC, there are no procedures to warn employees, evacuate the site, or conduct search and rescue. The limited conventional emergency drills that have taken place used scenarios for small bush fires outside of buildings and did not involve any significant consequences. At Tema Port there are well-established onsite communications as part of the normal operations and communication between the equipment operator and the Port control centre. Nonetheless, communication between on-site authorities and off-site authorities - including both communication equipment and communication procedures - remains a significant challenge at all facilities and practices.

### 3.5. Providing instructions, warnings and relevant information to the public

The Information Services Department (ISD) under the Ministry of Information has been identified at national level to provide instructions and warnings to the public. The NNRERP states the role of Ministry of Information during radiation emergencies to be performed by ISD. For this purpose ISD has a strategy to communicate instructions to the public by deploying special vans equipped with loudspeakers. Furthermore, loud speakers are also mounted in mosques, churches, and youth centres, and are generally recognized by the public as trustful and effective means of receiving information during emergencies. Debriefings are conducted via research officers to provide feedback about public reactions with the emergency.

Community Information Centers (CIC) have been re-established in the districts after a period of non-use, and are equipped by the government such that the public could go there for more instructions and information during any emergency.

### 3.6. Protecting emergency workers and helpers in an emergency

The total effective dose guidance levels for emergency workers are given in Appendix 4 of the NNRERP and are consistent with the guidance values for restricting exposure of emergency workers in GSR Part 7.

At the visited operating organizations the workers wore dosimeters, they were aware of the potential emergency scenarios and (in the cases where they exist) of the emergency procedures. Hand-held survey meters are available at some operating organizations. Personal protective equipment was not available at the visited operating organizations.

For first responders (e,g, firefighters or NADMO responders), there are no arrangements to provide dosimetry. Response organizations consistently stated that as soon as nuclear or radiological emergency is identified, RPI is notified and guidance and assistance is requested. Response organizations assume that RPI would provide for the protection of these emergency workers, although as previously discussed, RPI does not have procedures to do so.

There are no arrangements in place for emergency helpers, as defined in GSR Part 7.

### 3.7. Medical response

Instruction on how to recognize and diagnose radiation injuries is not included in the medical curriculum in the country, and is not addressed in continuing education programmes for medical practitioners.

| **Recommendation 8.** |
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| **Observation:** Medical personnel around the country are not trained on how to identify symptoms of radiation sickness. |
| **Basis for recommendation:** GSR Part 7 paragraph 5.60 states: "Arrangements shall be made for medical personnel, both general practitioners and emergency staff, to be made aware of the clinical symptoms of radiation exposure and of the appropriate notification procedures and other response actions that are warranted if a nuclear or radiological emergency has occurred or is suspected." |
| **Recommendation**: The Ghana Health Service should develop training for medical personnel on the recognition of symptoms of radiation overexposure to allow for the provision of first aid and critical medical treatment. |

Ridge Teaching Hospital provides general and emergency services and is designated in the NNRERP to receive contaminated patients or patients with radiation injuries. However, personnel at Ridge Teaching Hospital are not aware of these roles and responsibilities in the NNRERP. The current capabilities do not qualify for them to be designated to deal with patients resulting from radiation emergencies. The hospital is undergoing an expansion and is willing to take on these responsibilities in the future.

The National Ambulance Service has identified the challenges of responding to emergencies involving potentially contaminated victims and recognizes the hazard of such emergencies, but have not yet put in place arrangements on how to handle contaminated patients.

GHARR-1 has an on-site medical facility to provide immediate first aid. However, there has been no further collaboration with other national hospitals to provide for managing the treatment of radiation injuries.

