EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D — Nuclear energy, safety and ITER
D.3 — Radiation protection and nuclear safety

Technical Report on the Verification under the terms of Article 35 of the Euratom Treaty

MALTA

Routine and emergency radioactivity monitoring arrangements
Monitoring of radioactivity in drinking water and foodstuffs

15 – 16 March 2016

Reference: MT 16-01

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES:	Routine and emergency radioactivity monitoring arrangements Monitoring of radioactivity in drinking water and foodstuffs
LOCATIONS:	Valetta, Pieta, Benghajsa, Kordin
DATES:	15 – 16 March 2016
REFERENCE:	MT 16-01
TEAM MEMBERS:	Mr V. Tanner (team leader) Mr A. Ryan
REPORT DATE:	11 May 2017
SIGNATURES:	

V. Tanner A. Ryan

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TECHNICAL REPORT

1 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards.[1] Article 35 also gives the European Commission (EC) the right of access to such facilities in order that it may verify their operation and efficiency. The radiation protection and nuclear safety unit (ENER D.3) of the EC's Directorate-General for Energy (DG ENER) is responsible for undertaking these verifications. Directorate-General Joint Research Centre provides technical support during the verification visits and the preparation of the reports.

The main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

- Liquid and airborne discharges of radioactivity into the environment by a site;
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways;
- Levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] was published in the *Official Journal of the European Union* on 4 July 2006 describing practical arrangements for the conduct of Article 35 verification visits in Member States.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified Malta of its decision to conduct an Article 35 verification in a letter addressed to the Maltese Permanent Representation to the European Union. The Maltese Government subsequently designated the Radiation Protection Board (RPB) to lead the preparations for this visit.

This verification followed up on the 2008 visit, after which the Commission issued several recommendations[3].

[1] Council Directive 96/29/Euratom of 13 May 1996 setting out basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (OJ L-159 of 29/06/1996) which will be superseded by Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (OJ L 13 of 17.1.2014, p. 1).

[2] Commission Communication Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty, Practical arrangements for the conduct of verification visits in Member States (OJ C 155, 4.7.2006, p. 2–5).

[3] Article 35 Technical Report MT-08/07, 15 May 2009.

2.2 DOCUMENTS

In order to facilitate the work of the verification team, the national authorities supplied a package of information in advance.[4] Additional documentation was provided during and after the visit. The information thus provided was extensively used in drawing up the descriptive sections of the report.

2.3 PROGRAMME OF THE VISIT

The Commission and the RPB discussed and agreed upon a programme of verification activities in line with the Commission Communication of 4 July 2006 setting out practical arrangements for the conduct of Article 35 verification visits.

During the opening meeting, presentations were given on the following topics:

- the Radiation Protection Board;
- monitoring radioactivity in drinking water;
- implementation of the IAEA IRRS[5]-mission recommendations;
- Implementation of the Euratom Basic Safety Standards in Malta.

The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

The team carried out the verifications in accordance with the programme in Appendix 1. It met the following representatives of the national authorities and other parties involved:

Name	**Designation**
Paul Brejza	Executive Chairperson Radiation Protection Board
Joe Cremona	OHSA member of the Radiation Protection Board
Nadine Mercieca	Environment Protection Directorate Member of the Radiation Protection Board
Kevin Mercieca	Unit Manager, Waste Air Radiation and Noise Unit Environment Protection Directorate
Michael Nolle	Senior Environment Protection Officer Environment Protection Directorate
Clive Tonna	Superintendent of Public Health Director, Environmental Health Directorate Member of the Radiation Protection Board
Albert Gambin	Head of Public Health Laboratory
Doris Gambin	Technical Officer at Public Health Laboratory
Audrey Pullicino	Staff member at Public Health Laboratory
Raymond Camilleri	Staff member at Public Health Laboratory

[4] Replies to the preliminary information questionnaire addressed to the national competent authority, Received on 1 March 2016.

[5] IAEA Integrated Regulatory Review Service

Sandro Sammut	Senior Environmental Health Practitioner Environmental Health Directorate
Charles Bonnici	Senior Environmental Health Practitioner Environmental Health Directorate
Tilluck Bhikha	Medical Physicist Environmental Health Directorate
Mark Zammit	Leading Assistance Rescue Officer Civil Protection Department
Richard Zammit	Superintendent of Public Health
Brian Farrugia	Director EU Affairs Ministry for Social Dialogue, Consumer Affairs and Civil Liberties

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING

3.1 LEGISLATIVE ACTS REGULATING THE RADIOLOGICAL MONITORING OF THE ENVIRONMENT

There is no Maltese act or regulation which specifically targets the monitoring of environmental radioactivity. The Environment and Development Planning Act, which sets up the Malta Environment & Planning Authority (MEPA), includes provisions related to environmental monitoring, but it is not specific to the monitoring of environmental radiation.

