VALUE FOR MONEY AUDIT REPORT

of the

AUDITOR-GENERAL

on the

MANAGEMENT OF ENTITIES OWNING RADIATION EMITTING DEVICES

by

RADIATION PROTECTION AUTHORITY OF ZIMBABWE (RPAZ)

under

OFFICE OF THE PRESIDENT AND CABINET

VFM: 2018: 07

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The Hon. D. Marapira
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Dear Sir

I hereby submit my Value for Money Audit Report, on the Management of entities owning radiation emitting devices by Radiation Protection Authority of Zimbabwe in terms of Section 11 of the Audit Office Act *[Chapter 22:18]*.

Yours faithfully,

M. Chiri (Mrs)
AUDITOR-GENERAL

Harare
December 24, 2018

OAG ZIMBABWE
Office of the Auditor-General

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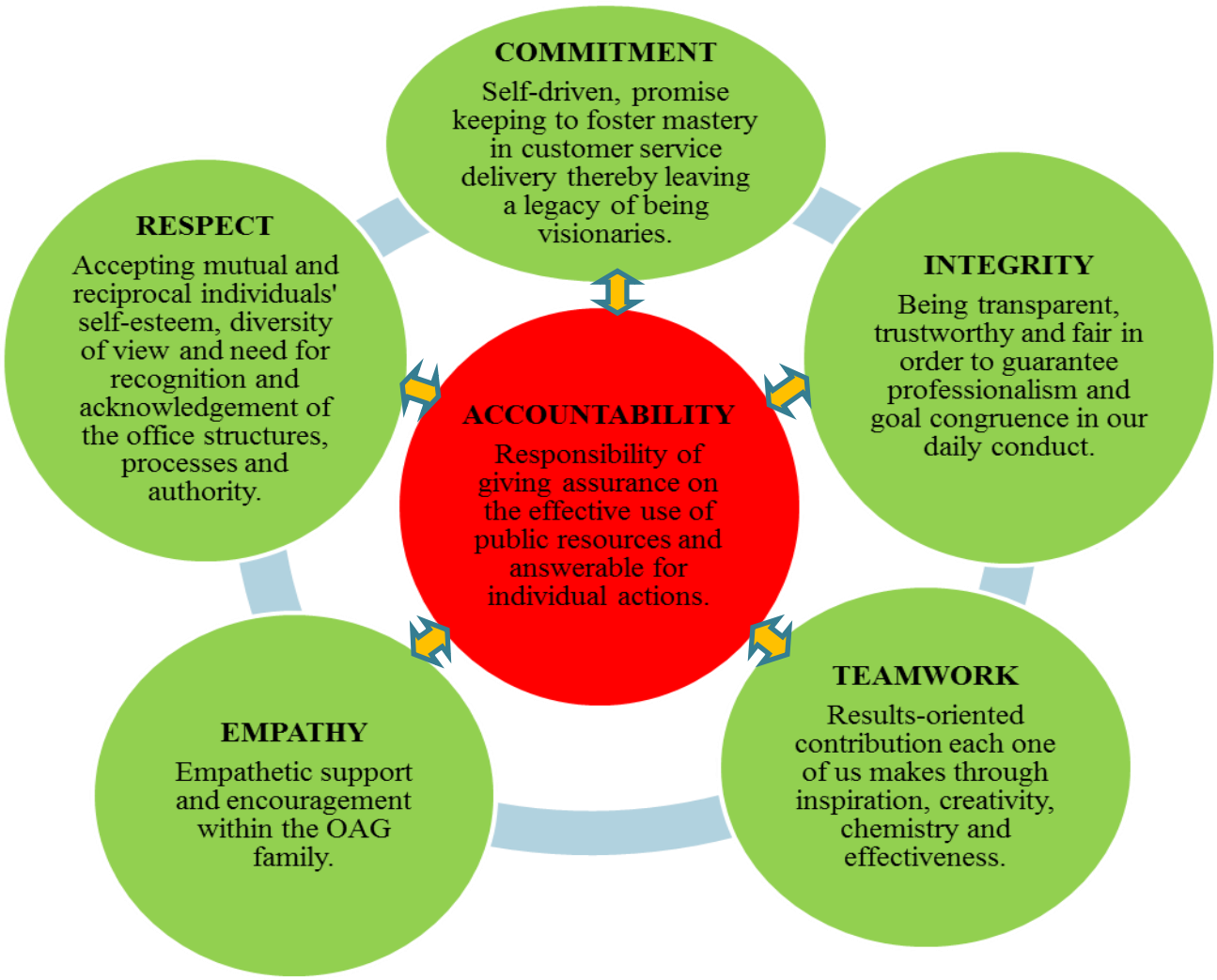

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ABBREVIATIONS

AC:	Assessment Criteria
AQ:	Audit Question
CEO:	Chief Executive Officer
CT:	Computed Tomography
GSR:	General Safety Requirements
IAEA:	International Atomic Energy Agency
MoHCC:	Ministry of Health and Child Care
MOU:	Memorandum of Understanding
MSv:	Millisievert
OPC:	Office of the President and Cabinet
RAIS:	Regulatory Authority Information System
RPAZ:	Radiation Protection Authority of Zimbabwe
RSO:	Radiation Safety Officer
SI:	Statutory Instrument
ZIMRA:	Zimbabwe Revenue Authority

GLOSSARY OF TERMS

Authority: Refers to Radiation Protection Authority of Zimbabwe.

Diagnostic examination: A test procedure performed to confirm, or determine the presence of disease in an individual suspected of having the disease.

Dosimeter: A device that measures exposure to ionizing radiation for human radiation protection and measurement of dose in both medical and industrial processes.

Facility: A place or building where radiation emitting equipment is used or stored.

Gamma Rays: High-energy electromagnetic radiation emitted by certain radionuclides used to kill cancer cells and to sterilise medical equipment.

General Safety Requirements: Safety Standards provided by International Atomic Energy Agency.

International Atomic Energy Agency: An international organization that seeks to promote the peaceful use of nuclear energy, and to inhibit its use for any military purpose, including nuclear weapons.

Millisievert: The international unit used to measure the amount of radiation received.

Nuclear medicine: A branch of medical imaging that uses small amounts of radioactive material to diagnose and determine the severity of diseases.

Orphan source: A self-contained radioactive source that is no longer under proper regulatory control.

Radiation Safety Officer: A person within an organization responsible for the safe use of radiation and radioactive materials as well as regulatory compliance.

Radiation: Is the emission or transmission of energy in the form of waves or particles through space or a material medium.

Radionuclide: An unstable form of a chemical element that radioactively decays, resulting in the emission of nuclear radiation.

Radiotherapy: Use of high-energy rays, usually x-rays and similar rays (such as electrons), to treat disease. The high-energy rays damage cancer cells and stops them from growing and dividing.

Regulatory Inspections: An examination by review of documents, observation, measurement and tests undertaken by the Authority during any stage of the regulatory process to ensure compliance of a facility to legal requirements.

Source: A radioactive material or by-product that is specifically manufactured or obtained for the purpose of using the emitted radiation.

Tumour: A lump or growth in a part of the body.

X-ray: Is an electromagnetic radiation that differentially penetrates structures within the body and creates images of these structures on photographic film or a fluorescent screen.

EXECUTIVE SUMMARY

Radiation protection management in Zimbabwe is the responsibility of the Radiation Protection Authority of Zimbabwe (RPAZ) under the Office of the President and Cabinet (OPC). The Authority is headed by a Chief Executive Officer who reports to the Board of Directors. It is the RPAZ's responsibility to ensure that the exposure of radiation is minimum. The RPAZ ensures minimum exposure by creating awareness to provide a safe working environment, promote knowledge of radiation risks, minimize unsafe practices, control radiation risks and share responsibility among stakeholders.

The Authority was founded by the Radiation Protection Act [*Chapter 15:15*]. The RPAZ uses SI 62 and 106 of 2011 for Safety and Security of Radiation Sources and SI 134 of 2012 for the fees it charges.

This Value for Money audit covered the management of entities owning radiation devices by RPAZ for the period January 1, 2014 to August 31, 2018. It was motivated by media reports and RPAZ internal documents (Management report and Integrated Regulatory Review Service report) which highlighted failure by facilities to comply with radiation protection regulations. In addition, lack of formal co-operation with national authorities that were responsible for radiation safety and emergency response, inadequacies of radiation protection services and monitoring by RPAZ was identified as a motivation.

Results of the pre-study also motivated the audit in that the RPAZ was not carrying out inspection of facilities and some facilities were operating without licenses.

The audit was conducted in accordance with INTOSAI standards. These standards require that a Value for Money audit should be planned in a manner which ensures that an audit of high quality is carried out in an economic, efficient and effective way and in a timely manner. Data collection methods used were documentary reviews, interviews and inspections.

Summary of findings

My audit revealed weaknesses in the management of entities owning radiation emitting equipment in order to ensure avoidance of unnecessary exposure. The weaknesses are on the following;

- Inspection of facilities
- Issuance of operating licenses for facilities
- Awareness of possible radiation risks

1. **Inspection of facilities**

The RPAZ inspection returns revealed that the Authority inspected 709 out of a total of 853 facilities meaning that there was a variance of 144 for the period under review.

Verification of the actual inspections carried out for the respective years revealed that there were also 35 facilities which were said to have been inspected but the evidence of inspection was not available for audit. This was caused by RPAZ repeating inspections of the same facilities while other facilities would go without inspections for more than the prescribed period.

Failure to carry out inspections contributed to:

- Facilities operating without a Radiation Safety Officer(RSO) further resulting in Facilities operating without an emergency plan. Out of 104 facilities, 32 had not appointed RSOs and some facilities had RSOs without appointment letters.
- 22 out of 69 facilities operating without displaying manufacturer's instructions which provide guidance to operators on how to operate the machine or equipment.
- 12 facilities keeping sources in storage facilities which were not licenced by RPAZ and exposing people to radiation.
- 14 out of 69 facility employees performing radiation procedures without dosimeters which measures exposure to ionizing radiation. The RPAZ was also not prioritising the calibration of radiation monitoring equipment so as to ensure reliable readings are obtained.

2. **Operating licenses of facilities**

A review of the facility files revealed that a significant number of facilities operated without licenses for the period January 1, 2014 to August 31, 2018 (135 in 2014, 138 in 2015,165 in 2016, 146 in 2017 and 161 in 2018). Furthermore, in 2017 and 2018, thirty (30) facilities were licensed without meeting licensing conditions such as appointment of RSO, Emergency plan and ensuring that occupationally exposed workers are monitored.

These issues were caused by the fact that the RPAZ was not implementing the licensing conditions and requirements in a systematic way. In addition, there may have been lack of coordination between the licensing and inspection departments. For the licensing department to be able to carry out its operations appropriately, it requires information from the inspection department such as the compliance history of a facility.

3. **Awareness**

The inspection of 69 facilities revealed that the Authority was not providing promotional material to facilities which was meant to conscientise stakeholders about the risks associated with radiation exposure. Furthermore, interviews with facility

representatives revealed that no radiation promotional materials were available at public places. Examples included airports, hospitals, mines and industries.

Inadequate awareness was caused by the fact that the RPAZ awareness programs focused much on programmed national events such as ZITF and Agricultural shows which are carried out once every year. The RPAZ developed 2 fliers in July 2018 providing details responding to public concerns over the safety of the use of microwave ovens as well as details relating to radiation safety awareness on reducing radiation. The fliers were only available at RPAZ head office in Harare.

Inadequacy of awareness on radiation issues resulted in the following:

- 15 facilities imported radiation sources without import licenses.
- RPAZ was not providing awareness through training of ZIMRA officials and interviews with 14 ZIMRA employees working at the ports of entry and exit revealed that RPAZ was not providing training for the detection of imported or exported radiation sources**.**
- RPAZ was not advising ZIMRA of the identity of importers or exporters within two days to enable ZIMRA to deal with such importation or exportation. Hence, a total of 103 sources were imported while 10 were exported without notifying ZIMRA.
- The contact details provided in the RPAZ National emergency plan were for the Authority's office phone numbers which could not be continuously available to receive notifications while the 2 mobile numbers were for former employees.

RECOMMENDATIONS

The following recommendations are aimed at improving the RPAZ in carrying out its mandate of protecting people and the environment against the negative effects of radiation.

1. The RPAZ should ensure that inspections of facilities are done in accordance with the graded approach. The graded approach requires that facilities are categorised according to the types of sources and their related risks. The RPAZ inspections should be done in order to make sure that facilities comply with the Act and licensing conditions. These include ensuring:

- The enforcement of the Act by making sure that all facilities appoint a trained and experienced RSO.
- That all occupationally exposed employees are monitored using dosimeters.
- That the Authority prioritize calibration of radiation monitoring equipment to ensure reliable readings or dose reports are obtained. The Authority should consider coordinating with other stakeholders so that calibration services are done locally. This will cut costs and reduce pressure on demand of forex. This will further and consequently eliminate the logistical problems which emanate from sending the equipment outside the country.

- That facilities develop emergency plans and implement them.
- The enforcement of license conditions which require facilities to display manufacturer's instructions.
- That there is availability of a licenced standard storage facility for sources not in use to reduce unnecessary exposure to human, animal life and the environment.
- Corrective action is taken on all monitoring findings to avoid their recurrence.

2. The RPAZ should take enforcement actions such as written warning, closure and seizure of equipment against all non-compliant facilities to ensure that only compliant facilities continue to operate. Furthermore, the RPAZ should license facilities that meet licensing conditions. Licensing, Inspection and Dosimetry Departments should improve on coordination so that each department has the same information on inspection findings and that appropriate enforcement action is taken.

3. The Authority should consider using different forms of media to reach out to stakeholders so that they become aware of the dangers of radiation exposure rather than just focusing on programmed national events such as ZITF and Agricultural shows.

   Awareness material such as fliers, magazines or pamphlets should also be distributed to public places such as hospitals, clinics, airports and mines so as to create awareness.

   Providing awareness through programmed regular training of ZIMRA officials is also critical in that all imported radiation sources would be properly identified to ensure proper handling as there is high rate of job rotation at ZIMRA. This would help to curb unnecessary exposure to the public and the environment. The Authority can also provide ZIMRA with radiation detection equipment for radioactive sources and physical inspection for powered sources.

   A comprehensive emergency plan which has functional notification points or hotlines should be established to ensure incidences are reported timeously.
   The RPAZ should devise a mechanism to receive emergency notifications 24 hours/day, either through among others, Short Message Service (SMS) alerts, voice messages or emergency e-mail notifications.

CHAPTER 1

INTRODUCTION

1.1 Background

Radiation protection management in Zimbabwe is the responsibility of the Radiation Protection Authority of Zimbabwe (RPAZ) under the Office of the President and Cabinet (OPC).

The Radiation Protection Authority of Zimbabwe is a statutory body established in terms of Section 3, of the Radiation Protection Act [*Chapter 15:15*] of 2004. The Authority uses Statutory Instrument 62 and 106 of 2011 for Safety and Security of Radiation Sources and SI 134 of 2012 for the fees charged by Authority.

According to Section 5 (1) (b) of the RPAZ [*Chapter 15:15*] Act the board of the Authority is responsible for formulating the general policy of the Authority and controls its operations. The Minister appoints board members who should come from nominations provided by the Ministries of Energy, Agriculture, Environment and Education. The other members are the dean of the medical school of the University of Zimbabwe; the Director of the Department of Water in the Ministry responsible for Rural Resources and Water Development; and the Director of Civil Protection. The other 3 are nominated by the minister in consultation with the President.