The existing experience in responding to the Ebola Virus Disease (EVD) outbreak and other public health emergencies could be a good base to integrate the response to radiation emergencies, as well as the current notification system in which the notification points should be aware when contaminated persons are referred to the designated hospital.

| **Recommendation 9.** |
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| **Observation:** There are no arrangements at the national level to refer potentially contaminated and/or injured persons and accidentally overexposed victims to a specialized facility for medical treatment. |
| **Basis for recommendation:** GSR Part 7 paragraph 5.64 states: "Arrangements shall be made to identify people with possible contamination or having possibly been exposed sufficient to result in radiation induced health effects and to provide them with appropriate medical attention including longer term medical follow up. These arrangements shall include:<br>(a) guidelines for effective diagnosis and treatment;<br>(b) designated medical personnel trained in clinical management of radiation injuries;<br>(c) designated institutions for evaluating radiation exposure (external and internal), for providing specialized medical treatment and for longer term medical actions." |
| **Recommendation**: The Ministry of Health should define arrangements for providing definitive care for patients with radiation injuries and/or contamination. |

### 3.8. Communicating with the public throughout an emergency

A public communication strategy is in place, coordinated by NADMO and implemented by the ISD, part of the Ministry of Information. NADMO and ISD work to identify the information from all sources needed in the messaging and to secure the appropriate expert participation in the communication. The information will then be translated (as required) to the local community language and disseminated as packages of information. There is a recognition that technical information needs to be broken down to a plain understandable language to the general public.

The ISD has a very well organized presence and arrangements covering the 216 districts of Ghana. Connections for public communication through TV channels and Radio stations have been established. More than 100 vans and 150 mobile cinemas are distributed in advance to perform public awareness and outreach programmes. Public information officers (PIO) working for any governmental organization are actually ISD staff seconded to the other government organization. In case of an emergency each district assembly notifies the correspondent PIO who will report to ISD for further actions. ISD then coordinates with the relevant response organization to arrange for press conference or distribution of information over media houses locally and internationally. These settings are also used for monitoring rumours and respond to public concerns, as has been demonstrated in past emergencies.

| Good practice 1. |
| --- |
| **Observation:** The Information Services Department has distributed emergency equipment, including mobile loud speakers, to the district level within the country and has staff in place in the districts to maintain an active outreach program. |
| **Basis for good practice:** GSR Part 7 paragraph 5.66 states: "Arrangements shall be made for providing useful, timely, truthful, clear and appropriate information to the public in a nuclear or radiological emergency, with account taken that the usual means for communication might have been damaged in the emergency or by its initiating event (e.g. by an earthquake or by flooding) or overburdened by use. These arrangements shall also include arrangements for keeping the international community informed, as appropriate. These arrangements shall account for the protection of sensitive information in circumstances when a nuclear or radiological emergency is initiated by a nuclear security event. Communication with the public in a nuclear or radiological emergency shall be carried out on the basis of a strategy to be developed at the preparedness stage as part of the protection strategy. Arrangements shall be made to adjust this strategy in the emergency response on the basis of prevailing conditions." |
| **Good practice:** The Information Services Department has a well-defined system for outreach and public communications before and during an emergency enacted at the district level. |

During transnational emergencies, ISD follows a similar process to gather information from the response organizations and then sends the consolidated information ready for release to the Ministry of Foreign Affairs, who distributes it through official channels. ISD also has experience interacting with international news media during transnational conventional emergencies, most recently during the Ebola Virus Disease outbreak in the region.

The NDMP, NNRERP, and the National Standard Operating Procedures (SOP) for Emergency Response in the Event of a Nuclear or Radiological Accident include arrangements for ensuring the provision of useful, prompt, accurate and open information to the public throughout an emergency, how to respond to incorrect information, rumours and requests for information from the public, news and information media. However these arrangements are yet to be tested.

### 3.9. Taking early protective actions

Since there are limited arrangements for taking urgent protective actions, it follows that there are no arrangements for taking early protective actions. In the NNRERP, the Ministry of Environment, Science, Technology and Innovation (MESTI) and GAEC are charged with coordinating decontamination, if needed, although no procedures have been developed or drills conducted. It should be noted that the MESTI was unavailable due to the extreme weather event during the mission, so this is based on the national plans and interviews with GAEC.

The plans do not specify who would have the authority to lift any restrictions that are put in place during an emergency. For smaller emergencies participants agreed that the On-Scene Commander would be able to remove or adjust cordon areas after monitoring by GAEC personnel. But for larger emergencies or for public areas with significant population or infrastructure it was agreed that this would be a national decision coordinated by the Head of NADMO with advice from GAEC.