Malta's procedures for monitoring environmental radioactivity are set out in the Radiation Protection Board's Operating Procedure RPB-OP-S-2010-1-Environmental Monitoring.[6] Under Regulation 9(3) of LN 44/2003,[7] the Radiation Protection Board (RPB) can give advice (including on environmental issues) to any government entity.

3.2 LEGISLATIVE ACTS REGULATING THE RADIOLOGICAL SURVEILLANCE OF FOODSTUFFS

The Maltese Food Safety Commission is an umbrella organisation charged with monitoring and co-ordinating activities relating to food/feed (for animals used for human consumption) by virtue of the Food Safety Act.[8] For live animals and feeding stuffs, the monitoring requirements are set out in the Veterinary Services Act.[9]

Responsibility for matters related to the issue of clearance for food/feed from third countries lies with the government agencies listed in Table I below. The Customs Department releases foods/feeds once clearance has been received from either the Environmental Health Directorate (EHD) or the Veterinary Services.

6 Radiation Protection Board Operation Procedures, RPB-OP-S-2010-1-Environmental monitoring, 28 June 2013

7 Regulation 9(3) of LN 44/2003, National Framework for Radioactive Waste Management

8 FOOD SAFETY ACT to make provision for any matter related to food safety and to a Food Safety Commission, to introduce new provisions for enforcement in relation to food, and to repeal the Food, Drugs and Drinking Water Act, 13th September, 2002. http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=8915&l=1

9 VETERINARY SERVICES ACT to establish and consolidate the requirements in the veterinary field, veterinary medicinal products, feeding stuffs and zoo technical requirements and for the regulation of the veterinary profession, 1st February, 2002. http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=8903&l=1

Table I. Government agencies in charge of monitoring food and feeding stuffs

Responsible body	Type of food/feed	Responsibility given by
Environmental Health Directorate	All foods excluding live animals	Food Safety Act
Veterinary Services	Live animals, feeding stuffs	Veterinary Services Act

The EU regulations relating to the Chernobyl accident and possible future accidents have not been transposed individually, but the European Union Act (Chapter 460) states that all EU regulations are binding in Malta.[10]

The Trading Regulations (Legal Notice 315/2004) require traders to be registered with the Food Safety Commission.[11] Traders must notify the appropriate body (the EHD or veterinary services) and supply an export certificate that shows that the radioactivity is below the radionuclide contamination limit for each consignment of food/feeds.

Malta has designated contact points for the rapid alert system for food and feed, available 24/7, and includes an on-call duty system within the EHD.

3.3 LEGISLATIVE ACTS REGULATING THE RADIOLOGICAL SURVEILLANCE OF DRINKING WATER

In 2016, Malta transposed Council Directive 2013/51/EURATOM of 22 October 2013, which sets out the requirements for protecting the health of the general public with regard to radioactive substances in water intended for human consumption.[12]

3.4 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The Maltese monitoring programme (RPB-OP-S-2010-1-Environmental Monitoring) is based on Commission Recommendation 2000/473/Euratom[13] on the application of Article 36 of the Euratom Treaty. In addition, the following IAEA documents have been used in drafting the radioactivity monitoring programmes:

- IAEA-TECDOC-1000, Clearance of materials resulting from the use of radionuclides in medicine, industry and research;
- IAEA Safety Standards Series WS-G-2.3, Regulatory control of radioactive discharge the environment;
- IAEA Safety Report Series Nr.19, Generic models for use in assessing the impact of discharges of radioactive substances to the environment.