Section 4 of the RPAZ Act *[Chapter 15:15]* identifies the following as the functions of the Authority.

i. To issue standards and norms governing exemption, notification, registration and licensing of radiation sources and radiation protection and safety.
ii. To define the regulation standards and norms and exposures that are excluded from regulatory requirements on the basis that they are not capable of being subjected to regulatory control.
iii. To issue authorizations for the possession and use of radiation sources, define regulations and authorizations as well as the detailed obligations to be placed on those who possess radiation sources.
iv. To conduct inspections and obtain performance information concerning radiation sources and take such action as is necessary to enforce any prescribed requirements.
v. To protect the health and safety of workers and the members of the general public.
vi. To approve persons with specified radiation protection responsibilities and ensure that adequate national arrangements for response to radiological accidents are established.

vii. To initiate, recommend and provide support for intervention as appropriate on matters relating to the safety of radiation sources.
viii. To provide support and advice on the disposal of radioactive waste materials or irradiating[1] devices.
ix. To establish and maintain registers of importers, exporters, manufacturers, users and operators of devices or materials capable of producing ionizing radiation.

1.2 Motivation

The audit was motivated by reports in the local media and Integrated Regulatory Review Service (IRRS) (peer review) report concerning failure by facilities to comply with radiation protection regulations, the lack of formal co-operation with national authorities that are responsible for radiation safety and emergency response, inadequacies of radiation protection services and monitoring by the RPAZ.

The Patriot newspaper dated March 27, 2014, revealed that radiation exposure from industries, diamond mining activities (security), normal discharges from coal power stations, airport and boarder security check equipment expose people to radiation, thus monitoring and controlling the effects of radiation is important.

In 2014, the International Atomic Energy Agency *(*IAEA) through the IRRS conducted a Peer Review of Zimbabwe's Radiation Regulatory Framework and reported that there was no formal co-operation with national authorities that are responsible for radiation safety and emergency response. According to the Financial Gazette, dated June 11, 2015, people in Zimbabwe across various professions in hospitals, mining and industry, reportedly now require radioactive material-exposure monitoring to ensure that they are not being affected by its harmful effects.

The Zimbabwe Mail dated February 10, 2015 reported that Zimbabweans are at risk of radiation exposure with more than 100 institutions having failed to comply with radiation protection regulations. On September 24, 2016, the Herald reported that Harare Central Hospital installed a CT Scanner and invited patients to come in for free services before obtaining a license from RPAZ as required, consequently exposing 12 people including a pregnant woman to ionizing radiation. The World Nuclear Association website[2] reported incidences in Brazil, Thailand, Belgium and India where people were exposed to radiation and consequently some suffered radiation sickness and some died.

Further, it was motivated by the Pre-study results which indicated that RPAZ was not conducting inspections of facilities and awareness on radiation issues.

[1] Devices that produce radiation.
[2] http://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/nuclear-radiation-and-health-effects.aspx

1.3 Vision, Mission and Objectives

The RPAZ aims to be an internationally acclaimed regulator in the field of radiation protection by the year 2025. Its mission is to protect people and the environment from the harmful effects of radiation. The Authority's objectives are:

- To provide an adequate legislative framework that allows for safe and secure use of nuclear materials and radiation sources.
- To ensure adequate protection of all occupationally exposed workers in line with international standards.
- To ensure optimum protection of patients from medical exposure to radiation.
- To protect members of the public and the environment against effects of radiation.
- To control the importation and exportation of radioactive sources in line with the International Atomic Energy Agency (IAEA) Guidelines on Imports and Exports.

1.4 Organizational Structure

Radiation Protection Authority of Zimbabwe is a regulatory body that falls under the Office of the OPC. It is run by the board of directors. The Chief Executive Officer (CEO) is the head of executive functions and also the Chief Radiation Protection Officer. The CEO is assisted by seven (7) heads of departments. These are the Human Resource and Administration Manager, Chief Quality Assurance Officer, Internal Auditor, Chief Finance Officer, Chief Licensing Officer, Legal and Corporate Affairs secretary and Chief Inspections and Dosimetry Officer. For the detailed Organogram refer to **Annexure A.**

1.5 Funding

The sources of funding for the Authority were application fees, accreditation fees, dosimetry fees, Government grants, import license fees, registration fees, fines, training fees, sundry income, interest income and recoveries as shown on Table 1 below:

Table 1: Funding

Actual receipts	2014	2015	2016	2017
	Amount $	**Amount $**	**Amount $**	**Amount $**
Application fees	6 020	6 520	8 640	7 820
Accreditation fees	8 500	14 150	12 000	8 520
Dosimetry fees	186 500	217 400	122 000	133 400
Government grants	445 895	429 985	65 824	10 000
Import license fees	32 900	19 100	44 800	16 000
Registration fees	1 392 060	1 366 890	1 019 500	1 114 600
Fines	111 012	249 750	38 646	68 670
Training fees	38 550	30 000	35 037	25 950
Sundry income	19 857	3 518	100	-
Interest income	183	290	308	844
Recoveries	-	-	10 713	-
Total	**$2 241 477**	**$2 337 603**	**$1 357 567**	**$1 385 804**

Source: Receipt returns

From the above Table the RPAZ is mostly funded by registration fees which have been on a downward trend from 2014 to 2016 although there was a marginal increase of $95 100 in 2017 compared to 2016. Government grants were second in terms of income for the Authority for the years 2014 and 2015 but in 2016 to 2017 dosimetry fees took over that position.

1.6. Design of the audit

1.6.1 Audit objective

To assess if RPAZ was effectively and efficiently monitoring entities owning radiation emitting devices in order to avoid unnecessary radiation exposure to people and the environment.

1.6.2 Audit scope

The auditee was RPAZ and the audit focused on management by the RPAZ of entities owning radiation devices. The audit covered the period January 01, 2014 to August 31, 2018. The geographic limit was Zimbabwe and covered all the 10 provinces.

1.6.3 Audit Questions (AQ) and Audit Criteria(AC)

AQ. 1

Is the Authority carrying out inspections?

A.C. 1
According to Section 18 (1) (a) of the RPAZ Act [*Chapter 15:15*] and the inspection Policy clause 4 RPAZ shall maintain a planned and systematic inspection program to monitor compliance of facilities with licensing requirements.

A.Q. 1.1
Are facilities operating with a Radiation Safety Officer (RSO)?

A.C. 1.1
According to Section 16 (a) of the RPAZ Act [*Chapter 15:15*] the owner or occupier of a facility shall appoint a RSO experienced in radiation health and safety measures.

A.Q. 1.2
Is every occupationally exposed worker monitored?

A.C. 1.2
According to the RPAZ dosimetry procedure manual clause 1, the dosimetry department has the mandate of monitoring all occupationally exposed workers in Zimbabwe.

A.Q.1.2.1
Is calibration of radiation monitoring equipment being done at least once in every 2 years?

A.C.1.2.1
According to Section 5.3 of Dosimetry Procedures Manual all the Authority's radiation monitoring instruments (the Landauer and Harshaw) shall be calibrated at least once in every two years.

A.Q.1.3
Is there an emergency plan for every facility?

A.C. 1.3
According to Section 40 (a) of the SI 62 of 2011, registrants and licensees shall, if a radioactive material or substance under their responsibility has a potential for accidents which may provoke unforeseen exposure of any person, ensure that an emergency plan appropriate for the source and its associated risks is prepared and kept operational.

A.Q. 1.3.1
Are facilities displaying written manufacturer's instructions at the control display?

A.C. 1.3.1
According to the conditions of licensing medical equipment emitting radiation requirement 2, the facility should display written manufacturer's instructions at the control display.

A.Q. 1.3.2
Are sources not in use being properly controlled by RPAZ?

A.C. 1.3.2
According to Section 1 (l) of the RPAZ Act [*Chapter 15:15*], RPAZ will advise on matters relating to the safety of radiation sources and the disposal of radioactive waste materials.

A.Q.2
Are all facilities operating with an annual license?

A.C. 2
According to Licensing Department Procedures Manual clause 2.2.7 (a) the department issues a license certificate with associated conditions for facilities and practices meeting regulatory requirements. This license must be renewed annually.

A.Q. 3
To what extent is RPAZ carrying out awareness programs to educate stakeholders about the possible dangers of being exposed to radiation?

A.C.3
According to GSR Part 1 Requirement 36, the regulatory body (RPAZ) shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.

A.Q.3.1
Is the RPAZ providing awareness on import/export licensing requirements to all stakeholders?

A.C 3.1
According to the agreement clause 3.1of the M.O.U between the RPAZ and ZIMRA, no radiation sources shall be imported into or exported out of Zimbabwe unless covered by a license covered by the RPAZ.

A.Q.3.2

To what extent is the RPAZ providing awareness through training of ZIMRA officials to identify radiation emitting equipment that is imported into and exported out of the country?

A.C.3.2

According to the MOU clause 6 and management representation, RPAZ shall facilitate radiation safety training to all officers designated by ZIMRA to be able to identify imports or exports of radiation emitting equipment.

A.Q. 3.3

To what extent is RPAZ notifying ZIMRA of importers and exporters within 2 days of the issue of the license?

A.C 3.3

According to the M.O.U clause 5.3, in the event that RPAZ issues a new license to any person authorizing them to import or export radiation source, it shall, within two days of such authorization advise ZIMRA of the identity of that person and any other information that will enable ZIMRA to deal with such importation or exportation.

A.Q.3.4

To what extent are notification points continuously available to receive any notification or request for assistance in order to respond promptly or to initiate an off-site response?

A.C3.4

According to GSR-2 para. 4.16, notification points shall be established that are responsible for receiving emergency notifications of an actual or potential nuclear or radiological emergency. The notification points shall be continuously available to receive any notification or request for assistance and to respond promptly or to initiate an off-site response.

1.7 Methodology

I conducted the audit in accordance with International Standards of Supreme Audit Institutions (ISSAI's). These standards require that a performance audit should be planned in a manner which ensures that an audit of high quality is carried out in an economic, efficient and effective way and in a timely manner. In conducting the audit, I engaged an expert, the Dean in the Physics Department from the University of Zimbabwe (UZ) to advise on technical areas and issues regarding radiation management. The expert was involved in the tour of facilities for a week and review of audit plan and draft report. In collecting data, I reviewed documents, carried out interviews and inspected facilities.

1.7.1 Documentary Review

Documentary review was done to gather background information on the functions, procedures and policies and inspection reports related to the operations of RPAZ. The documents reviewed are listed on **Annexure B.**

1.7.2 Interviews

Testimonial data was obtained through interviews. The interviews centered on every day duties and responsibilities of the officers and other stakeholders, the challenges faced and confirmation or corroboration of the data obtained from the documents reviewed. Detailed list of key personnel and stakeholders interviewed are on **Annexure C.**

1.7.3 Physical Inspections

Physical inspections of the facilities owning radiation emitting equipment were also carried out to appreciate how monitoring and inspection was done on facilities and whether the facilities were following licensing conditions. The inspections were conducted to verify the type and number of sources at the facilities, how the sources were stored and whether the occupationally exposed employees were being monitored through the use of dosimeters. The inspections were also carried out to determine whether facilities were displaying manufacturer's instructions of the equipment and whether they had emergency notification points as required by the IAEA general safety standards.

In the process, to obtain a comprehensive understanding of the total operation of the department. The tasks performed during the physical inspection are described below.

Entrance briefing

An entrance briefing was done in order to discuss the methods, objectives and details of the audit.

Assessment

Both the infrastructure of the department and the overall radiation programmes were inspected. Checklists were designed to organize the audit programme and to ensure coverage of all relevant areas. The tools used included:

a. Staff interviews;
b. A complete tour of the facility;
c. A review and evaluation of procedures and all relevant documentation, including a review of records;
d. Observation of some practical implementation of working procedures.

Exit briefing

After the assessment an exit briefing was convened at the institution with management in interactive exit briefing where I presented my preliminary findings. **Annexure D** provides a list of all facilities inspected.

1.8 Sampling

In the process of conducting the audit, I used the cluster sampling method where provinces and facilities were selected based on the concentration of radioactive sources. Facilities with medium and high risk sources such as nuclear medicine, CT scan, gauges and x-rays were selected since they produce high doses of radiation. Out of a total population of 364 facilities, 114 facilities were sampled. Documentary review was performed for all the 114 facilities, out of which 69 facilities were inspected. Table 2 below shows the categories and a breakdown of facilities inspected and those where documentary review was performed. Refer to **Annexure E** for further details.

Table 2: Number of sampled facilities according to industry/practice

	Medical and veterinary	**Industry**	**Research and agencies**	**Total**
Total population	245	91	28	**364**
Inspection	38	29	2	**69**
Documentary review	74	38	2	**114**

Source: Register of sources

CHAPTER 2

2.1 DESCRIPTION OF THE AUDIT AREA

Radiation is energy that is transmitted in the form of rays or waves or particles. Radiation can either be ionizing or non-ionizing. Non ionizing radiation causes some heating effect, but usually not enough to cause any kind of long-term damage to human tissues. Examples of non-ionizing radiation are radio waves, and microwaves. Ionizing radiation is radiation with sufficient energy to cause ionization in the human tissue through which it passes. The RPAZ is concerned with the management of sources that emit ionizing radiation rather than non-ionizing radiation. Examples of ionizing radiation are x-rays and gamma rays. Ionizing radiation exposure means the measure of the ionization of air due to ionizing radiation. It is dependent on the proximity of the person to the source. Exposure to high doses of radiation may result in deaths, cancer and heritable gene diseases. Examples of cancers that may be caused by radiation according to the IAEA report of 1996 are marrow, bone and lung.

The World Nuclear Association (WNA) reported the following incidences that occurred in other countries as indicated below:
In 1987 at Goiania in Brazil, a discarded radiotherapy source stolen from an abandoned hospital and broken open caused four deaths and 20 cases of radiation sickness[3]. In Thailand (Samut Prakan) in 2000 a source in a scrap metal yard exposed many people resulting in 10 being hospitalized with radiation sickness (ARS), of whom three died. In March 2006 at the Institute for Radioelements (IRE) in Fleurus in Belgium a worker at a commercial irradiation facility received a high radiation dose from a gauge, resulting in severe health effects. In India (Mayapuri) in April 2010 an orphan gauge from university equipment in a scrap metal yard exposed many people, eight people being hospitalized with ARS, of whom one died.

In Zimbabwe ionizing radiation is used in industries such as mining, manufacturing, medicine, agriculture, research and education. The uses are as follows:

Mining

Radiation is used in mines for measuring and controlling the thickness of materials on production lines and security scanning using X-ray units.

Manufacturing

The manufacturing industry uses radiation to check fluid levels in kilns and containers, measuring density and moisture in materials, eliminating static electricity where dust

[3] Radiation sickness is damage to your body caused by a large dose of radiation often received over a short period of time.

causes a problem, detecting smoke (as used in household and industrial smoke detectors) and producing images of welds in piping, turbines, engine parts and other components.

Agriculture

The agricultural industry makes use of radiation to improve food production and packaging. Plant seeds, for example, are exposed to radiation to bring about new and better types of plants. Besides making plants stronger, radiation can be used to control insect populations such as tsetse fly, thereby decreasing the use of dangerous pesticides. Radioactive material is also used in gauges that measure the thickness of eggshells to screen out thin, breakable eggs before they are packaged in egg cartons. In addition, many of our foods are packaged in polyethylene shrink-wrap that has been irradiated so that it can be heated above its usual melting point and wrapped around the foods to provide an airtight protective covering.