### 3.10. Managing radioactive waste in an emergency

The NNRERP does not address the challenge of radioactive waste generated during the emergency response. The national policy regarding waste is not discussed, the only mentioning of the issue is done in NNRERP Appendix 3 that lists "advising the Commission on matters relating to radiation protection and waste safety" among the responsibilities of the RPB.

The National Radioactive Waste Management Centre (WMC) operates within the compound and as part of GAEC. The Centre is designed to store waste generated during normal operation of radiation facilities and activities. Currently only a small portion of its storage capacity is used. In principle, this facility is suitable for accepting and storing a limited amount of waste that would be generated in an emergency situation. If the amount of such waste exceeded the available storage capacity then additional areas should be assigned for this purpose.

Nevertheless, the national policy on management of radioactive waste generated during an emergency is not clear, there are no plans for characterization, criteria and disposal of such waste and there is no indication in the relevant planning document of how the non-radiological impacts of the contamination should be handled.

| **Suggestion 2.** |
|---|
| **Observation:** The national policy on management of radioactive waste generated during an emergency is not clear, there are no plans for characterization, criteria and disposal of such waste and there is no indication in the relevant planning document of how the non-radiological impacts of the contamination should be handled. |
| **Basis for suggestion:** GSR Part 7 paragraph 5.83 states: "Radioactive waste arising in a nuclear or radiological emergency, including radioactive waste arising from associated protective actions and other response actions taken, shall be identified, characterized and categorized in due time and shall be managed in a manner that does not compromise the protection strategy taking into account prevailing conditions at these evolve." |
| **Suggestion:** The government should consider developing national policy on the management of radioactive waste generated during a nuclear or radiological emergency, with clear criteria on its characterization and disposal. |

### 3.11. Mitigating non-radiological consequences

The NDMP provides an all-hazards overview of mitigating hazards related to, but not directly caused by, an emergency. The NNRERP does not provide specific guidance in the case of a nuclear or radiological emergency. ISD is prepared, as part of its public communications efforts, to provide messaging to the public in order to mitigate non-radiological consequences. In the interviews, ISD, NADMO, and GAEC all recognized the need to continue public communications after an emergency in order to manage long-term concerns and fears of the public, industry, and others.

### 3.12. Requesting, providing and receiving international assistance

When a trans-boundary nuclear or radiological emergency occurs within Ghana, GAEC will keep the Ministry of Foreign Affairs informed of all government response activities, in

accordance with the NNRERP. In the event of a nuclear or radiological emergency which requires the activation of the NNRERP, requests for assistance from the international community are anticipated. In order to facilitate obtaining such necessary assistance, GAEC should make these requests directly in keeping with established procedures and within their area of competence.

However, Ghana has not signed yet the *Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency*, which would facilitate the mobilization of foreign assistance through the IAEA Response Assistance Network (RANET), if needed.

| **Suggestion 3.** |
|---|
| **Observation:** Ghana has not signed yet the *Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency*, which would facilitate the mobilization of foreign assistance (RANET), if needed. |
| **Basis for suggestion:** GSR Part 7, Paragraph 5.91 states: "Arrangements shall be put in place and maintained for requesting and obtaining international assistance by States or international organizations and for providing assistance to States (either directly or through the IAEA) in preparedness and response for a nuclear or radiological emergency, on the basis of international instruments (e.g. the Assistance Convention), bilateral agreements or other mechanisms. These arrangements shall take due account of compatibility requirements for the capabilities to be rendered and obtained among different States so as to ensure the usefulness of these capabilities." |
| **Suggestion:** The Government should consider signing the *Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency*. |

Although the scope of the NNRERP is limited to Ghana and its territorial waters, it is recognized that both radiological emergencies in other countries and domestic radiological emergencies near Ghana international borders could require international cooperation. In such cases, the Ministry of Foreign Affairs is requested to work closely with other government agencies concerning any international responsibilities.

In the event of a nuclear or radiological emergency outside of Ghana that has a real or potential impact on Ghana, the Ministry of Foreign Affairs will co-ordinate contacts with foreign governments except in cases where existing agreements permit direct interagency communication.