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10 EUROPEAN UNION ACT provides for Malta's accession to the European Union and makes provision consequent and ancillary thereto, 16th July, 2003. http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=8926&l=1

11 Subsidiary legislation 449.43, Trading Regulations, 1st June, 2004 http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=11120&l=1

12 Food Safety Act (CAP. 449) Protection of Public Health, Radioactive substances in water intended for human consumption, Regulations, L.N. 8 of 2016

13 Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole, EU Official Journal L 191 , 27/07/2000 P. 37-46 http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000H0473&from=EN

4 BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING

4.1 RADIATION PROTECTION BOARD

Malta's radiation and nuclear infrastructure, including its Radiation Protection Board (RPB), were set up under Legal Notice (LN) 44 of 2003,[14] part of the Prime Minister's Enabling Powers Act[15]. The RPB is an inter-ministerial body comprising representatives of the health, environment, occupational health and safety, and civil protection agencies, as shown in Figures 1 and 2 below. Figure 1 shows the bodies represented within the RPB, their parent ministries, and their respective responsibilities as regards the environmental monitoring programme.

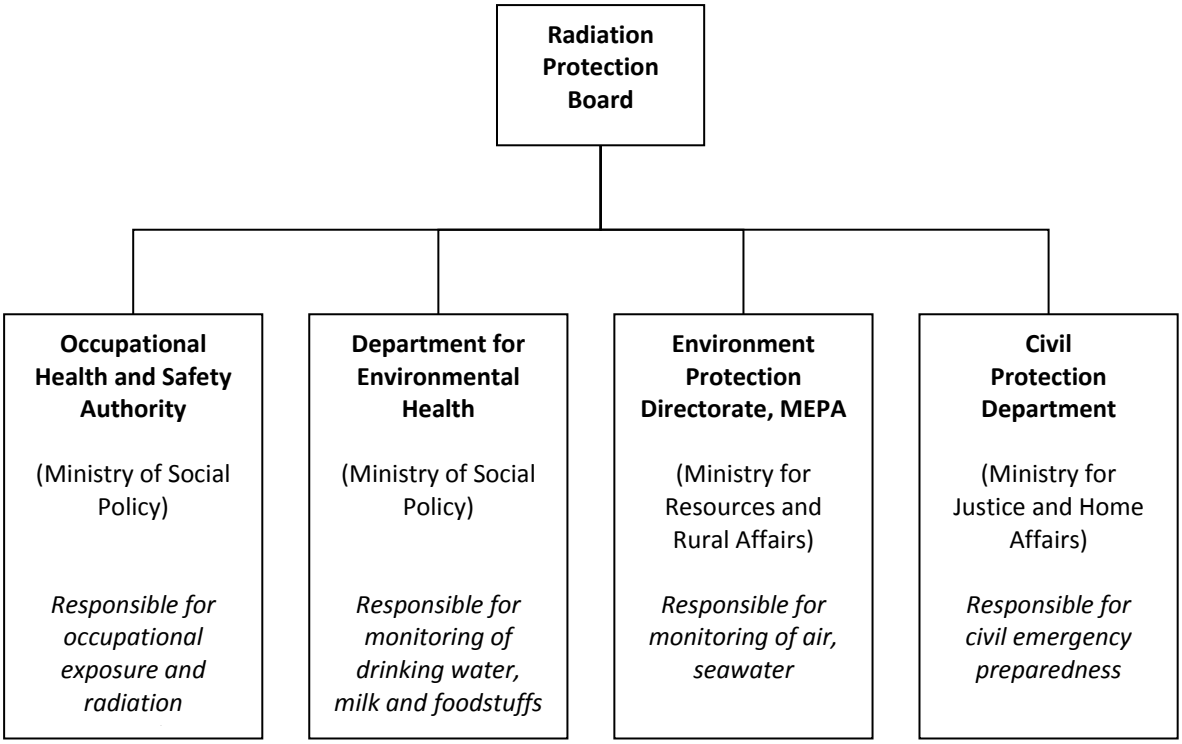

Figure 1. Bodies represented within the RPB

The RPB is the national coordinator for all matters concerning environmental radioactivity and radiation protection, including for the implementation of the Euratom Treaty primary and secondary legislation. It is responsible for preparing reports for the EU and international institutions in accordance with Malta's obligations. The RPB is appointed by Malta's Prime Minister under the provisions of the Nuclear Safety and Radiation Protection Regulations (LN44/2003). Each member agency nominates one member of the Board. The Occupational Health and Safety Authority (OHSA) nominates the Executive Chairperson of the Board, which makes it the Board's lead authority.