Medicine

In medicine radiation is used for the purposes of diagnostic examinations and radiotherapy. In diagnostic examinations, X-ray scans are used to detect injury or the presence of foreign objects in patients and CT scans create a computer-generated 3D image of cross-sections of the body. Nuclear medicine procedures, where a patient is injected with radioactive material are also used for diagnostic and therapy purposes. This is used in conjunction with a radiation detection instrument to locate tumours and assess the health of organs. In radiotherapy, high radiation doses are used to kill cancerous cells.

Research and education

In research and education radiation is used for labelling pharmaceuticals, labelling in molecular biology, geological testing, demonstration aids for teaching purposes, non-destructive analysis of samples and biological and medical research.

In using radiation for the above functions, radiation sources should be monitored by regulating imports and exports, use, and disposal. This is done in order to ensure or avoid negative effects of radiation on human life and the environment. The RPAZ performs its functions with the help of other players listed below:

2.2 Roles and responsibilities of key players

2.2.1 Central Government

Government provides grants used to fund the operations of the Authority through the O.P.C. The central government also appoints the Board and coordinates stakeholders.

2.2.2 Ministry of Health and Child Care (MoHCC)

In the event of a nuclear and radiological emergency, the MoHCC through Government Hospitals will be responsible for providing appropriate medical care for overexposed or contaminated individuals. Where a radiological accident involves the medical use of radioactive materials, MoHCC provides medical advice to RPAZ. MoHCC is also responsible for monitoring the long-term health problems that could arise due to the radiological events.

2.2.3 Zimbabwe Revenue Authority (ZIMRA)

The RPAZ and the ZIMRA signed a Memorandum of Understanding (M.O.U) in June 2012 which aimed at establishing a cooperation mechanism between the RPAZ and the ZIMRA in relation to the import and export of radiation sources. According to the Customs and Excise Act [*Chapter 23:02*] ZIMRA is responsible for controlling the country's imports and exports. ZIMRA ensures that no importation or exportation of radiation sources is allowed into or out of Zimbabwe unless covered by a license issued by the RPAZ. According to clause 3.2 of the M.O.U, in the event that no such license is provided at the time of importation or exportation, the goods shall be held by the ZIMRA in a secure place pending production or obtaining of a license by the importer or exporter.

2.2.4 International Atomic Energy Agency

This is an international organization which develops safety standards to protect the health and minimize the danger to people's life and property associated with the use of radiation. Furthermore, it also offers capacity building including training and provision of technical support.

2.3 Process description

2.3.1 Importation

Any facility or person who intends to import radiation equipment should first obtain an import license from the RPAZ according to clause 3.1 of the M.O.U.

Furthermore, clause 5.3, stipulates that in the event that the RPAZ issues a new license to any person authorizing them to import or export a radiation source, it shall, within two days of such authorization, advise the ZIMRA of the identity of that person and any other information that will enable the ZIMRA to deal with such importation or exportation. In addition, the M.O.U clause 6 states that, the RPAZ shall facilitate radiation safety training to all officers designated by the ZIMRA.

In the event of failure to comply with the requirements of the RPAZ Act [*Chapter 15:15*], on importation or exportation, the Authority is supposed to invoke Section 20 (2) of the RPAZ Act [*Chapter 15:15*]. The section requires that any person who

contravenes any of the provisions of the Act relating to or in connection with the importation of radiation emitting devices or radioactive materials or deals in any radiation source without being in possession of a valid license shall be guilty of an offence and is supposed to be punished by a fine or imprisonment. In addition, clause 4a-e of the Enforcement Policy requires the RPAZ to seize substances or equipment to avoid risk of exposure to the public.

2.3.2 Use of a source

Authorization of the source

Following importation, the importer must ensure that the source/equipment is registered with the RPAZ for use. The process is as follows:

According to the Licensing Department Procedures Manual clause 2.2.1 page 6, notification to use any sources of radiation must be made to the Department of Licensing for the Licensee to be authorized to possess, use or store such equipment. The Licensing Department adopts a graded approach in the determination of whether a facility is authorized through notification, registration or licensing. According to the RPAZ integrated regulatory system clause 1.4, the graded approach is the regulatory Authority's approach where all programmes are based on the risk categorization of the different practices. Those practices/activities with the highest risk are given more attention in terms of the authorization requirements, authorization conditions, compliance inspections and reporting requirements. Equipment with high risk are radiotherapy while nuclear gauges, X-Rays and CT scanners are medium risk while dental equipment are low risk or low dose.

Application for license to operate

The user/facility submits a completed application form to the RPAZ which the Authority uses to process applications. The application form shall contain the applicant's identification information, the type of the required license, the general description of the activities to be performed, the general description of the basic characteristics and location of the facility. The application must be signed by the applicant/licensee if the applicant is a natural person or by the person who has the authority to represent the applicant. The application must be accompanied by proof of availability of a RSO and trained operators, emergency plan, operational procedures and proof of payment for license fees together with an application for employee monitoring.

When the application has been fully completed, the licensing department captures the clients' information in a database known as Regulatory Authority Information System (RAIS).

Application assessment

According to the Licensing Department Procedures Manual page 12 procedure 2.2.3, all license applications are given a specific RAIS number in the recording process. Applications are given a unique sequence number so that its subsequent progress through the authorization process can be tracked. After the application has been entered in the RAIS, RPAZ is supposed to make a review and assessment of application submitted. The Licensing Department Procedures Manual page 13 procedure 2.2.4, states that the review and assessment process constitutes document reviews, licensee interviews and inspections. In doing this, the Licensing department relies on information from the Inspection department on whether the licencee meets all the licensing requirements. The Licensing department acquires an understanding of the equipment, the safety concepts, and the operating principles proposed by the operator.

After the review and assessment of the application is done, a decision to approve or reject is made by the Licensing Department. According to the authorisation requirements the facilities should meet the following licensing requirements:

- **Monitoring of occupationally exposed workers**

  According to the Dosimetry Procedure Manual clause 1.1 and license conditions the Dosimetry Department at the Radiation Protection Authority of Zimbabwe has the mandate of monitoring all occupationally exposed workers in Zimbabwe. According to Dosimetry Procedure Manual clause 1, the department is responsible for workplace monitoring of radiation facilities using radiation detection equipment/survey meters. The Authority uses 2 types of dosimeters for monitoring occupational exposure to radiation, namely the Harshaw 6600 Plus Thermoluminescence Dosimeter (TLD) reader and the Landauer Semi-Manual Inlight Optically Stimulated Luminescence (OSL) reader. These are a type of equipment that is used to measure an absorbed dose of ionizing radiation.

  Each monitored employee should have 2 dosimeters but one dosimeter is worn at a time. The need for 2 dosimeters is that when one dosimeter goes for reading to the RPAZ, the employee will be monitored with the other dosimeter. Dosimeters should be submitted to RPAZ for reading every month as required by the dosimeter issue form condition. The RSO is responsible for ensuring that all occupationally exposed workers in an organisation are being monitored.

  Dosimeter readings are averaged over the monitoring period to obtain average exposure over the period. The exposure limit for occupationally exposed employees as set by the IAEA is 20mSv per year for employees in continuous radiation employment. For monthly readings of dosimeters this dose limit is further averaged by the RPAZ to

1.7mSv per month. Dosimeters are supposed to be submitted each month for reading in order to detect and correct any over-exposure or potential over-exposure.
The equipment used by the Authority to read dosimeters should be calibrated at least once in every two years as required by Section 5.3 of the Dosimetry Procedures Manual. The calibration of equipment is done to ensure correct dose records are obtained. Furthermore, according to Section 3.6 of the dosimetry procedures, preventative maintenance should be carried out on a monthly basis to maintain the reader in proper operating condition.

- **Appointment of a Radiation Safety Officer (RSO)**
  According to Section 16 of the RPAZ Act [*Chapter 15:15*] the owner or occupier of a facility shall appoint a person experienced in radiation health and safety measures as a radiation safety officer within the facility. The RSO maintains adequate records to ensure employee and public protection at a facility. The officer must be knowledgeable about the requirements of the RPAZ and the provisions of the certificate of authorization. The duties of the RSO are to ensure that all persons using or working in the facility are supplied with two monitoring devices and any other protective accessories necessary to carry out radiation procedures with the lowest possible risk.

  The RSO also ensures that radiation workers employed within the facility are given proper instruction on radiation safety measures. Proper care is taken of radioactive wastes if they appear in the course of the use of radiation sources as described in the codes of practice issued by the Board for protection of persons exposed to ionizing radiation and that the wastes are only disposed of in accordance with the licence granted for the purpose.

- **Emergency plan by facilities**
  According to Section 40 (a) of the SI 62 of 2011, registrants and licensees shall, if a radioactive material or substance under their responsibility has a potential to cause or pose unforeseen risk of exposure of any person, ensure that an emergency plan appropriate for the source and its associated risks is prepared and kept operational.

2.3.3 Approval or rejection of an application

The factors that influence the outcome of the review and assessment for the granting or denying an authorization are justification of practices, safety of occupationally exposed workers and public exposure and emergency procedures. The department issues a license certificate with associated conditions for facilities and practices meeting regulatory requirements according to clause 2.2.7 (a) of the Licensing Department Procedures Manual.

2.3.4 Renewal of licenses

Upon expiry, of a license, every licensee wishing to continue his or her licensed

operation shall, on or before December 31, on a yearly basis, apply to the Authority in writing, for the renewal of the license according to the Licensing Department Procedures Manual 2.2.8 (a). According to the Licensing Department Procedures Manual page 16 procedure 2.2.8, after considering an application for the renewal of a certificate of approval and any additional information requested and the results of a review and assessment by the Authority, the Authority may issue a certificate of renewal of approval in writing with conditions specified in the license.

Displaying of manufacturer's Instructions

According to the conditions of licensing medical equipment emitting radiation requirement 2, it is a requirement by the RPAZ that the facility should display written manufacturer's instructions at the control display.

After a license has been issued, the inspection and dosimetry department verifies compliance of facilities to licensing condition through inspections in accordance to the inspection policy as expressed by the enforcement policy.

2.4. Inspections

An inspection is an examination by review of documents, observation and testing to ensure compliance of a facility to RPAZ requirements. According to the RPAZ inspection policy clause 5, the Inspection and Dosimetry Department develops inspection schedule/programme at the beginning of each year which is in line with strategic plans and shall be observed during the course of the year.

This plan is developed using the graded approach which entails classifying or grading facilities according to the risks associated with the practice as stipulated by the clause 1.4 of the RPAZ integrated regulatory system. A high risk category requires a high frequency of inspection. Using the graded approach, Table 3 below shows frequency of inspections according to categories.

Table 3: Inspection Program according to category

Facility category	Frequency of inspections (Years)
Nuclear medicine and	1
Diagnostic Radiology (Computer Tomography)	2-3
Diagnostic Radiology (X-Ray equipment)	3-5
Industrial Radiology	1
Radiation Gauges	3-5

Source: Inspection Program

Nuclear medicine is ranked to be high in risk because the people who administer it will be at risk as the administered patient will be radioactive. Diagnostic radiology (CT

scan) is considered high risk because they produce high doses of radiation. Gauges in most cases are sealed and are mounted therefore ranked low.
According to Section 18 (1) (a) of the RPAZ Act and the inspection Policy clause 4, RPAZ shall maintain a planned and systematic inspection program to monitor compliance of facilities to licensing requirements.

The policy further states that the inspection programme be efficient, objective and consistent. Clause 5 of the policy further explains that the objective is to verify that all practices are authorized; the licensee complies with the legislation and any imposed conditions or requirements.

After inspection, the Inspection and Dosimetry department prepares an inspection report for each facility visited. According to the RPAZ Inspection Policy Clause 5 (g), a copy of inspection report shall be provided to the facility inspected. The report contains results of all inspections and will be the basis for notifying the Licensee of inspection findings, and of any requirements, to be complied with. According to the Enforcement policy clause 2, compliance is verified through inspections in accordance with the inspection policy. In the event of non-compliance, the RPAZ shall take necessary enforcement action. The enforcement actions shall be in accordance with Section 18 of the RPAZ Act. Enforcement actions shall properly reflect the safety or security significance of the violations and shall be carried out on a risk graded approach. Clause 4a-e of the Enforcement Policy**,** details actions that RPAZ can take which include verbal notification, written notices or warnings, closure of facilities, seizure of substances or equipment and taking the violating facilities to court where violations are severe or where the licensee does not co-operate.

2.5 Awareness

According to GSR Part 1 Requirement 36 the regulatory body (RPAZ) shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body. According to management RPAZ makes awareness of radiation issues through radio programmes, Zimbabwe International Trade Fair (ZITF) and Harare Agriculture Show (HAS).

RPAZ also encourages awareness activities within facilities through the RSO who has the duty to educate and supervise radiation awareness programs.

2.6 National Emergency response

When sources are in the country, operation, storage and disposal of radiation sources have a risk to people and the environment. It is the responsibility of the RPAZ through Inspection and Dosimetry Department to establish National emergency preparedness and response arrangements. In the event of any emergency, facilities in possession of a

radioactive source should notify RPAZ as the regulatory authority. To this end, according to GSR 2 para. 4.16, notification points shall be established that are responsible for receiving emergency notifications of an actual or potential nuclear or radiological emergency. The notification points shall be continuously available to receive any notification or request for assistance and to respond promptly or to initiate an off-site response.

When RPAZ is notified, it should coordinate with other players or stakeholders and according to GSR 2 para. 4.10, make arrangements for the implementation of a command and control system for the response to a nuclear or radiological emergency. This shall include arrangements for coordinating activities, for developing strategies and for resolving disputes between the response organizations concerning functions, responsibilities, authorities, the allocation of resources and priorities.

2.7 Storage of sources not in use

The facilities get to a point where they do not need the sources anymore or are keeping them for future use. According to IAEA disused sources are defined as sources that are no longer used and there is no intention of using them again in the practices they were authorized for. A country should have a storage facility for disused sources. According to Section 4 (1) (i) of the RPAZ Act [*Chapter 15:15*] the authority is mandated to advise on matters relating to the safety of radiation sources and the disposal of radioactive waste materials.

CHAPTER 3

FINDINGS

The RPAZ has experienced challenges in ensuring that it protects people and the environment against the negative effects of radiation. This was evidenced by the fact that people and the environment were being unnecessarily being exposed to radiation.

This Chapter starts by presenting my findings on unnecessary exposure to radiation. In trying to assess whether RPAZ is achieving its objective, the following issues were identified.

At Harare Central Hospital, the hospital used a CT scanner during its training of radiology staff to diagnose patients including pregnant women during the week of 23-27 May 2018 without a valid license. This machine had not yet been commissioned to ensure safety for patients, workers and the public. Furthermore, the scanner was installed in a room that had not been designed and approved for such high risk practice by the Authority. The use of such machine exposed people to unnecessary radiation.

In October 2016, at the Ministry of Transport's Eastlea Depot, a fire broke out and burnt an ISO freight container in which 26 disused radioactive sources were stored. The fire consumed part of the container's wooden floor, thereby reaching the sources**.** The sources were designed for moisture-density gauging. The burnt sources exposed the environment to an extent that when the national security inspection team (technical committee) toured the facility in December 2017, they could not physically verify the sources. The reason why they could not verify the sources was because of their safety as the burnt sources had potential to cause contamination to the environment and could have caused fatalities. The team instructed RPAZ to deal with the issue as a matter of urgency.

Furthermore, employees at some facilities using radioactive sources were taking between 4-31 months without being monitored despite the fact that some of them were using CT scanners which produce high doses of radiation. This was the case with Parirenyatwa diagnostics, Parirenyatwa Radiotherapy centre and Mutare Provincial Hospital.