### 3.13. Terminating an emergency

There are currently no arrangements or criteria in place to terminate a nuclear or radiological emergency. Similar to the discussion under identification, notification, and activation, a similar process should be followed when terminating the emergency situation, i.e., applying pre-established criteria to justify termination the existing emergency condition. These criteria should be established in advance in order to provide defensible criteria and credible messaging to the public. These efforts should be coordinated by NADMO and GAEC.

### 3.14. Analysing the emergency and emergency response

NADMO, during many years of activity, has collected a lot of experiences about conventional emergencies (e.g., flooding, fires, disease outbreaks). Often times there is a debriefing or informal analysis of the emergency and the emergency response. However, these emergencies

are not formally reviewed to identify lessons for future emergencies, including nuclear or radiological emergencies.

| **Suggestion 4.** |
| --- |
| **Observation:** There is no program to analyze the emergency and emergency response. |
| **Basis for suggestion:** GSR Part 7 paragraph 5.99 states: "Arrangements shall be made to document, protect and preserve, to the extent practicable, in an emergency response data and information important for an analysis of the nuclear or radiological emergency and the emergency response. Arrangements shall be made to undertake a timely and comprehensive analysis of the nuclear or radiological emergency and the emergency response with the involvement of interested parties. These arrangements shall give due consideration to the need for making contributions to relevant internationally coordinated analysis and for sharing the findings of the analysis with relevant response organizations…" |
| **Suggestion:** NADMO and GAEC should consider ensuring that the nuclear or radiological emergency and the emergency response are systematically analyzed in order to identify actions to be taken to prevent other emergencies and to improve emergency arrangements. |

# 4. DETAILED FINDINGS ON REQUIREMENTS FOR INFRASTRUCTURE

## 4.1. Authorities for emergency preparedness and response

The national plans for EPR are established in the form of the NDMP and NNRERP, as described in previous sections, but the delegation of authority during an emergency is not clear. While the NNRERP assigns decision-making authority to specific positions, it is unclear who would fill some of those positions, and whether the authority would actually be delegated during an emergency. The implementation of the Incident Command System across organization varies resulting in a system that may not have clear authorities, especially in a radiological emergency at a location that is not a pre-established facility or practice.

## 4.2. Organization and staffing for emergency preparedness and response

While the operating organizations and response organizations have clearly defined roles and responsibilities within the NNRERP, these organizations have not conducted any analysis of the staffing that is necessary to fulfill these responsibilities. Rather, the small radiological emergencies that have occurred so far have been handled by small teams of volunteers gathered during working hours. It is not clear how the organizations would fulfill these responsibilities during non-working hours, or during a larger emergency. There have been no tests of notifying the responders with specialized radiation expertise during non-working hours in order to test the activation time.

| **Recommendation 10.** |
|---|
| **Observation:** The NNRERP establishes roles and responsibilities of organization involved in a radiological emergency but these organizations have not considered what the minimum number and the qualification of personnel is needed to fulfill these responsibilities. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.10 states: "Appropriate numbers of suitably qualified personnel shall be available at all times (including during 24 hour a day operations) so that appropriate positions can be promptly staffed as necessary following the declaration and notification of a nuclear or radiological emergency. Appropriate numbers of suitably qualified personnel shall be available in the long term to staff the various positions necessary to take mitigatory actions, protective actions and other response actions." |
| **Recommendation**: The government should ensure that the overall organization for emergency preparedness and response is clearly specified and staffed with sufficient personnel who are qualified for their intended duty. |

## 4.3. Coordination of emergency preparedness and response

The responsibility of each response organization and the coordination between them is defined clearly in the NNRERP. Coordination during the preparedness phase is discussed more under Chapter 2.2 Roles and Responsibilities. Coordination during the response phase is discussed more in Chapter 3.1 Managing Emergency Response Operations. There is a need for additional procedures and training – especially on the Incident Command System - to ensure a consistent situational awareness among all responders.