[14] Legal Notice 44 of 2003 National Interest Act (Cap. 365), Nuclear Safety and Radiation Protection (Amendment) Regulations, 2003
http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lp&itemid=25197&l=1

[15] The National Interest Act facilitates the implementation of certain treaties and measures and the restriction of trade and travel where the national or international interest of Malta so requires. It also makes it possible to enact certain provisions of the Charter of the United Nations, 3rd August, 1993.
http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=8835&l=1

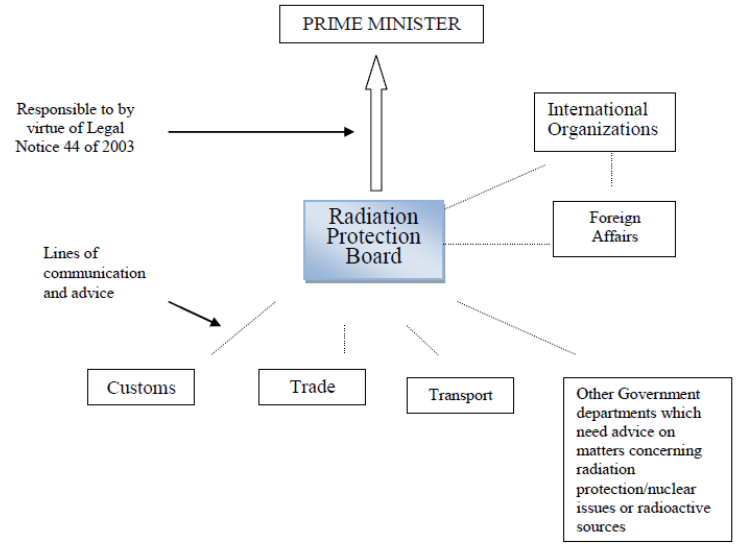

Figure 2. Position of the RPB within the Maltese administration

Malta's procedures for monitoring radioactivity in the environment are specified in the RPB's Operating Procedure RPB-OP-S-2010-1-Environmental Monitoring. Under this operating procedure, the office of the RPB's Executive Chairperson has been assigned the following duties:

- to coordinate a review of the Operating Procedure;
- to be the EU contact point for issues relating to Articles 35 and 36 of the Euratom Treaty;
- to send information to the European Commission via the Radioactivity Environmental Monitoring (REM) data submission tool;
- to issue discharge authorisations for nuclear medicine establishments;
- to collate all monitoring results on an annual basis.

The RPB is usually Malta's lead agency for coordinating contacts with the European Commission and the IAEA. It does not have a laboratory for measuring radiation, but it does have a number of portable hand-held instruments for monitoring contamination and alpha-, beta- and gamma-radiation.

4.2 ENVIRONMENT PROTECTION DIRECTORATE

The Environment Protection Directorate (EPD) is the Malta Environment and Planning Authority (MEPA) body responsible for monitoring environmental radioactivity. MEPA is currently under the responsibility of the Office of the Prime Minister. The EPD coordinates all environmental work with the Ministry for Sustainable Development, Environment and Climate Change. MEPA functions under the Environment and Development Planning Act[16] which will eventually be repealed by the Environment Protection Act[17] (published but not yet fully in force). When the Development Planning Act enters into force, environmental monitoring issues will be handled by the recently set up Environment and Resources Authority.

[16] The Environment and Development Planning Act protects the environment, and provides for the planning and management of development and for the establishment of an authority responsible for this and related matters, 31 March, 2014. http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=11407&l=1

[17] Act No. I of 2016 provides for the protection of the environment and for the establishment of an authority responsible for this and related matters, 8th January, 2016. http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lp&itemid=27255&l=1

Under the RPB's Operating Procedure RPB-OP-S-2010-1-Environmental Monitoring, the EPD has been assigned the following tasks:

- to continuously monitor the gamma dose rate measurement and send data to the European Radiological Data Exchange Platform (EURDEP);
- to monitoring air particulates;
- to monitor coastal waters;
- to monitor soil;
- to send copies and summaries of the monitoring results to the Office of the RPB's Executive Chairperson as soon as they are available;
- to immediately inform the Office of the RPB's Executive Chairperson and the Civil Protection Department of any high values;
- to notify the Office of the RPB's Executive Chairperson of any failure to fulfil monitoring requirements in accordance with this document.

4.3 ENVIRONMENTAL HEALTH DIRECTORATE

The Environmental Health Directorate (EHD) of the Ministry of Energy and Health is responsible for areas such as food safety and environmental-health-related issues such as bathing water. Their main acts include the Food Safety Act and the Public Health Act. Others include Tobacco Control Act and the Code of Police Laws. Food safety checks are mainly related to food production from non-animal origin products, and the retail and catering sectors.