These incidences unnecessarily exposed people and the environment to radiation as revealed under the following findings:

- **Inspection of facilities**
- **Issuance of operating licenses for facilities**
- **Awareness of possible radiation risks**

3.1 Inspection of facilities

According to Section 18 (1) (a) of the RPAZ Act and the Inspection Policy clause 4, RPAZ shall maintain a planned and systematic inspection program to monitor compliance of facilities with licensing requirements. Documentary review of the inspection returns revealed that for the period 2014 to 2017 RPAZ did not manage to conduct 144 planned inspections as shown in Table 4 below.

Table 4: Inspections analysis

Year	Planned	Actual	Variance	Percentage variance
2014	165	165	-	-
2015	305	217	88	29
2016	185	160	25	14
2017	198	167	31	16
Total	**853**	**709**	**144**	

Source: Inspection returns

In 2014, the Authority planned to inspect 165 facilities and according to RPAZ inspection return they inspected 165 facilities. In 2015 planned inspection rose from 165 to 305 representing an 85% increase. Planned inspections were reduced by 40% from 305 inspections in 2015 to 185 inspections in 2016. There was however, a marginal increase of 7% from 185 inspections in 2016 to 198 inspections in 2017. The actual inspection as shown on Table 4 above were on a downward trend from 217 in 2015 to 160 in 2016 facilities meaning that the inspections went down by 57 facilities. The percentage variances between planned and actual inspections were all negative ranging between 14% to 29%.

According to interviews with management it was revealed that the cause of the reduction in inspections was as a result of technical staff (inspectors) leaving the Authority.

However, despite the fact that management attributed the reduction of inspections to loss of key staff, Table 5 below shows the relationship between the number of inspections and number of inspectors for the period January 2014 to December, 2017.

Table 5: Number of Inspections compared to the number of inspectors per year

Year	2014	2015	2016	2017
Actual inspections	165	217	160	167
Number of inspectors	10	11	13	7
Ratio of inspections per inspector	16	20	12	23

Source: Inspector returns

From the above Table, in 2014, with 10 inspectors the Authority made 165 inspections reflecting that each on average inspected 17 facilities. In 2015 the Authority conducted 217 inspections with 11 inspectors and facilities inspected increased by 52 facilities. Each inspector on average inspected 20 facilities. The inspectors increased from 11 to 13 in 2016, but inspections went down to 160 showing reduction of 57 facilities. This means that each inspector inspected an average of 12 facilities. In 2017, inspections increased from 160 to 167 while inspectors dropped from 13 to 7 meaning that each inspector inspected an average of 23 facilities.

Therefore, the Authority performed well with fewer inspectors as shown in 2014, 2015 and 2017 as compared to 2016 where few inspections were done despite having more inspectors.

A further verification of inspection returns for each year revealed that from a sample of 114 facilities, 10 facilities in each of 2014 and 2015,7 and 8 in 2016 and 2017 respectively which were said to have been inspected had no evidence of inspection. The facilities are listed in Table 6 below.

Table 6: The following facilities did not have evidence of inspection

	2014	2015	2016	2017
1.	Freda Rebecca Gold Mine	St. Micheals Hospital	Bantex global	Ministry of Transport
2.	Kadoma Population Health Centre	Concession District Hospital	Ministry of transport	Rapha medical
3.	Bantex Global	ZIMRA forbes border post	Father O'Hea Mission Hospital	Ndanga district hospital
4.	Borradaile Hospital	Bonda mission hospital	Freda Rebecca Mine	Rusape general hospital
5.	Beitbridge District Hospital	Mutare Provincial hospital	Kadoma paper mills	Bonda mission
6.	Thornhill Hospital	Birchenough bridge Hospital	Nyanga District Hospital	Birchenough bridge Hospital
7.	PSMI 47 George Silundika	Chinhoyi provincial	ZIMRA NHS Airport Harare	ZIMRA Harare international Airport
8.	Concession District Hospital	Marondera provincial hospital	-	St. Alberts Mission hospital
9.	PSMI Shashi	Borradaile Hospital	-	-
10.	Luisa Guidotti Hospital	Queen marry Hospital	-	-

Source: Facility files and inspections

According to management and the RPAZ integrated regulatory system clause 1.4, the graded approach is the regulatory Authority's approach where all programmes are based on the risk categorization of the different practices. The frequency of inspections as guided by the graded approach are 1 year for nuclear medicine and industrial radiology, diagnostic radiology is between 2-3 years. Diagnostic radiology and radiation gauges' frequency is 3-5 years.

Despite the fact that the plans were being made on an annual basis using the graded approach, I further observed that 18 facilities listed below were being inspected more frequently than required by the graded approach as shown on Table 7 below:

Table 7: Facilities inspected without following the graded approach

Facility	**2014**	**2015**	**2016**	**2017**	**Graded approach**
ZISCO steel	X	✓	✓	X	3-5 years
ZIM alloys	X	✓	X	✓	3-5 years
Gweru Provincial hospital	X	X	✓	✓	3-5 years
ZIMASCO Kwekwe	X	✓	✓	✓	3-5 years
ZIMRA JM Nkomo	✓	X	✓	✓	3-5 years
CAAZ JM Nkomo	✓	X	✓	✓	3-5 years
PSMI Bulawayo	✓	X	✓	✓	3-5 years
Delta Beverages	✓	X	✓	✓	3-5 years
Mpilo X-ray	✓	✓	✓	X	3-5 years
Turnall Holdings	✓	✓	✓	✓	3-5 years
Mpilo Radiotherapy	✓	✓	✓	X	2-3 Years
Robert Stevernage veterinary service	✓	✓	X	✓	3-5 years
UBH	✓	✓	✓	✓	3-5 years
Gwanda Provincial Hospital	✓	X	✓	✓	3-5 years
Bindura Provincial Hospital	X	✓	✓	X	3-5 years

Source: Facility files

Key

✓: Facility inspected

x: No inspection in the year.

Details are shown on **Annexure D**. Some facilities were not being inspected because available resources were not being distributed to inspect more facilities using the graded approach which became effective in 2015. Had the Authority carried out inspections according to plan, this could have assisted in identifying and enforcing the following across entities and sectors in order to protect a wide section of the citizens:

Management comments

The observation was noted and the Authority indicated that the decline in the number of inspections in 2016 resulted from the decline in government funding which put a strain on the limited funds available for use. Further, the increase in radiation security activities led to a decline in the number of inspections per inspector.

It was further explained that while the graded approach was introduced in 2014, the graded approach to inspections was adopted in 2018 where the frequency of inspections is based on the risk of the facility. Previously, the Authority was still establishing a baseline and could not implement a graded approach on inspections although a graded approach was being implemented in the other regulatory aspects like authorisation where a multi-stage authorisation system was required for high risk facilities. Additionally, the Authority carries out follow- up and investigative inspections which are in addition to the scheduled inspections. In the previous years prior to 2018, the annual inspection plan would cover all the facilities with an inspection being scheduled per each facility.

3.1.1 Appointment of RSO

According to Section 16 (a) of the RPAZ Act [*Chapter 15:15*], the owner or occupier of a facility shall appoint a person experienced in radiation health and safety measures as a RSO within the facility. The RSO shall ensure that all persons using or working in the facility are supplied with at least one monitoring device and any other protective accessories necessary to carry out radiation procedures with the lowest possible risk. The RSO is responsible for ensuring that all radiation workers employed within the facility are given proper instructions on radiation safety measures. The RSO should also ensure that proper care is taken of radioactive wastes if they appear in the course of the use of radiation sources as described in the codes of practice.

A review of 114 facility files revealed that 32 facilities had not appointed RSOs to ensure proper management of radiation sources. Out of a total of 114 facilities, 69 facilities were inspected to verify the existence of RSOs. From the 69 facilities inspected, 51 facilities had trained and experienced RSOs, although 14 of the RSOs had no appointment letters from their organisations highlighting the duties which were to be performed by the RSO and giving the RSO rights and responsibilities regarding the company's records and personnel. These facilities were licensed and consequently going against the law regardless of them not complying with some regulation requirements. Refer to **Annexure F** for details**.**

Management comments

The RPAZ acknowledged the observation but pointed out that, going forward, the Authority shall require facilities to attach proof of appointment of RSOs and a

declaration from the appointed persons confirming the appointment and an understanding of the responsibilities.

3.1.2 Monitoring of occupationally exposed workers

According to the RPAZ dosimetry procedure manual clause 1, the dosimetry department has the mandate of monitoring all occupationally exposed workers in Zimbabwe. Dosimeters are instruments used to collect radiation doses which must be worn by each exposed worker. They should be submitted for reading to the RPAZ using readers which detect the total dose obtained on the dosimeter for the indicated period. The dose reading must be within the IAEA guidelines and should be investigated if a higher dose is obtained.

My inspection of 69 facilities revealed that 14 facilities had employees performing radiation procedures without dosimeters. These facilities were Nyanga Hospital, Forbes Border post, Bonda Hospital, Birchenough Bridge Hospital, Zvishavane Hospital, Shurugwi Hospital, RBZ Bulawayo, RBZ Harare, Rapha health care/Radon Radiology Joina City, Parliament of Zimbabwe, Kwekwe Hospital, Bulawayo Municipality, ZIMRA Joshua Mqabuko Nkomo Airport, RoadLab Civil Engineering, Blonton Management Consultants and Harare Central Hospital.

If occupationally exposed workers do not wear dosimeters it will be difficult to verify the dose of radiation that they have been exposed to and therefore they would be at risk of over-exposure and would have been unnecessarily exposed to radiation.

Dosimeters are required to be read monthly in order to identify and correct possible over exposure within a reasonable time frame. A review of dose reports revealed that the monitoring period for occupationally exposed employees was exceeding the prescribed 1 month as required by the issue form. However, the RPAZ gives a 3 months' allowance period for the reading of dosimeters. This is so because the dosimeters known as TLDs start fading after 3 months and thereafter reading becomes difficult. The Dose reports for facilities on **Annexure G** revealed that monitoring was not being done within the stipulated period. Readings were being done after 4 months with the highest being 30 months for the period January 1, 2014 to August 31, 2018.

From a review of 114 facility files, there was no evidence of any communication from the RPAZ following up on non-submitted dosimeters and issuing any enforcement actions as prescribed by the Enforcement Policy. Keeping or wearing dosimeters for too long may result in ineffective monitoring as dosimeter readings will be averaged over months and in the event of an over exposure to radiation, it may go undetected and cause difficulties in tracing the actual period of unnecessary exposure. Furthermore, TLD and OSL readers broke down between the period 2017 and August 31, 2018 and

2016 to 2017 respectively, meaning that RPAZ was not in a position to read dosimeters as the Authority had only one machine per each type of dosimeter.

The breakdown was due to non-maintenance of equipment used for reading dosimeters. Section 3.6 of the Procedures Manual requires monthly maintenance of such equipment. There was no evidence of preventive maintenance from January 2014 to December 2016. The evidence obtained showed that in 2017 the Harshaw 6600 plus reader was serviced once, and the Landauer reader was serviced 3 times in the same year. However, maintenance only started in January 2017 but it was not being done on a monthly basis as required.

Management comments:
The RPAZ acknowledged the observation and further noted that it will conduct an audit of the facilities to ensure that all occupationally exposed workers are under monitoring as well as increase awareness among radiation workers.

The Authority indicated that it will increase enforcement to ensure that dosimeters are submitted timely as agreed with the facilities. A fine has been proposed in the Amendment Bill to enforce compliance.

Regarding the non-maintenance of equipment, the Authority uses an online maintenance system with the suppliers. However, when there is a hardware failure replacements have to be sourced from the manufacturers who are based in Germany and France for the TLD and OSL systems, respectively. Delays in securing foreign currency increases the downtime.

Calibration of radiation monitoring equipment

According to Section 5.3 of Dosimetry Procedures Manual all the Authority's radiation monitoring instruments shall be calibrated at least once in every two years. My review of calibration certificates revealed that radiation monitoring instruments were not being calibrated at least once in every two years. The Landeur Semi Manual in light CSL reader was calibrated after more than two years between the periods February 2014 and May 2017. The Harshaw 6600 plus TLD reader was never calibrated during the period January 1, 2014 to August 31, 2018.

The calibration of equipment is done to ensure the correct dose records are obtained. Non calibration of radiation monitoring equipment compromised the efficiency of the equipment and the credibility of dose reports. Non credibility of dose results can cause alarm where there are high readings and false confidence where there are low readings.

Management comments
The observation was noted and the Authority explained that they highly prioritize the calibration of equipment. However, calibration is done outside the country as

there are no calibration facilities in Zimbabwe. The Authority has so far been securing the services from South Africa, Tanzania and Algeria. The sourcing of foreign currency and logistical challenges impact on the timely calibration.

It is highly recommended that the country should establish a secondary standards dosimetry laboratory to enable the Authority and all those who are required to comply with the Radiation Protection Act to have local access to calibration services. With the current set up, a lot of facilities including the radiotherapy and nuclear medicine facilities fail to comply besides putting a drain on scarce foreign currency resources. Use of uncalibrated equipment in the medical sector greatly compromises the quality of services delivered and affects the attainment of the desired treatment outcome. Having a secondary standards dosimetry laboratory will improve the health and safety of the population and also contribute to foreign currency savings.

Auditor's Evaluation
RPAZ as the regulatory authority should take steps to initiate the process so that the machines are properly calibrated for the safety of citizens.

3.1.3 Emergency plans for facilities

According to Section 40 (a) of the SI 62 of 2011, registrants and licensees shall ensure that an emergency plan appropriate for the source and its associated risks is prepared and kept operational.

My review of 114 facility files revealed that a total of 71 facilities had no emergency plans as required by the Statutory Instrument as shown on Table 8 below.

Table 8: Facilities without emergency plans per province

Province	**Sampled facilities**	**Facilities without emergency plan**
Harare	17	9
Bulawayo	16	11
Manicaland	9	5
Matabeleland South	9	6
Midlands	15	5
Masvingo	7	3
Mashonaland central	16	13
Mashonaland East	9	7
Mashonaland West	11	7
Matabeleland North	5	5
Total	**114**	**71**

Source: RPAZ register of sources

This was corroborated by inspections of 69 facilities out of which 37 facilities had no emergency plans. Absence of emergency plans at a facility has a risk that in the event of an emergency occurring, the operators would not be able to know what steps to take and consequently failing to reduce the risk or mitigate the consequences of the incident. Details of facilities without emergency plans are on **Annexure H.**

Management comments

The observation was noted and the Authority highlighted that it had taken a graded approach in the requirement for emergency plans where all high risk facilities are mandated to have emergency plans as a precondition for authorization.

3.1.4 Displaying of manufacturer's instructions by facilities

According to the license to use radiation emitting equipment condition 2**,** written procedures provided by the manufacturer and outlined in the manuals for the operation and maintenance of the devices/sources must be displayed. These procedures shall be followed by each authorized operator. My inspection of 69 facilities revealed that 39 facilities (57%) had not displayed manufacturer's instructions as required by the licensing conditions. Refer to Table 9

Table 9: Facilities without manufacturer's instructions displayed per province

Province	**Inspected facilities**	**Facilities without instructions on display**	**Percentage (%)**
Harare	17	8	47
Bulawayo	16	10	63
Manicaland	9	6	67
Midlands	14	7	50
Masvingo	5	3	60
Matabeleland south	7	5	71
Mashonaland central	1	-	0
Total	**69**	**39**	**57**

Source: RPAZ register of sources

Annexure I shows the details of facilities whose equipment had no manufacturer's instructions displayed on the control panel.