### 4.4. Plans and procedures for emergency response

As previously discussed, there are established plans and procedures at the national level, but response organizations and operating organizations have not developed specific plans and procedures to fulfill their roles. Most critically, GAEC received in 2013 a Safety Analysis Report (SAR) from an external vendor that includes within it a facility emergency plan. However, GAEC and GHARR-1 staff are unfamiliar with the content of this plan or the responsibilities it places on them. The plan includes specific classification systems, emergency action levels (EALs), operational intervention levels (OILs) and other critical information that is necessary during an emergency response. The plan, however, is limited only to the GHARR-1 reactor and is not applicable site-wide at the GAEC compound, which also includes an irradiation facility, the WMC, and other radioactive material storage areas. There is no consideration for events, such as a fire at the WMC, which could affect GHARR-1 and the irradiation facility.

| **Recommendation 11.** |
|---|
| **Observation:** The Ghana Atomic Energy Commission (GAEC), as the operator of the Ghana Research Reactor 1 (GHARR-1), has not established the emergency procedures that should support the existing emergency preparedness and response plan. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.20 states: "The operating organization and response organizations shall develop the necessary procedures and analytical tools to be able to perform the functions specified in Section 5 for the goals of emergency response to be achieved and for an emergency response to be effective." |
| **Recommendation**: GAEC should document the emergency response procedures that will be implemented should a nuclear or radiological emergency occur at the Ghana Research Reactor 1 (GHARR-1) or the larger GAEC site. |

### 4.5. Logistical support and facilities

NADMO is in the process of equipping their newly designed national emergency centre at their headquarters in Accra. It is anticipated that all response organizations would send a representative to this emergency centre during a large nuclear or radiological emergency. The centre contains equipment, including computers, phones, and radios, to support an emergency response. Other response organizations do not have emergency centres. GAEC would use existing office space in the RPI offices as an emergency centre, although it should be noted that this is in the same building as GHARR-1.

The NNRERP contains in Appendix 3 a list of major equipment available from each designated response organization. The list represents a good initial overview of the major equipment available but does not describe equipment that could be used in an emergency. Additionally, this list could be moved out of the NNRERP so that it can be updated more frequently. It does not, for example, include equipment available from the Nuclear Security Support Centre, which was created after the NNRERP.

| **Suggestion 5.** |
|---|
| **Observation:** The list of available emergency equipment from facilities and response organizations is not complete and is not updated on a regular basis. |
| **Basis for suggestion:** GSR Part 7 paragraph 6.22 states: "Adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as procedures, checklists, manuals, telephone numbers and |

| Suggestion 5. |
| --- |
| email addresses) shall be provided for performing the functions specified in Section 5. These items and facilities shall be selected or designed to be operational under the conditions (such as radiological conditions, working conditions and environmental conditions) that could be encountered in the emergency response, and to be compatible with other procedures and equipment for the response (e.g. compatible with the communication frequencies of other response organizations), as appropriate. These support items shall be located or provided in a manner that allows their effective use under the emergency conditions postulated." |
| **Suggestion:** The government should consider regularly updating the list of available equipment for emergency response. |

| Recommendation 12. |
| --- |
| **Observation:** GAEC does not have a facility emergency centre. The Central Alarm Station (CAS) is not staffed 24/7, mainly because it does not have redundant power supplies and cannot function without offsite power. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.24 states: "Emergency response facilities or locations shall be designated to support the emergency response under the full range of postulated hazardous conditions." |
| **Recommendation**: GAEC should establish a central alarm station and emergency center with adequate equipment, including redundant power supplies, and which are not in the same building as the research reactor. |

### 4.6. Training, drills and exercises

Although Chapter 5.3 of the NNRERP defines a requirement for training for emergencies to be part of the general training required for all staff, the training program varies between response organizations. At the national level, organizations have a small number of personnel who are very well trained in the emergency preparedness and response arrangements. These are mostly individuals who helped to develop the national plans and procedures, and participate in the planning and preparedness committee under NADMO. Outside of these individuals, there are not many people trained in the existing plans and procedures. At NADMO, officers repeatedly stated that in the event of any nuclear or radiological emergency, they would call the officer responsible for that plan and seek advice. At GAEC, there is a lack of training related to the existing emergency plans and procedures related to on-site emergencies. Similarly, there has been no training at GAEC to fulfill their role to respond to other emergencies and integrate into the Incident Command System, as is discussed in Chapter 3.1 Managing Emergency Response Operations. Other organizations, including first responders, have only limited awareness level training for nuclear or radiological emergencies and would rely entirely on the advice from NADMO and GAEC before taking actions beyond establishing a cordon area.