Under the RPB's Operating Procedure RPB-OP-S-2010-1-Environmental Monitoring, the EHD has been assigned the following tasks:

- to monitor water meant for human consumption;
- to monitor a mixed diet consumed by the average person;
- to monitor milk;
- to send copies and summaries of results to the Office of the RPB's Executive Chairperson as they become available;
- to immediately inform the Office of the RPB's Executive Chairperson of any high values;
- to notify the Office of the RPB's Executive Chairperson of any failure to follow the monitoring rules set out in this document

4.4 CIVIL PROTECTION DEPARTMENT

The Civil Protection Department (CPD) which falls under the Ministry for Home Affairs and National Security is responsible for emergency preparedness arrangements in Malta. Radiological emergency preparedness procedures are included in the RPB's operating procedure RPB-OP-S-Emergency Framework-2010-1. This procedure is based on the threat assessment detailed in the document RPB-OP-S-Emergency Threat Assessment-2010-1.

5 RADIOACTIVITY MONITORING PROGRAMMES

5.1 INTRODUCTION

Malta lies approximately 95 km to the south of Sicily and 300 km to the north of the African coastline and has a total surface area of 316 km². The Maltese archipelago comprises seven islands of which only the three largest, Malta, Gozo, and Comino, are inhabited. The main island (Malta) is 27 km long. There are no permanent rivers or lakes and natural water resources are scarce: roughly half of Malta's potable water is supplied from boreholes and half from desalination plants. Malta's proximity to North Africa means that Malta is often affected by dust laden winds blowing from the Sahara.

The islands are for the most part composed of marine sedimentary rocks, principally limestone. Therefore, elevated levels of natural radioactivity and radon would not be expected and natural background radiation levels are low, of 100 nSv/h or less.

There are no nuclear power plants or other installations of the nuclear fuel cycle in Malta. The nearest nuclear power plants and nuclear fuel cycle installations are situated more than 1200 km away, in the south of France. Malta was not significantly affected by the radioactive fallout from the Chernobyl accident.

There are no producers of radioisotopes or significant NORM[18] industries in Malta. The main applications of ionising radiation are unsealed sources used for medical purposes and sealed sources used for industrial non-destructive testing and industrial nuclear gauges. The only planned discharges of radioactivity into the environment in Malta are associated with medical activities using unsealed sources in two hospitals.

Because of the country's small size, the Maltese authorities consider Malta to constitute a single region for the purposes of assessing radiological exposure in line with Recommendation 2000/473/Euratom. The first national surveillance plan was approved by the RPB in order to fulfil the requirements of the Euratom Treaty Articles 35 and 36. The plan, which was drawn up with the assistance of an expert provided by the IAEA, was designed to be in line with the practices set out in Recommendation 2000/473/Euratom on the application of Article 36 of the Euratom Treaty.

The possibility of a detectable radioactive contamination of the environment is very small. The main scenarios are a far-reaching contamination plume from a major nuclear accident in Europe or an accident in a nuclear-powered vessel in the Mediterranean Sea.

In line with Article 35 of the Euratom Treaty, there is a programme for monitoring radioactivity in the environment in Malta. There are also arrangements for monitoring radioactive discharges from medical facilities. The office of the RPB's Executive Chairperson has a coordinating role as regards radiation and nuclear issues. Environmental monitoring tasks are performed by the government entities listed in Table II.

Table II. Government entities in charge of monitoring radioactivity

Monitoring commitment	Responsible body	Organisation responsible
Continuous ambient gamma dose rate	Environment Protection Directorate	Malta Environment and Planning Authority
Air particulate	Environment Protection Directorate	Malta Environment and Planning Authority
Coastal waters	Environment Protection Directorate	Malta Environment and Planning Authority
Soil	Environment Protection Directorate	Malta Environment and Planning Authority
Water for human consumption	Environmental Health Directorate	Ministry for Energy and Health
Mixed diet	Environmental Health Directorate	Ministry for Energy and Health
Milk	Environmental Health Directorate	Ministry for Energy and Health

[18] Naturally Occurring Radioactive Material

5.2 MONITORING OF EXTERNAL GAMMA DOSE RATE

The external gamma dose rate is monitored by fixed gamma dose rate monitors that are always in operation. The EPD takes measurements at four locations (Kordin, Attard, Benghajsa and Gharb) (Figure 4 below).