The display of these procedures will assist in the reduction of the risk of machine mishandling which may in turn cause radiation over-exposure through improper use, accidents or machine malfunction.

Management Comment

The RPAZ noted the observation and pointed out that it will strengthen enforcement of all licensing conditions to applicable facilities.

3.1.5 Disposal of sources not in use

According to Section 36 (3) of SI 62 of 2011, no person shall dispose of any radioactive waste unless the disposal facility designed and constructed specifically for this purpose is licenced and operational. Properly constructed facilities which are licensed by RPAZ will ensure high security of radiation sources and reduces the risk of misuse and theft for unspecified purposes. It will also ensure that no unnecessary exposure occurs to people and the environment in the vicinity in which the sources are stored.

My inspection of 12 facilities revealed that they did not have evidence of approval of infrastructure designed and constructed for the purpose of disposing of radioactive waste. The entities were keeping sources in storage facilities whose designs were not approved and not licenced by the RPAZ. See Table 10 below for details.

Table 10: Facilities with sources stored under different conditions

Entity Name	Number of sources	Where source is stored
ZISCO Steel (Redcliff)	6	Not dismantled, still fixed on the plant.
ZIM Alloys (Gweru)	3	Former guard room in salvage yard, with insecure windows.
ZIMASCO (Kwekwe)	3	Underground concrete casing.
ZIMASCO (shurugwi)	3	2 stored in concrete casing and 1 in metal casing in the geology storeroom.
Bindura Nickel Corporation (BNC)	6	4 Stored in an instruments workshop storeroom, 2 still mounted on the plant.
Ministry of Transport	28	22 in a Metal Cargo container, 4 in separate concrete casings, 2 in the laboratory.
ICRISAT	1	Office room.
Fidelity printers	1	Vault.
Murowa Diamonds	1	Still mounted on the plant.
Bulawayo City Council	1	Manufacturer's casing in general store room.
Blonton Management consultants	1	Unsealed Metal Casing.
PPC Collen Bawn	12	Secured mine cave.

Source: Inspection of facilities

From the above Table it was clear that there was no standard storage mechanism for disposal or storage of sources not in use. However, interviews with RSOs of 2 facilities (ZIMASCO Kwekwe and ZIMASCO Shurugwi) revealed that their temporary storage facilities were constructed under the supervision of RPAZ. Since they were constructed under the supervision of RPAZ, these storage facilities were considered to be less risky as there was no leakage of radiation as was shown by the inspection reports reviewed. Picture 1 and 2 show the storage facilities for ZIMASCO Kwekwe and Bindura Nickel Corporation. If all storage facilities were constructed like the one at ZIMASCO-Kwekwe *(*picture1) that could ensure safety for employees and public and reduce

unnecessary exposure since this was constructed under RPAZ monitoring. However, those at BNC, Zim alloys and ZIMASCO (Shurungwi) were not approved by RPAZ thereby possibly exposing employees and the public to unnecessary radiation exposure.

This was caused by RPAZ's failure to advise entities on the standard for constructing facilities for the storage of sources not in use. Such storage facilities should be approved and monitored by RPAZ.

Picture 1

Source OAG: ZIMASCO- Kwekwe 10/7/18

Picture 2

Source: OAG: Bindura Nickel Corporation (BNC) mine 2/2/18

Failing to develop a standard storage mechanism for sources no longer in use may result in improper disposal, destruction or loss of the equipment. The loss or destruction of radiation sources results in the contamination of the environment or fatalities as was mentioned on 2.1 second paragraph of this report. This is because these sources continue to emit radiation wherever they are. Such was the case at the Ministry of Transport Depot where 5 source (troxlers) which were stored in an ISO freight container with a wooden floor were destroyed by fire in 2016.

Furthermore, in September 2014, a radioactive source (nuclear density gauge) was detected at one of South Africa's scrap metal dealers and upon investigation, this source was said to have come from Zimbabwe. This went to an extent of straining diplomatic relations between the countries. Another Density Gauge was found in the scrap yard at a Zimalloys Mine in December, 2016. Delta bottling company also lost a source in the same year.

Management comments

The Authority acknowledged the observation and highlighted that a national disused radioactive source management facility is currently under construction and nearing completion.

On the burning of the container storage of the sources at the Ministry of Transport, it had great potential to cause contamination to the environment and

exposure to persons that could have caused fatalities. The burnt radioactive sources were recovered and placed in concrete containers as an interim measure. The ultimate solution is to condition the sources for repatriation to the manufacturers or long term storage.

The incident reflects a poor safety culture on the part of the user (Ministry of Transport) which is also evidenced by a poor history of licensing compliance.

In addition, the Authority further stated that in recovering lost or destroyed sources it requires a number of players. For instance, in the case of the Ministry of Transport where 5 density gauges were burnt in an ISO freight container storage which had a wooden floor in 2016, the players involved were the RPAZ, Zimbabwe Republic Police, Zimbabwe National Army, Fire Brigade, City of Harare Ambulances, Ministry of State Security, Ministry of Transport, Parirenyatwa Group of Hospitals. To perform this recovery exercise it cost USD 70 000.

However, the burnt radioactive sources still need to be conditioned with the technical support of the International Atomic Energy Agency (IAEA) and the equipment manufacturers from the United States of America. The costs of the conditioning programme will approximately cost of USD 197 421.

Auditor's Evaluation
Despite the fact that the RPAZ classified the Ministry of Transport as having poor safety culture, there was no evidence of inspections being carried out at the facility for the period under review to assess the safety of disused sources. Evidence of inspection that was availed for audit was the one conducted by the security technical team in December 2016.

3.2 Issuance of operating licenses for facilities

According to Licensing Department Procedures Manual clause 2.2.7 (a), the department issues a license certificate with associated conditions and practices for facilities meeting regulatory requirements. This license must be renewed annually. My review of 114 facility files revealed that a minimum of 35 and a maximum of 61 facilities operated without licenses for the period January 1, 2014 to August 31, 2018. See Table 12 below for details.

Table 12: Licensing of facilities

Year	Total	Unlicensed facilities	Percentage of unlicensed Facilities
2014	114	61	54%
2015	114	50	44%
2016	114	53	46%
2017	114	35	31%
As at August 31, 2018	114	40	35%

Sources: Facility files

The operation of facilities without a license was attributed to non-enforcement of the RPAZ Act and the enforcement policy which requires non-compliant facilities to be issued with written warnings, closure of facilities or seizure of equipment. See **Annexure J** for details

Audit also noted that, RPAZ was licensing facilities which did not meet licensing requirements. There were 30 (thirty) facilities that were licensed between 2017 and 2018 which did not meet requirements, for instance appointment of RSO trained on radiation issues, displaying of emergency plan and manufacturer's instruction. Furthermore, I also noted that Gwanda Provincial Hospital and Ndanga Hospital were closed by the RPAZ for non-licensing. However, they were reopened after license payments had been processed even without meeting other licensing requirements (such as dosimeters for occupationally exposed employees).

During the year, Inspection and Dosimetry Department conducts inspections and when the year ends the facilities are supposed to renew licenses. The licensing department should use the findings of the inspection department to assess whether they should renew a license or not. The Licensing and Inspection and Dosimetry departments were not coordinating in sharing information on the outcome of inspections resulting in issuing or renewing of licenses to facilities that did not meet the minimum requirements.

From interviews with facility representatives it was revealed that licenses were taking long to process and reach their destination. Some of the facilities were ISO certified and the delays in receiving their licenses meant that they were deemed non-compliant by other certifying bodies. The delay ranged from 2 to 3 months and the cause for the delay according to RPAZ management is that certificates were sent by post and some of them would get lost and returned back to RPAZ.

Management comments

The RPAZ acknowledged the observation and highlighted that non-compliance challenges have been high in public institutions i.e. Government provincial, district and mission hospitals. The main challenges are in the following:

- **Appointment of and training of RSOs**
- **Payment of licensee and dosimetry fees**

Engagements have been made with the Ministry of Health and Child Care to address the challenges. In order to expedite the processing of licenses, the Authority have introduced the electronic Licensing System (ELAM) which enables timely communication between the Authority and applicant as well as enabling the applicant to check real time processing of their application.

The Authority will strengthen the enforcement actions on non-compliant facilities as provided for by the Radiation Protection Act.

3.3 Awareness of possible radiation risks

According to GSR Part 1 Requirement 36 the regulatory body (RPAZ) shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body. It is also the responsibility of the RPAZ to ensure that all stakeholders, importers and exporters are aware of the risks associated with radiation sources so as to properly manage the importation or exportation of the sources.

My inspection of 69 facilities revealed that RPAZ did not have mechanisms in place to raise and promote awareness on possible radiation risks to ensure the public is conscientised on radiation issues. Information on possible radiation risks from the RPAZ was also not available at public places, for example at airports, hospitals, mines and industries.

RPAZ was limiting its awareness programs to programmed national events such as ZITF and Agricultural shows which are carried out once every year without utilising other media platforms like fliers, magazines or sms platforms. However, the RPAZ developed 2 fliers in July 2018 responding to public concerns over the safety on use of microwave ovens and the other one was on providing safety awareness on reducing radiation. However, the fliers were only available at RPAZ head office in Harare.

Management comments

The Authority agreed to the observation and highlighted that it uses various platforms to raise awareness among stakeholders and this includes Radio and TV Programs, website: which is regularly updated to provide useful information, social media platforms such as twitter, Facebook and WhatsApp. The RPAZ participates at national exhibitions events such as ZITF, Harare Agricultural show, Medical and Health expos, ZIMRA health galas and cancer awareness

programs. Due to budget constraint, the Authority has not yet been able to participate in provincial and district exhibitions.

The Authority also conducts training for Radiation Safety Officers (RSO) and presentations on invitation to various fora such as NSSA programs and facility based trainings. The major challenge faced by the Authority is on resources to carry out a national radiation awareness program that covers both the public and facilities using radiation technology in the country.

Auditors Evaluation
Without having secured more resources, in the interim, the RPAZ has fliers at its head office which could be distributed to stakeholders in provinces and districts.

On training of RSOs, the facility representatives especially government institutions indicated that they really needed training but the cost of training was too high. However, for the benefit of citizens, RPAZ should liaise with the Ministry of Health and Child Care which has training facilities that they can use to train RSOs at a minimal cost for each province or district. Further strategies need to be formulated so that awareness reach all the ordinary citizens of Zimbabwe.

The following were the effects of inadequate awareness on radiation issues:

3.3.1 Imported/Exported sources

Clause 3.1 of the M.O.U between the RPAZ and ZIMRA, stipulates that no radiation sources shall be imported into or exported out of Zimbabwe unless covered by a license issued by RPAZ. I observed through a review of files that the following 15 facilities as shown in Table 13 below imported radiation sources without import licenses as required.

Table 13: Radiation sources imported without licenses

Year	Facility name	Source type
2014	RoadLab Civil Engineering	Troxler
2016	Continental Marketing	X-Ray Machine
2016	Slowgrad Engineering	XRF
2016	Medfirst 24Hr Medical Centre	X-Ray Unit
2016	Malbereign 24 Hour Medical Centre	X-Ray Unit
2016	Roberts Stevenage Veterinary services	X-Ray Unit
2016	Blonton Management Consultants	Density gauge
2017	Fidelity Printers	X-Ray Unit
2017	Harare Central Hospital	CT Scanner
2017	Mpilo Central Hospital	CT Scanner
2017	Chinhoyi Provincial Hospital	CT Scanner
2017	Bulawayo United Hospitals	CT Scanner

2017	Masvingo Provincial Hospital	CT Scanner
2017	MHCC Head office	CT Scanner
2017	Mutare Provincial Hospital	CT Scanner

Source: retrospection licensing return and inspections

Interviews with RSOs from RoadLab Civil Engineering and Roberts and Stevenage Veterinary services revealed that they were initially not aware that the importation of sources required a license from the regulatory Authority. However, they became aware after being fined for not following due process and after inspectors visited them for inspection, respectively.

This was partly attributed to RPAZ's failure to raise awareness with or train ZIMRA officials for them to identify radioactive sources upon entry into the country and also RPAZ's failure to notify ZIMRA of importers and exporters within 2 days as agreed in the M.O.U.

Importation of sources without licenses may result in radiation sources coming into the country without being accounted for by RPAZ or not recorded in the RPAZ registers and consequently, the radiation sources may be used without proper monitoring and handling. Further, radiation sources can for example be abused by creating bombs.

Management comments

The Authority noted the observation and explained that the challenges of imports without authorization are due to lack of enforcement of import and export control. It was further pointed out that the mechanisms will be strengthened including awareness among users.

3.3.2 Notification of ZIMRA by RPAZ of importers and exporters within 2 days

According to the M.O.U clause 5.3, in the event that the RPAZ issues a new license to any person authorizing them to import or export radiation sources, it shall, within two days of such authorization, advise the ZIMRA of the identity of that person and any other information that will enable ZIMRA to deal with such importation or exportation. This is done in order for ZIMRA to be aware of the importer and to reduce processing time at the border as some nuclear medicine sources have a short life span. This will also reduce the risk of fake RPAZ import licenses being processed and deemed as originals by ZIMRA.

I observed through documentary review that there was no evidence of any communication from the RPAZ to inform the ZIMRA on importation or exportation of radiation sources. Table 14 below shows that between 2014 and 2017, 103 sources were imported while 10 were exported without notifying ZIMRA.

Table 14: Imports and exports without RPAZ notifying the ZIMRA

Year	Number of imports	Number of exports
2014	31	4
2015	32	-
2016	21	4
2017	19	2
Total	**103**	**10**

Source: Imports and exports returns

Non notification of ZIMRA officials may result in sources entering or leaving the country without trace.

Management comments

RPAZ acknowledged the observation and highlighted that strengthening of information exchange between RPAZ and ZIMRA on import and export control will be included in the review of the MOU underway.

3.3.3 Identification of imported/exported sources by ZIMRA officials

According to the MOU clause 6, and management representation, RPAZ shall facilitate radiation safety training to all officers designated by ZIMRA to be able to identify imports or exports of radiation emitting equipment.

I noted through interviews of 14 ZIMRA officials stationed at Robert G. Mugabe International Airport, National Handling Services, Forbes border post, Joshua Nkomo International Airport, Plumtree and Beitbridge border post that RPAZ was not raising awareness through training of ZIMRA officials for them to be able to identify imported/exported sources. Table 15 below shows facilities and ZIMRA officials interviewed.

Table 15: Number of interviewed ZIMRA officials

Facility	Number of officials
R.G. Mugabe Airport and AGS	3
Forbes border post	5
Joshua Nkomo international Airport	1
Plumtree border post	2
Beitbridge border post	3
Total	**14**

Source: ZIMRA Interviews

Some radiation sources used in Nuclear medicine have a short life span and require urgent attention to ensure they do not expire while in storage. If ZIMRA officials are not aware of such information and if notification is not done by RPAZ, they may detain

the sources at ports of entry resulting in their expiry while in storage. Furthermore, Radiation sources may not be properly handled therefore exposing the ZIMRA and cargo handling officials to unnecessary radiation.

Management comments

The Authority agreed to the observation and pointed out that the RPAZ has engaged and made recommendations to ZIMRA for the inclusion of radiation safety in the revenue officers training curriculum. This will ensure that all graduating officers possess requisite knowledge before deployment.