| Recommendation 13. |
| --- |
| **Observation:** Training programs for first responders to a radiation emergency are not formalized, and training is not systematically implemented to ensure organizations at all levels are able to perform preparedness and response functions. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.28 states: "The operating organization and response organizations shall identify the knowledge, skills and |

| Recommendation 13. |
| --- |
| abilities necessary to perform the functions specified in Section 5. The operating organization and response organizations shall make arrangements for the selection of personnel and for training to ensure that the personnel selected have the requisite knowledge, skills and abilities to perform their assigned response functions. The arrangements shall include arrangements for continuing refresher training on an appropriate schedule and arrangements for ensuring that personnel assigned to positions with responsibilities in emergency response undergo the specified training." |
| **Recommendation**: NADMO and GAEC should ensure that a training program is developed and implemented for first responders and other response organizations. |

There have not yet been any nuclear or radiological emergency drills or exercises in the country to test the existing plans and the training of response personnel, although the NNRERP recognizes the importance of conducting such exercises. At GAEC exercises are conducted on a nominally annual basis, although they have not yet involved a nuclear or radiological emergency scenario.

| Recommendation 14. |
| --- |
| **Observation:** There have been no drills or exercises conducted by facilities identified as emergency preparedness category III, and there is no national exercise program in place for practices identified as emergency preparedness category IV. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.30 states: "Exercise programmes shall be developed and implemented to ensure that all specified functions required to be performed for emergency response, all organizational interfaces for facilities in category I, II or III and the national level programmes for category IV or V are tested at suitable intervals. These programmes shall include the participation in some exercises of, as appropriate and feasible, all the organizations concerned, people who are potentially affected and representatives of news media. The exercises shall be systematically evaluated (see para. 4.10(h)) and some exercises shall be evaluated by the regulatory body. Programmes shall be subject to review and revision in the light of experience gained (see paras 6.36 and 6.38)." |
| **Recommendation**: The government should ensure that exercise programs are established for all facilities and practices, that all response organizations are included, and that the exercises are systematically evaluated. |

### 4.7. Quality management

The NNRERP identified the need to review and update the plan and associated procedures. It specified that "a regular Quality Management review of the plans and the procedures will be conducted annually. Lessons learned from accidents around the world, drills, and exercises will be taken into account." The NNRERP further specifies that contact information should be updated quarterly and a major review and revision of the plan should be undertaken every 5 years. Although the NNRERP was published in 2010 there have been, to date, no efforts to update the plan, mainly due to competing priorities and limited resources.

RPB does not require a quality management programme from operating organizations or licensees during the licensing process.

| Recommendation 15. |
| --- |
| **Observation:** The defined quality management program contained in the NNRERP is not implemented or documented. |
| **Basis for recommendation:** GSR Part 7 paragraph 6.36 states: "Arrangements shall be made to maintain, review and update emergency plans, procedures and other arrangements and to incorporate lessons from research, operating experience (such as in the response to emergencies) and emergency exercises." |
| **Recommendation**: The government should ensure that the defined quality management program is implemented and documentation is maintained. |

## Appendix I: IAEA Mission Team Composition

| No. | Name and LAST NAME | Position | Organization |
|---|---|---|---|
| **1.** | Mr Peter ZOMBORI | EPREV Team Leader | IAEA IEC (Consultant) |
| **2.** | Mr Mark BREITINGER | EPREV Team Coordinator | IAEA IEC |
| **3.** | Mr Mohommad HAMADALNEEL | EPREV Team Member | Sudanese Nuclear and Radiological Regulatory Authority |
| **4.** | Mr Mario PALOMBA | EPREV Team Member | Italian National Agency for New Technologies, Energy and Sustainable Economic Development, TRIGA RC-1 |
| **5.** | Mr Mothusi RAMERAFE | EPREV Team Member | South Africa National Nuclear Regulator |