3.3.4 Emergency notification points/hotlines

According to GS-R-2 para. 4.16, the RPAZ shall establish emergency notification points that are responsible for receiving emergency notifications of an actual or potential nuclear or radiological emergency. The notification points shall be continuously available to receive any notification or request for assistance and to respond promptly or to initiate an off-site response.

I observed through the review of the National Emergency Plan that a notification point with office numbers and two mobile numbers was established for receiving emergency notification of actual or potential nuclear or radiological emergency. However, the notification office contact numbers, could only be used during working hours and were not manned after hours. Furthermore, the mobile numbers on the emergency plan, were not reachable. A representative of management revealed that the 2 mobile numbers were for former employees who had since left employment with the Authority.

Furthermore, interviews with 69 RSOs or facility representatives revealed that all the facilities had emergency contact details for RPAZ employees to call when need arose, but the numbers were not displayed on the facilities emergency plans to contact the Authority in case of emergencies. **Annexure H** refers.

Management comments

The RPAZ noted the observation and pointed out that the Authority will update the contact person and further introduce the toll free lines for radiation emergency notifications. The operation of the emergency notification system needs to be integrated in the national command centre coordinated by the Department of Civil Protection (DCP). The accession to the Convention on Early Notification in the Case of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Incident will further strengthen the country's emergency preparedness and response infrastructure.

CHAPTER 4

4. CONCLUSIONS

4.1. General conclusion

The RPAZ is not putting in place effective mechanisms to manage radiation sources as evidenced by the number of unlicensed facilities, inadequate monitoring of occupationally exposed workers and inadequate awareness programs. As a result of the above the RPAZ may fail to achieve its mandate of protecting people and the environment from unnecessary exposure to radiation.

4.2. Specific conclusions

The following are specific conclusions:

4.2.1 Although the Authority provided a schedule of inspected facilities, there was no evidence to show that all facilities were being inspected to ensure compliance with radiation management regulations.

The RPAZ was not enforcing the Act in ensuring that all facilities owning radiation emitting equipment comply with the RPAZ Act. This was shown by the fact that some facilities had employees not being monitored while other facilities had no emergency plans. The RPAZ was not ensuring that facilities display manufacturer's instructions and this may cause mishandling of radiation equipment. The RPAZ was also not implementing the graded approach.

Calibration of Radiation monitoring equipment was not being done according to the procedure manual. This may result in unreliable dose readings being obtained.
The RPAZ has not developed standard mechanisms for the storage of radiation sources not in use. This may result in unnecessary exposure to human and animal life and the environment.

4.2.2 The RPAZ was not enforcing the Act to ensure facilities were licensed. Some of the facilities were being licensed without meeting licensing conditions and there was minimal coordination between the Licensing department and Inspection Department.

4.2.3 There were no adequate promotional materials for radiation protection where possible radiation risks are outlined. This may result in continued exposure to radiation due to lack of knowledge.

The RPAZ has not been implementing the M.O.U with ZIMRA resulting in the ZIMRA officials failing to identify radiation emitting equipment on importation or exportation.

Equipment can also be used without licensing thereby exposing people to various health hazards.

Emergency notification points were not readily available at all times which may result in delays in reporting of emergencies and also carrying out disaster management actions.

CHAPTER 5

5. RECOMMENDATIONS

The following recommendations are aimed at improving the RPAZ in carrying out its mandate of protecting people and the environment against the negative effects of radiation.

5.1 The RPAZ should ensure that inspections of facilities are done in accordance with the graded approach. The graded approach requires that facilities are categorised according to the types of sources and their related risks. The RPAZ inspections should be done in order to make sure that facilities comply with the Act and licensing conditions. These include ensuring:

- The enforcement of the Act by making sure that all facilities appoint a trained and experienced RSO.
- That all occupationally exposed employees are monitored using dosimeters.
- That the Authority prioritize calibration of radiation monitoring equipment to ensure reliable readings or dose reports are obtained. The Authority should consider coordinating with other stakeholders so that calibration services are done locally. This will cut costs and reduce pressure on demand of forex. This will further and consequently eliminate the logistical problems which emanate from sending the equipment outside the country.
- That facilities develop emergency plans and implement them.
- The enforcement of license conditions which require facilities to display manufacturer's instructions.
- That there is availability of a licenced standard storage facility for sources not in use to reduce unnecessary exposure to human, animal life and the environment.
- RPAZ should see to it that corrective action is taken on all monitoring findings to avoid their recurrence.

5.2 The RPAZ should take enforcement actions such as written warning, closure and seizure of equipment against all non-compliant facilities to ensure that only compliant facilities continue to operate. Furthermore, the RPAZ should license facilities that meet licensing conditions. Licensing, Inspection and Dosimetry Departments should improve on coordination so that each department has the same information on inspection findings and that appropriate enforcement action is taken.

5.3 The Authority should consider using different forms of media to reach out to stakeholders so that they become aware of the dangers of radiation exposure rather than just focusing on programmed national events such as ZITF and Agricultural shows.

Awareness material such as fliers, magazines or pamphlets should also be distributed to public places such as hospitals, clinics, airports and mines so as to create awareness.

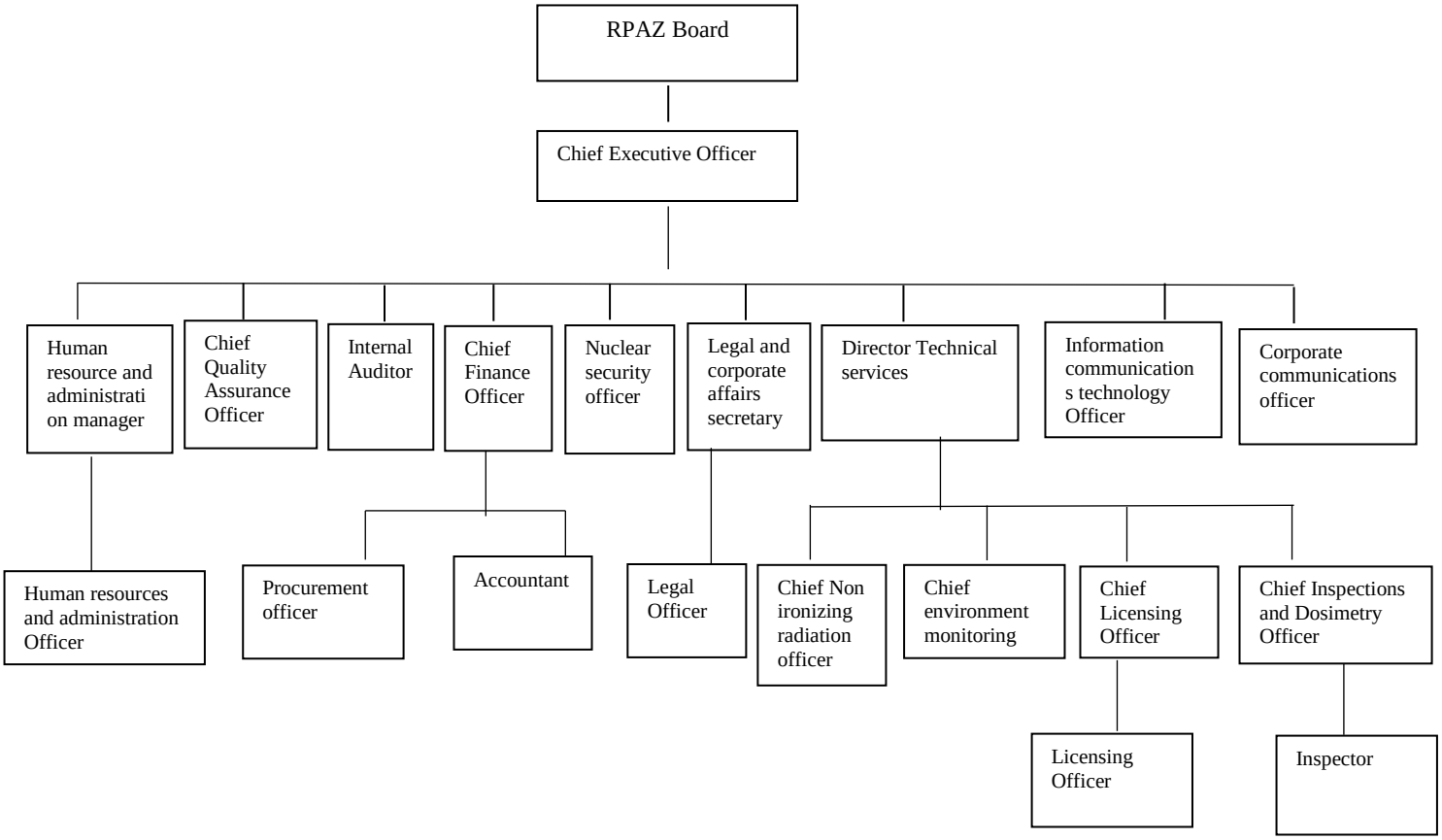
Providing awareness through programmed regular training of ZIMRA officials is also critical in that all imported radiation sources would be properly identified to ensure proper handling as there is high rate of job rotation at ZIMRA. This would help to curb unnecessary exposure to the public and the environment. The Authority can also provide ZIMRA with radiation detection equipment for radioactive sources and physical inspection for powered sources.

A comprehensive emergency plan which has functional notification points or hotlines should be established to ensure incidences are reported timeously.
The RPAZ should devise a mechanism to receive emergency notifications 24 hours/day, either through among others, Short Message Service (SMS) alerts, voice messages or emergency e-mail notifications.

ANNEXURES

ANNEXURE A

ORGANOGRAM



ANNEXURE B

DOCUMENTS REVIEWED

Document	**Purpose**
Appraisal reports for senior management	Assess performance of management.
Audited Financial statements	Performance of the Authority and funding.
Board Minutes	Strategic direction decided to be taken by those charged with governance.
Dosimetry procedure manual	To understand the requirements when reviewing and assessing the performance of the dosimetry division.
Enforcement Policy	Understanding guidance provided to the staff and stakeholders on the Authority's approach to compliance and enforcement.
External and Internal Audit reports	Assessing issues raised from the previous audit reports.
Facility Files	To understand the history of a facility.
Inspection checklist for industrial radiation sources, radiotherapy facilities, Checklist for commissioning and regular inspection of nuclear medicine facilities	To appreciate what is verified during inspection of facilities.
Inspection Plans and reports	To understand whether the Authority is planning and implementing plans.
Inspection Policy	Policies in place to do with inspections.
Job Descriptions	Understanding duties and responsibilities.
Licensing Procedure Manual	To understand the procedure followed by RPAZ in licensing and requirements needed when processing the licenses.
Operational Guidelines	To understand the parameters in which they operate in.
Radiation Protection Act *[Chapter 15:15]*	Understanding the mandate, functions of the RSO, Actions to be taken in the event of facilities failure to comply with the Act.
Registers (import and export, Radiation sources, issued, amended, suspended and revolved facilities.	To identity sources that were suspended, licenses issued, amended and revoked.
Review and assessment of license application diagnostic and radiology.	To understand the requirements for reviewing and assessing of license application diagnostic and radiology.
Review and assessment of license application radiotherapy.	To understand the requirements when reviewing and assessing licenses for application radiotherapy.
Statutory Instrument 134 of 2012	Fees schedule.
Strategic Plans (2012-2016 and 2015-18)	To get an understanding on the objectives of the Authority.

ANNEXURE C

KEY PERSONNEL AND STAKEHOLDERS INTERVIEWED

Province	Organization	Interviewee
	RPAZ	
	RPAZ	Chief Executive Officer
	RPAZ	Internal Auditor
	RPAZ	Legal and corporate services
	RPAZ	Chief Finance Officer
	RPAZ	Human Resources and Administration Manager
	RPAZ	Chief Licensing Officer
	RPAZ	Chief Inspection Officer
	RPAZ	Chief Quality Assurance Officer
	Other Harare Stakeholder:	
	ZIMRA head office engineering services	Head of engineering services
	Parirenyatwa Group of Hospitals	Director of operations
	Harare Central Hospital	Chief Executive Officer
	Oncocare	Radiation Safety Officer
	Ministry of Health and Child care	Deputy director equipment
	Parliament of Zimbabwe	Security officer
	RBZ Harare	Assistant operation manager
	PSMI George Silundika	Radiation Safety Officer
	ZERA	Radiographer
	West Hospital	Radiographer
	Rapha medicals	Radiographer
	Ministry of transport	Radiation Safety Officer
	Baines imaging	Radiation Safety Officer
	PSMI Parkview	Radiation Safety Officer
	DX Centre	Administrator
	Dr. Chirambasukwa-West end	Radiation Safety Officer
Mashonaland Central	Bindura Trojan Mine	Radiation Safety Officer
Manicaland	Mutare Hospital	Radiation Safety Officer
	Birchenough bridge Hospital	Matron
	Rusape Hospital	Medical superintendent
	Nyanga Hospital	X-ray Operator
	Bonda Mission Hospital	Matron
	Mutare-Baines imaging	Radiation Safety Officer
	Rusape 24Hour Medical Centre	Facility Doctor

	Mutare PSMI radiology	Radiation Safety Officer
Midlands	Kwekwe Hospital	Medical superintendent
	Zisco steel	Radiation safety officer
	Sable Chemicals	Radiation safety officer
	ZIM Alloys	Radiation safety officer
	Gweru Provincial Hospital	Radiation safety officer
	Unki mine	Radiation safety officer
	ZIMASCO Clinic	Matron
	ZIMASCO Kwekwe	Radiation safety officer
	ZIMASCO Shurugwi Plant	Health and safety officer
	Shurugwi District Hospital	Administrator and the radiographer
	Zvishavane District Hospital	Administrator and the radiographer
	Mimosa Mine	Radiation safety officer
	Murowa Diamonds Mine	Radiation safety officer
	Gaths mine/Shabane	Medical doctor
Bulawayo	Bulawayo Municipality Engineering	Health and safety assistant
	CAAZ Bulawayo JM	Radiation safety officer
	JM Airport Zimra	X-ray operator
	NUST Physics Department	Head of physics department
	ICRISAT	Safety officer
	Mpilo Nuclear Medicine	Radiation safety officer
	PSMI Bulawayo	Team leader
	Delta Beverages	Radiation safety officer
	Mpilo X-Ray	Radiation safety officer
	Turnal Holdings	Radiation safety officer
	RoadLab Civil Engineering	Radiation safety officer
	PPC Collen Bawn	Radiation safety officer
	Mpilo Radiotherapy	Radiation safety officer
	Roberts and Stevenage	Radiation safety officer
	UBH	Radiation safety officer
	Blonton Management consultants	Administrator
	RBZ Bulawayo	Radiation safety officer
Masvingo	PSMI Masvingo	Team leader
	Bikita Minerals	Radiation safety officer
	Morgenster Mission Hospital	Hospital doctor and x-ray operator
	Masvingo Hospital	Administrator and Radiation safety officer
	Ndanga District Hospital	Administrator and X-ray operator
Matabeleland south	Gwanda Provincial Hospital	Medical superintend and the x-ray operator

	Fort X-Ray	x-ray operator
	Tshelanyambe Hospital	Hospital doctor
	Beitbridge District Hospital	Radiation safety officer
	ZIMRA Beitbridge Border	Acting area manager and Radiation safety officer
	PPC Collen Bawn	Radiation safety officer
	ZIMRA Plumtree Border	Area manager and Radiation safety officer

ANNEXURE D

INSPECTION ANALYSIS FOR FACILITIES

Facility	2014	2015	2016	2017
HARARE				
ZIMRA NHS	No	No	No	No
ZIMRA Airport Arrivals	No	No	No	No
Parirenyatwa Diagnostics	No	No	No	No
Parirenyatwa Radio therapy	No	No	No	No
Oncocare	No	No	No	No
Harare Central Hospital	No	Yes	No	No
Parliament of Zimbabwe	No	No	No	No
RBZ Harare	No	No	No	No
PSMI George Silundika	No	No	No	No
ZERA	No	No	No	No
West Hospital	No	No	No	No
Rapha Healthcare systems (randon)	No	No	No	No
Ministry of transport	No	No	No	No
Baines imaging	No	No	No	No
PSMI Parkview	No	No	No	No
DX Centre	No	No	No	Yes
Dr. Chirambasukwa-West end	No	No	No	No
MANICALAND				
Mutare Hospital	No	No	No	No
PSMI Radiology Mutare branch	No	No	No	No
Rusape Hospital	No	No	No	No
Rusape 24 Hour	No	No	No	No
Bonda Mission	No	No	No	No
Nyanga Hospital	No	No	No	No
Forbes Border Post	No	No	No	No
Birchenough bridge Hospital	No	No	No	No
Baines Imaging mutare	No	No	No	No
MIDLANDS				
Kwekwe Hospital	No	No	Yes	No
ZISCO steel	No	Yes	Yes	No
Sable Chemicals	No	Yes	No	Yes
ZIM Alloys	No	Yes	Yes	Yes
Gweru Provincial Hospital	No	No	Yes	Yes
Unki mine	No	No	No	Yes
ZIMASCO Clinic	No	No	No	No
ZIMASCO Kwekwe	No	Yes	Yes	Yes
ZIMASCO Shurugwi Plant	No	Yes	Yes	Yes
Shurugwi District Hospital	No	Yes	No	No
Zvishavane Hospital	No	Yes	No	Yes
Mimosa Mine		Yes	No	Yes
Murowa Diamonds Mine	No	Yes	No	No

Gaths mine/Shabane	No	No	No	No
BULAWAYO				
Bulawayo Municipality Engineering	Yes	No	No	Yes
CAAZ Bulawayo JM	No	Yes	Yes	Yes
JM Airport Zimra	Yes	Yes	Yes	No
NUST Physics Department	NA	Yes	NA	NA
ICRISAT	No	No	Yes	No
Mpilo Nuclear Medicine	Yes	Yes	Yes	Yes
PSMI Bulawayo	Yes	No	Yes	Yes
Delta Beverages	Yes	No	Yes	Yes
Mpilo X-Ray	Yes	Yes	Yes	No
Turnal Holdings	Yes	Yes	Yes	Yes
RoadLab Civil Engineering	No	No	No	Yes
Mpilo Radiotherapy	Yes	Yes	Yes	No
Roberts and Stevenage veterinary services	Yes	Yes	No	Yes
UBH	Yes	Yes	Yes	Yes
Blonton Management consultants	No	No	No	No
RBZ Bulawayo	No	No	Yes	
Masvingo				
PSMI Masvingo	Yes	No	No	No
Bikita Minerals	No	No	No	No
Morgenster Mission Hospital	No	No	No	No
Masvingo Hospital	No	No	No	Yes
Ndanga District Hospital	No	No	No	No
Matabeleland South				
Gwanda Provincial Hospital	Yes	No	Yes	Yes
Fort X-Ray	Yes	No	No	Yes
Tshelanyambe Hospital	No	Yes	Yes	No
Beitbridge District Hospital	No	No	Yes	Yes
ZIMRA Beitbridge Border	No	Yes	Yes	No
PPC collen bawn	Yes	No	Yes	Yes
ZIMRA Plumtree Border	Yes	No	Yes	Yes
Mashonaland Central Province				

Bindura Nickel Corporation	No	No	No	No
Matabeland North				
ZPC Hwange Power Station	No	Yes	No	No
PSMI Radiology-Victoria falls	No	Yes	No	No
Tsholotsho District Hospital	No	No	No	No
Mbuma Mission Hospital	No	No	No	Yes
Makomo resources	No	Yes	No	Yes
Mashonaland Central				
Bindura provincial hospital	No	Yes	Yes	No
Concession district Hospital	No	No	No	No
Mvurwi hospital	No	No	No	No
Chitsungo Hospital	Yes	No	No	No
Ponai medical	No	Yes	No	No
PSMI Shashi	No	No	No	No
Karanda Mission Hospital	No	Yes	No	No
Mount Darwin Hospital	No	Yes	No	No
St Alberts mission	No	No	No	No
Howard hospital	Yes	No	No	No
PSMI Bindura	No	No	No	No
Freda Rebecca Gold	No	No	No	No
Canterbury Mine	No	No	No	No
Mashonaland West				
Bantex Global Chinhoyi	No	Yes	No	No
St Ruperts Mayer Mission Hospital	No	No	No	No
Chegutu Hospital	No	No	No	No
Kadoma Paper Mills	Yes	No	No	No
Chinhoyi Hospital	No	No	No	No
Kadoma Population Health Centre	No	No	No	No
Queen Mary	No	No	No	No
ZIMASCO Mtorashanga	No	No	No	No
Father O'HEA Hospital	No	No	No	No
Zimplats Trauma Centre	No	No	No	No
Zimplats Medical Ngezi	No	No	No	No
Habour Medical Centre	No	No	No	No
Mashonaland East				
Zimra Nyamapanda	No	No	No	No
Marondera Hospital	No	No	No	No

Chivhu General Hospital	No	No	No	No
Breckridge Investments	No	Yes	No	No
ZIMRA Chirundu Border	No	No	No	No
St. Michaels	No	No	No	No
Murewa Hospital	No	No	No	No
Luisa Guidotti Hospital	No	No	No	No
Borraidale Hospital	No	No	No	No
Midlands				
Thornhill Hospital	No	No	No	No
Masvingo				
Ngomahuru psychiatric hospital	No	No	Yes	No
Manyama Mission Hospital	No	No	Yes	Yes
Matebeleland South				
River Range Mine	No	No	No	No
Mtshabezi Hospital	No	No	No	Yes

Key

No: inspection planned but not done

Yes: inspection planned and done

ANNEXURE E

NUMBER OF SAMPLED FACILITIES ACCORDING TO INDUSTRY/ PRACTICE

	Categories of sources					
	Medical and veterinary		**Industry**		**Research and agencies**	
Inspection per province	**Total facilities**	**Facilities audited**	**Total facilities**	**Facilities audited**	**Total facilities**	**Facilities audited**
Harare	112	11	43	6	23	-
Bulawayo	21	6	9	8	3	2
Manicaland	14	8	3	1	-	-
Matabeleland South	7	4	3	3	1	-
Midlands	20	5	11	9	-	-
Masvingo	19	4	3	1	-	-
Mashonaland central	14	-	3	1	1	-
Total	**207**	**38**	**75**	**29**	**28**	**2**
Documentary review per province						
Harare	112	11	43	6	23	-
Bulawayo	21	6	9	8	3	2
Manicaland	14	8	3	1	-	-
Matabeleland South	7	5	3	4	1	-
Midlands	20	6	11	9	-	-
Masvingo	19	6	3	1	-	-
Mashonaland East	9	7	1	2	-	-
Mashonaland West	21	10	7	2	-	-
Matabeleland North	8	3	8	2	-	-
Mashonaland Central	14	12	3	3	1	-
Total	**245**	**74**	**91**	**38**	**28**	**2**

Source: National radiation sources register

ANNEXURE F

RADIATION SAFETY OFFICER ANALYSIS

Facility	Existence of RSO as per record	Physical existence of RSO	Availability of Appointment letter	Certified
Inspected facilities				
Harare				
ZIMRA NHS	Yes	Yes	Yes	Yes
ZIMRA Airport	Yes	Yes	Yes	Yes
Parirenyatwa Diagnostics	Yes	Yes	No	Yes
Parirenyatwa Radiotherapy	Yes	Yes	No	Yes
Oncocare	Yes	Yes	Yes	Yes
DX Chinamano	Yes	Yes	Yes	Yes
Harare Hospital	Yes	Yes	No	Yes
Baines Imaging	No	Yes	Yes	Yes
Parliament of Zimbabwe	Yes	Yes	No	Yes
RBZ Harare	No	No	No	No
PSMI George Silundika	Yes	Yes	Yes	Yes
ZERA	No	No	No	No
Westend Hospital	Yes	Yes	Yes	Yes
Rapha Healthcare Systems	No	No	No	No
Ministry of Transport	Yes	Yes	Yes	Yes
PSMI Parkview	Yes	Yes	Yes	Yes
Dr Chirambasukwa Westend	Yes	Yes	Yes	Yes
Manicaland				
Mutare Hospital	Yes	No	No	No
PSMI Radiology Mutare branch	Yes	Yes	Yes	Yes
Rusape Hospital	No	Yes	No	Yes
Rusape 24 Hour	Yes	Yes	Yes	Yes
Bonda Mission	No	No	No	No
Nyanga Hospital	No	No	No	No
Forbes Border Post	No	Yes	Yes	Yes
Birchenough bridge Hospital	No	No	No	No
Baines Imaging Mutare	Yes	Yes	Yes	Yes
Midlands				
Kwekwe Hospital	No	No	No	No
ZIMASCO Kwekwe	Yes	Yes	Yes	Yes
Zisco steel	No	No	No	No
Sable Chemicals	Yes	Yes	Yes	Yes
ZIM Alloys	Yes	Yes	Yes	Yes
Gweru Provincial Hospital	Yes	No	No	No
Unki mine	Yes	Yes	Yes	Yes
ZIMASCO Clinic	Yes	No	No	No
Zimasco Shurugwi Plant	No	No	No	No

Shurugwi District Hospital	No	No	No	No
Zvishavane Hospital	No	No	No	No
Mimosa Mine	Yes	Yes	Yes	Yes
Murowa Diamonds Mine	Yes	Yes	Yes	Yes
Gaths mine/Shabane	N/A	N/A	N/A	N/A
BULAWAYO				
Bulawayo Municipality Engineering	Yes	Yes	Yes	Yes
CAAZ Bulawayo JM	Yes	Yes	No	Yes
JM Airport Zimra	Yes	Yes	Yes	Yes
NUST Physics Department	Yes	Yes	Yes	Yes
ICRISAT	No	No	No	No
Mpilo Nuclear Medicine	Yes	Yes	No	Yes
PSMI Bulawayo	Yes	Yes	Yes	Yes
Delta Beverages	Yes	Yes	Yes	Yes
Mpilo X-Ray	Yes	Yes	Yes	Yes
Turnall Holdings	Yes	Yes	Yes	Yes
RoadLab Civil Engineering	Yes	Yes	Yes	Yes
Mpilo Radiotherapy	Yes	Yes	No	Yes
Roberts and Stevenage	Yes	Yes	Yes	Yes
UBH	Yes	Yes	No	Yes
Blonton Management Consultants	No	No	No	No
RBZ Bulawayo	Yes	Yes	No	Yes
Masvingo				
PSMI Masvingo	Yes	Yes	Yes	Yes
Bikita Minerals	Yes	Yes	Yes	Yes
Morgenster Mission Hospital	No	No	No	No
Masvingo Hospital	Yes	Yes	No	Yes
Ndanga District Hospital	No	No	No	No
Matabeleland South				
Gwanda Provincial Hospital	Yes	Yes	No	Yes
Fort X-Ray	Yes	Yes	No	Yes
Tshelanyambe Hospital	No	No	No	No

Beitbridge District Hospital	Yes	Yes	No	Yes
ZIMRA Beitbridge Border	Yes	Yes	Yes	Yes
PPC Collen Bawn	Yes	Yes	Yes	Yes
ZIMRA Plumtree Border	Yes	Yes	Yes	Yes
Mashonaland Central				
Bindura Trojan Mine (BNC)	Yes	Yes	Yes	Yes
DOCUMENTARY REVIEW OF FACILITIES				
Midlands Province				
Thornhill Hospital	N/I	N/A	N/A	N/A
Matabeleland South				
River Range Mine	N/I	N/A	N/A	N/A
Mtshabezi Hospital	N/I	N/A	N/A	N/A
Masvingo Province				
Ngomahuru Psychiatric Hospital	N/I	N/A	N/A	N/A
Manyama Mission Hospital	No	N/A	N/A	N/A
Matebeleland North		N/A	N/A	N/A
ZPC Hwange Power Station	N/I	N/A	N/A	N/A
PSMI Radiology Victoria Falls	Yes	N/A	N/A	N/A
Tsholotsho District Hospital	N/I	N/A	N/A	N/A
Mbuma Mission Hospital	N/I	N/A	N/A	N/A
Makomo Resources	N/I	N/A	N/A	N/A
Mashonaland Central		N/A	N/A	N/A
Bindura provincial hospital	Yes	N/A	N/A	N/A
Concession district Hospital	No	N/A	N/A	N/A
Guruve district hospital	Yes	N/A	N/A	N/A
Mvurwi hospital	Yes	N/A	N/A	N/A
Chitsungo Hospital	No	N/A	N/A	N/A
Ponai Medical	No	N/A	N/A	N/A
PSMI Shashi	Yes	N/A	N/A	N/A
Karanda Mission Hospital	No	N/A	N/A	N/A
Mount Darwin Hospital	No	N/A	N/A	N/A
St. Alberts Mission Hospital	No	N/A	N/A	N/A
Howard hospital	Yes	N/A	N/A	N/A

PSMI Bindura	Yes	N/A	N/A	N/A
Shamva District Hospital	No	N/A	N/A	N/A
Freda Rebecca Gold	Yes	N/A	N/A	N/A
Mine Canterbury Mine	Yes	N/A	N/A	N/A
Mashonaland West				
Kadoma Paper Mills	Yes	N/A	N/A	N/A
Chinhoyi Hospital	No	N/A	N/A	N/A
Kadoma Population Health Centre	No	N/A	N/A	N/A
Bantex Chinhoyi	Yes	N/A	N/A	N/A
Queen Mary	No	N/A	N/A	N/A
Luisa Guidotti Hospital	Yes	N/A	N/A	N/A
ZIMASCO Mutorashanga	Yes	N/A	N/A	N/A
Zimplats Trauma Centre	Yes	N/A	N/A	N/A
Father O'HEA Hospital	Yes	N/A	N/A	N/A
Zimplats Medical Ngezi	Yes	N/A	N/A	N/A
Habour Medical Centre	No	N/A	N/A	N/A
Mashonaland East				
ZIMRA Nyamapanda	Yes	N/A	N/A	N/A
Marondera Hospital	No	N/A	N/A	N/A
Chivhu General Hospital	Yes	N/A	N/A	N/A
Breckridge Investments	Yes	N/A	N/A	N/A
ZIMRA Chirundu Border	Yes	N/A	N/A	N/A
Murewa Hospital	Yes	N/A	N/A	N/A
St Michaels Hospital	Yes	N/A	N/A	N/A
Luisa Guidotti Hospital	Yes	N/A	N/A	N/A
Borraidale Hospital	Yes	N/A	N/A	N/A

Key:
Yes: Facility has an RSO
No : Facility does not have an RSO
N/I : No information available