## Appendix II: Mission Schedule

### IAEA EPREV MISSION TO Ghana
### 31 MAY – 9 JUNE 2015
### PROGRAMME

| Time | Event |
|---|---|
| | Sunday 31 May |
| All day | *Internal Meeting for IAEA Review Team* |
| | Monday 1 June |
| 09:00 – 13:00 | **Entry Meeting** with all stakeholders and organizations<br>• Welcome and Introduction<br>• All-Hazards Emergency Preparedness and Response in Ghana<br>• Radiation Emergency Preparedness and Response in Ghana<br>• Presentation of EPREV Objectives and Process (IAEA Team Coordinator)<br>• Review of Programme (IAEA Team Leader)<br>• Closing Remarks |
| 13:00 – 14:00 | Lunch |
| 14:00 – 15:00 | **Interviews**<br>• NADMO<br>• GAEC |
| 15:00 – 15:30 | Transit from Hotel to NADMO |
| 15:00 – 17:00 | **Site Visit: NADMO** |
| 17:00 – 17:30 | Transit from NADMO to Hotel |
| 17:30 – 18:30 | *Daily Meeting for IAEA Review team* |
| | Tuesday 2 June |
| 08:30 – 09:00 | Transit from Hotel to GAEC |
| 09:00 – 14:00 | **Site Visit: GAEC**<br>• NNRI<br>• RPI<br>• BNARI<br>• WMC<br>*Lunch at GAEC during the visit* |
| 15:00 – 15:30 | Transit from GAEC to Ghana National Fire Service |
| 15:30 – 17:00 | **Site Visit: Ghana National Fire Service** |
| 17:00 – 17:30 | Transit from Ghana National Fire Service to Hotel |
| 17:30 – 18:30 | *Daily Meeting for IAEA Review team* |
| | Wednesday 3 June |
| 08:30 – 09:00 | Transit from Hotel to Korle Bu Teaching Hospital |
| 09:00 – 11:00 | **Site Visit: Korle Bu Teaching Hospital** |
| 11:00 – 11:30 | Transit from Korle Bu Teaching Hospital to Ridge Hospital |
| 11:30 – 12:30 | **Site Visit: Ridge Hospital** |
| 12:30 – 13:30 | Lunch |
| 13:30 – 14:00 | Transit from Ridge Hospital to Tema Port |
| 14:00 – 16:00 | **Site Visit: Tema Port** |

| | |
|---|---|
| 16:00 – 17:00 | Transit from Tema Port to Hotel |
| 17:00 – 18:00 | *Daily Meeting for IAEA Review team* |
| Thursday 4 June | |
| 09:00 – 13:00 | Interview:<br>• Information Services Department |
| 13:00 – 14:00 | Lunch |
| 14:00 – 14:30 | Transit from Hotel to National Ambulance Service |
| 14:30 – 16:00 | **Site Visit: National Ambulance Service** |
| 16:00 – 16:30 | Transit from National Ambulance Service to Hotel |
| 16:30 – 17:30 | *Daily Meeting for IAEA Review team* |
| Friday 5 June | |
| 09:00 – 12:00 | Interview:<br>• Ministry of Health |
| 12:00 – 13:00 | Lunch |
| 13:00 – 17:00 | Review and Clarification Meeting<br>• NADMO<br>• GAEC |
| 17:00 – 18:00 | *Daily Meeting for IAEA Review team* |
| Saturday 6 June | |
| 09:00 – 18:00 | *IAEA Review Team Report Writing* |
| Sunday 7 June | |
| 09:00 – 16:00 | *IAEA Review Team Report Writing* |
| 16:00 | Preliminary Draft Report sent to main counterpart |
| Monday 8 June | |
| 09:00 – 14:00 | Ghana counterparts review the draft report and provide comments. Main counterpart consolidates comments. |
| 11:30 – 12:30 | Interview:<br>• Environmental Protection Agency |
| 14:00 – 16:00 | IAEA Review Team and Ghana Counterparts meet to discuss and resolve any comments on the report |
| Tuesday 9 June | |
| 09:00 – 12:00 | Exit Meeting with all stakeholders and organizations<br>• Welcome and Introduction<br>• Presentation of Findings (IAEA Team Leader)<br>• Overview of Action Plan Development and Future Activities (IAEA Team Coordinator) |
| 12:00 | Conclusion of EPREV Mission |