ANNEXURE G

FACILITIES WITH DOSIMETER READING PERIODS EXCEEDING 3 MONTHS

Number	Facility	Report period	Number of months
1.	ZIMRA National Handling Services	March – August 2017	6 months
2.	Parirenyatwa diagnostics	September 2017 – March 2018	7 months
3.	Parirenyatwa Radiotherapy	September 2017 – March 2018	7 months
4.	Bindura Trojan Mine	February – October 2017	9 months
5.	Harare Central Hospital	March 2017-February 2018	12 months
6.	Mutare Hospital	October 2017 – June 2018	9 months
7.	Mpilo X-Ray	September 2016 – November 2017	15 months
8.	Plumtree Hospital	March 2016 – April 2018	26 months
9.	Turnall Bulawayo	April – December 2017	9 months
10.	Mt. Darwin Hospital	November 2016-April 2017	6 months
11.	Tshelanyemba Hospital	January-April 2016	4 months
12.	Mvurwi hospital	October 2016-May 2017	8 months
13.	Minerals Marketing Corporation of Zimbabwe	January 2014-July 2016	31 months
14.	Kwekwe Hospital	September 2013-April 2015	20 months
15.	Gwanda Provincial Hospital	December 2015-June 2017	19 months
16.	Chitsungo mission hospital	October 2016-February 2017	5 months
17.	ZIMASCO Shurugwi	December 2013-January 2016	26 months
18.	Bindura Nickel Corporation Laboratory	October 2016-February 2017	6 months
19.	Interventional Radiology Clinic	May-September 2015	5 months
20.	Drink Water Nursing Home	April 2016- October 2017	19 months
21.	Willowvale 24 Hr Radiology	June 2016-January 2017	8 months
22.	Standards Association of Zimbabwe	October 2016-February 2017	5 months

Source: Dose reports

ANNEXURE H

FACILITIES WITH AND WITHOUT EMERGENCY PLANS

Inspected Facilities	**Existence of Emergency Plans**	**RPAZ Emergency contact**
Harare		
ZIMRA NHS	No	No
ZIMRA Airport Arrivals	No	No
Parirenyatwa Diagnostics	Yes	No
Parirenyatwa radiotherapy	No	No
Oncocare	Yes	No
Harare Hospital	Yes	No
DX Centre- Chinamano	No	No
Parliament of Zimbabwe	No	No
RBZ Harare	Yes	No
PSMI George Silundika	Yes	No
ZERA	No	No
West Hospital	No	No
Rapha Healthcare systems (randon)	Yes	No
Ministry of Transport	No	No
Baines imaging	Yes	No
PSMI Parkview	Yes	No
Dr. Chirambasukwa-West end	No	No
Manicaland		
Mutare Hospital	No	No
PSMI Radiology Mutare branch	Yes	No
Rusape General Hospital	Yes	No
Rusape 24 Hour	No	No
Bonda Mission Hospital	No	No
Nyanga Hospital	Yes	No
ZIMRA Forbes Border Post	No	No
Birchenough bridge Hospital	No	No
Baines Imaging Mutare	Yes	No
Midlands		
Kwekwe Hospital	Yes	No
ZISCO steel	No	No
Sable Chemicals	Yes	No
ZIM Alloys	No	No
Gweru Provincial Hospital	Yes	No
Unki mine	Yes	No
ZIMASCO Clinic	Yes	No
Zimasco Shurugwi Plant	Yes	No
Shurugwi District Hospital	Yes	No
Zvishavane Hospital	No	No
Mimosa Mine	Yes	No

Murowa Diamonds Mine	Yes	No
Gaths mine/Shabane mine hospital	No	No
ZIMASCO Kwekwe	Yes	No
Bulawayo		
Bulawayo Municipality Engineering	No	No
CAAZ Bulawayo JM	No	No
ZIMRA JM Airport	No	No
NUST Physics Department	No	No
ICRISAT	No	No
Mpilo Nuclear Medicine	Yes	No
PSMI Bulawayo	No	No
Delta Beverages	Yes	No
Mpilo X-Ray	Yes	No
Turnal Holdings	Yes	No
RoadLab Civil Engineering	Yes	No
Mpilo Radiotherapy	Yes	No
Dr. Roberts and Stevenage veterinary services	No	No
Blonton Management consultants	No	No
UBH	No	No
RBZ Bulawayo	No	No
Masvingo		
PSMI Radilogy	Yes	No
Ndanga District Hospital	No	No
Morgenster Mission Hospital	No	No
Masvingo Hospital	Yes	No
Bikita Minerals	Yes	No
Matabeleland South		
ZIMRA Plumtree Border	No	No
PPC Collen Bawn	Yes	No
Tshelanyambe Hospital	No	No
Fort X-Ray	Yes	No
Gwanda Hospital	No	No
Beitbridge Hospital	No	No
ZIMRA Beitbridge Border	No	No

Mashonaland Central		
Bindura Trojan Mine (BNC)	No	No
Documentary Reviews of Facilities		
Matabeleland South		
River Range Mine	Yes	N/A
Mtshabezi Hospital	No	N/A
Matabeleland North		
ZPC Hwange Power Station	No	N/A
PSMI Radiology Victoria Falls	No	N/A
Tsholotsho Hospital	No	N/A
Mbuma Mission Hospital	No	N/A
Makomo Resources	No	N/A
Mashonaland Central		
Bindura provincial hospital	No	N/A
Concession district Hospital	Yes	N/A
Guruve district hospital	No	N/A
Mvurwi hospital	No	N/A
Chitsungo Hospital	No	N/A
Ponai medical	No	N/A
PSMI Shashi	No	N/A
Karanda Mission Hospital	No	N/A
Mount Darwin Hospital	No	N/A
St Alberts mission	No	N/A
Howard hospital	Yes	N/A
PSMI Bindura	Yes	N/A
Shamva District Hospital	No	N/A
Freda Rebecca Gold	No	N/A
Mine Canterbury Mine	No	N/A
Mashonaland West		
Bantex Global Chinhoyi	No	N/A
St Ruperts Mayer Mission Hospital	No	N/A
Chegutu Hospital	Yes	N/A

Kadoma Paper Mills	No	N/A
Chinhoyi Hospital	Yes	N/A
Kadoma Population Health Centre	No	N/A
ZIMASCO Mtorashanga	No	N/A
Zimplats Trauma Centre	Yes	N/A
Father O'HEA Hospital	Yes	N/A
Zimplats Medical Ngezi	No	N/A
Habour Medical Centre	No	N/A
Midlands		
Thorn hill Hospital	No	N/A
Masvingo		
Ngomahuru psychiatric Hospital	N/A	N/A
Manyama Mission Hospital	No	N/A
Mashonaland East		
Zimra Nyamapanda border post	No	N/A
Marondera Provincial Hospital	No	N/A
Chivhu General Hospital	No	N/A
Breckridge Investments	Yes	N/A
ZIMRA Chirundu Border	Yes	N/A
Murewa Hospital	No	N/A
St Michaels Hospital	No	N/A
Luisa Guidotti Hospital	No	N/A
Borraidale Hospital	No	N/A

Source: Facility Files

KEY:

No : Requirement not satisfied

N/A: Place not visited

Yes: Requirement Satisfied

ANNEXURE I

ANALYSIS OF FACILITIES WITH AND WITHOUT MANUFACTURER'S INSTRUCTIONS ON THE CONTROL DISPLAY

Facility	**Manufacturer's Instructions available**
Facilities Inspected	
Harare	
ZIMRA NHS	No
ZIMRA Airport	No
Parirenyatwa Diagnostics	Yes
Parirenyatwa Radiotherapy	No
Oncocare	Yes
Harare Central Hospital	No
Parliament of Zimbabwe	Yes
RBZ Harare	Yes
PSMI George Silundika	Yes
ZERA	Yes
West Hospital	No
Rapha Healthcare systems (randon)	No
Ministry of transport	N/A
Baines imaging	Yes
PSMI Parkview	Yes
DX Centre chinamano	No
Dr. Chirambasukwa-West end	No
Manicaland	
Mutare Hospital	No
PSMI Radiology Mutare branch	Yes
Rusape General Hospital	No
Rusape 24 Hour clinic	No
Bonda Mission Hospital	No
Nyanga Hospital	No
ZIMRA Forbes Border Post	Yes
Birchenough bridge Hospital	No
Baines Imaging	Yes
Midlands	
Kwekwe Hospital	No
ZISCO steel	N/A
Sable Chemicals	Yes
ZIM Alloys	N/A
Gweru Provincial Hospital	No
Unki mine	Yes
ZIMASCO Clinic	No
ZIMASCO Shurugwi Plant	No
Shurugwi District Hospital	No

Zvishavane Hospital	No
Mimosa Mine	Yes
Murowa Diamonds Mine	Yes
Gaths mine/Shabane mine hospital	No
ZIMASCO Kwekwe	Yes
Bulawayo	
Bulawayo Municipality Engineering	No
CAAZ Bulawayo JM	No
ZIMRA JM Airport	No
NUST Physics Department	No
ICRISAT	No
Mpilo Nuclear Medicine	Yes
PSMI Bulawayo	Yes
Delta Beverages	Yes
Mpilo X-Ray	Yes
Turnal Holdings	No
RoadLab Civil Engineering	No
Mpilo Radiotherapy	Yes
Dr. Roberts and Stevenage	Yes
Blonton Management	N/A
UBH	No
RBZ Bulawayo	No
Matabeleland South	
Tshelanyambe Hospital	No
ZIMRA Plumtree Border	No
PPC Collen Bawn	No
Plumtree District Hospital	No
Beitbridge Hospital	No
ZIMRA Beitbridge	Yes
Fort X Ray	No
Masvingo	
PSMI Masvingo	Yes
Ndanga District Hospital	No

Morgenster Mission Hospital	No
Masvingo Hospital	No
Bikita Minerals	Yes
Mashonaland Central	
Bindura Trojan Mine (BNC)	NA

Key:

N/A: Not Applicable

ANNEXURE J

LICENSING ANALYSIS

Facility	2014	2015	2016	2017	2018
HARARE					
ZIMRA NHS	U	U	L	U	L
ZIMRA Airport	U	U	L	U	L
Parirenyatwa Diagnostics	L	L	L	L	L
Parirenyatwa Radiotherapy	U	L	L	L	U
Oncocare	U	L	L	L	L
Harare Central Hospital	U	U	U	L	L
Parliament of Zimbabwe	U	U	U	U	U
RBZ Harare	U	U	L	L	L
PSMI George Silundika	L	L	L	L	L
ZERA	N/E	N/E	L	L	L
Westend Hospital	L	L	L	L	L
Rapha Healthcare systems (randon)	N/E	N/E	N/E	L	L
Ministry of transport	U	U	U	L	L
Baines imaging	L	L	L	L	L
PSMI Parkview	L	L	L	L	L
DX Centre chinamano	L	L	U	U	L
Dr. Chirambasukwa-West end	L	L	L	L	L
Manicaland					
Mutare Hospital	U	L	L	L	L
PSMI Radiology Mutare branch	U	U	L	L	L
Rusape General Hospital	L	L	U	U	U
Rusape 24 Hour	L	L	L	L	U
Bonda Mission Hospital	L	L	U	U	L
Nyanga Hospital	U	L	L	L	L
Forbes Border Post	U	U	L	U	L
Birchenough bridge Hospital	U	L	U	L	L
Baines Imaging Mutare	L	U	L	L	L
Midlands					
Kwekwe Hospital	U	U	L	L	L
Zisco steel	U	U	U	U	U
Sable Chemicals	U	U	U	U	L

ZIM Alloys	U	U	U	U	U
Gweru Provincial Hospital	L	L	L	U	U
Unki mine	L	L	L	L	L
ZIMASCO Clinic	L	L	L	L	U
Zimasco Shurugwi Plant	L	L	L	L	L
Shurugwi District Hospital	U	U	U	U	N/I
Zvishavane Hospital	U	U	U	L	U
Mimosa Mine	L	L	L	L	L
Murowa Diamonds Mine	L	L	L	L	L
Gaths mine/Shabane	U	U	U	U	U
ZIMASCO Kwekwe	L	L	L	L	L
Bulawayo					
Bulawayo Municipality Engineering	L	L	U	L	L
CAAZ Bulawayo JM	U	U	U	U	L
ZIMRA JM Airport	L	L	L	L	L
NUST Physics Department	R	R	R	R	R
ICRISAT	N/E	L	U	U	U
Mpilo Nuclear Medicine	U	U	U	L	L
PSMI Bulawayo	L	L	L	U	L
Delta Beverages	L	L	U	L	L
Mpilo X-Ray	L	L	U	U	L
Turnal Holdings	L	L	L	L	L
RoadLab Civil Engineering	L	U	U	L	U
Mpilo Radiotherapy	U	L	U	U	L
Dr. Roberts and Stevenage	L	L	L	L	L
Blonton Management	U	U	U	U	U
UBH	U	U	L	L	L
Matabeleland South					
ZIMRA Plumtree Border	U	U	L	U	L
PPC Collen Bawn	U	L	L	L	L
ZIMRA Beitbridge Border	U	U	U	L	L
Beitbridge Hospital	U	U	L	L	L
Gwanda Hospital	U	U	U	L	U
Fort X-Ray	N/E	L	L	L	L
Tshelanyemba Hospital	U	U	U	U	U
Mashonaland Central					

Bindura Trojan Mine	L	L	U	L	L
Documentary Review of Facilities					
Midlands					
Thorn hill Hospital	U	U	U	U	U
Matabeleland South					
River Range Mine	C	C	C	C	C
Mtshabezi Hospital	U	U	U	U	N/I
Matabeleland North					
ZPC Hwange Power Station	U	L	U	U	L
PSMI Radiology Vic Falls	U	L	U	L	L
Tsholotsho District Hospital	U	L	U	U	U
Mbuma Mission Hospital	U	U	U	L	L
Makomo Resources	U	U	L	L	L
Mashonaland Central					
Bindura provincial hospital	U	L	U	U	L
Concession district Hospital	U	U	L	U	L
Guruve district hospital	U	U	L	L	L
Mvurwi hospital	L	U	L	L	U
Chitsungo Hospital	U	U	U	U	U
Ponai medical	U	C	C	C	C
PSMI Shashi	L	L	L	L	L
Karanda Mission Hospital	U	L	L	L	L
Mount Darwin Hospital	U	U	L	L	U
St Alberts mission	L	U	U	U	U
Howard hospital	L	L	L	L	L
PSMI Bindura	L	U	U	L	C
Shamva District Hospital	U	U	L	U	U
Freda Rebecca Gold	N/E	L	L	L	L
Canterbury Mine	N/E	N/E	N/E	L	L
Mashonaland West					
Kadoma Paper Mills	U	U	U	U	C
Chinhoyi Hospital	L	L	L	L	L
Kadoma Population Health Centre	L	L	L	L	L
Queen Mary	L	U	U	U	C
Luisa Guidotti Hospital	L	L	L	L	L
ZIMASCO Mtorashanga	U	L	U	U	U

Zimplats Trauma Centre	L	L	L	L	L
Father O'HEA Hospital	L	U	L	L	U
Zimplats Medical Ngezi	L	L	L	L	L
Habour Medical Centre	N/E	N/E	N/E	U	U
Mashonaland East					
Zimra Nyamapanda	U	L	L	L	L
Marondera Hospital	U	U	U	U	U
Chivhu General Hospital	U	U	U	U	L
Breckridge Investments	U	U	C	C	C
Murewa Hospital	U	U	U	U	U
St Michaels Hospital	U	U	U	L	U
Borraidale Hospital	L	L	U	L	L
Masvingo Province					
PSMI Masvingo	L	L	L	L	L
Ndanga District Hospital	U	U	L	U	L
Morgenster Mission Hospital	U	U	L	U	L
Masvingo Hospital	U	U	L	U	L
Bikita Minerals	U	U	U	U	L

Key:
C: Facility Closed
N/E: Non Existent
N/I: No information available
R: Registered
U: Facility Unlicensed
L: Facility licensed