## Appendix III: List of Attendees to EPREV Mission Meetings

| No. | Name | Organization |
|---|---|---|
| **1.** | Abdul-Samad Issah | Ministry of Information |
| **2.** | Abdul-Samad Issah | Ministry of Information |
| **3.** | ACFO S. Nana Brenya | GNFS |
| **4.** | Alex Darocha | Nick TC SCAN (Tema Port) |
| **5.** | Anastasia Bleboo-Boafo | NADMO |
| **6.** | Caesar Nyadedzor (Dr) | Ridge Hospital |
| **7.** | Carl Christian Lokko | Nick TC SCAN (Tema Port) |
| **8.** | Charlotte Norman | NADMO |
| **9.** | Cyirl Schandorf (Prof.) | GAEC |
| **10.** | Dinah Asante-Mensah | Ridge Hospital |
| **11.** | Dora Asamoah (Ms) | GAEC/RPI |
| **12.** | Dzifa Agbodohu | Ridge Hospital |
| **13.** | E.A Pappoe | Greater Accra Regional Coordinating Council |
| **14.** | E.K. Srofenu (Dr.) | Ridge Hospital |
| **15.** | E. O. Darko (Prof) | GAEC/RPI |
| **16.** | Elizabeth Efua Essel | Information Services Dept. |
| **17.** | G. Emi-Reyrolds (Prof) | GAEC/RPI |
| **18.** | George Ashie | Ambulance Service |
| **19.** | Jennifer Boateng | Ridge Hospital |
| **20.** | Joseph Ofei Ankah | NADMO |

| No. | Name | Organization |
|---|---|---|
| **21.** | Koranteng Abrakwa | NADMO |
| **22.** | Kwaku Manu Afful | Ghana National Fire Service (GNFS) |
| **23.** | Kweku DeGrafl | NADMO |
| **24.** | Lawson Tevi | NADMO |
| **25.** | Lovelace Saopong | Environmental Protection Agency |
| **26.** | Moses A. Addo | GAEC |
| **27.** | Nii-Amarh Ashitey | Greater Accra Regional Coordinating Council |
| **28.** | Noe Ernest Nii Narku | Ridge Hospital |
| **29.** | Peter Davor | GAEC |
| **30.** | Razak Awudu | GAEC/RPI |
| **31.** | Ruth Antwi | Ridge Hospital |
| **32.** | Ruth Arthur | NADMO |
| **33.** | Samuel N.A. Tagoe | Korle Bu Teaching Hospital |
| **34.** | Sarah A Adinku (Mrs.) | NADMO |
| **35.** | Very Rev. Dr Maxwell Aryee | GAEC Hospital |
| **36.** | Winfred N. Tesia | NADMO |

## References


[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, GSR Part 7, IAEA, Vienna (Board of Governors Approved Draft, March 2015)

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, GSG-2, IAEA, Vienna (2011).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, GS-G-2.1, IAEA, Vienna (2007).

**Acronyms**
(Alphabetic order)

| Name | Position |
|---|---|
| CAS | Central Alarm Station |
| CIC | Community Information Centre |
| EAL | Emergency Action Level |
| EPR | Emergency Preparedness and Response |
| EPREV | Emergency Preparedness Review |
| EVD | Ebola Virus Disease |
| GAEC | Ghana Atomic Energy Commission |
| GHARR-1 | Ghana Research Reactor – 1 |
| IAEA | International Atomic Energy Agency |
| ICS | Incident Command System |
| ISD | Information Services Department |
| NADMO | National Disaster Management Organization |
| NAS | National Ambulance Service |
| NDMP | National Disaster Management Plan |
| NNRERP | National Nuclear and Radiological Emergency Response Plan |
| NRC | Nuclear Regulatory Commission (United States) |
| NSSC | Nuclear Security Support Centre |
| NWP | National Warning Point |
| OIL | Operational Intervention Level |

| Name | Position |
|---|---|
| PIO | Public Information Officer |
| RANET | Response and Assistance Network (RANET) |
| RPB | Radiation Protection Board |
| RPI | Radiation Protection Institute |
| SAR | Safety Analysis Report |
| SOP | Standard Operating Procedure |
| TOR | Terms of Reference |
| USIE | Unified System for Information Exchange in Incidents and Emergencies |
| WMC | Waste Management Centre |