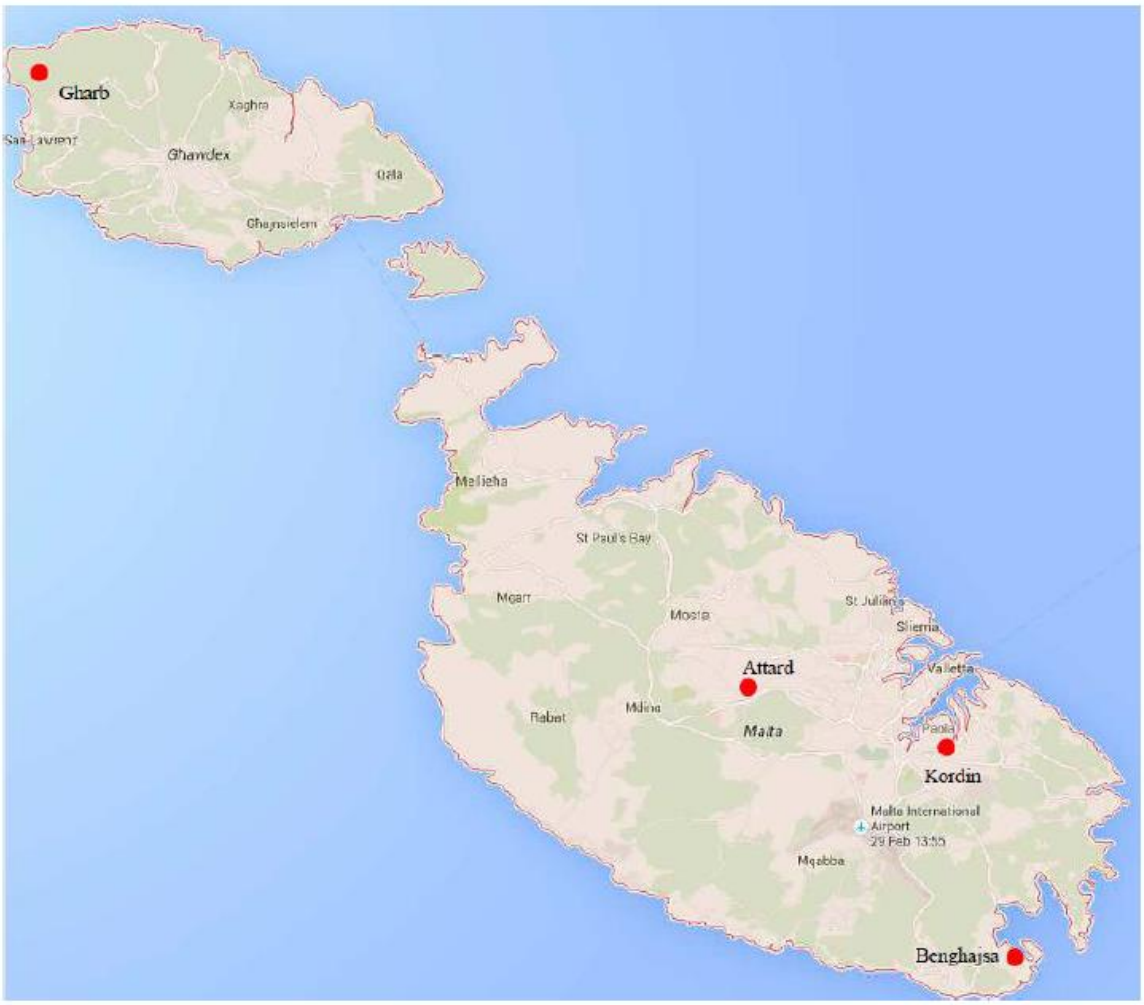

Figure 4. Locations of external gamma dose rate monitors and air samplers in Malta

Kordin: AMES Multifunctional Gamma Monitor AFA 203 with two probes

Attard, Benghajsa, Gharb: RTS SMU-01W

Data from the Kordin station is stored on a computer at the site and sent via LAN to an ftp account. The data from the other three stations is collected via SIM by a central server at MEPA. Both data sets and the meteorological data from the air quality monitoring equipment are combined in a single database. These data sets are then sent to the ftp-box from where they are picked up by the European Radiation Data Exchange Platform (EURDEP).

The Kordin station is configured to send an SMS to certain numbers when the gamma dose rate exceeds twice the annual average. If this threshold is exceeded at one of the other three sites, an email is sent to MEPA staff. In addition, EURDEP sends an automated alert to specified contacts if the dose rate value in any of the stations exceeds 300 nSv/h.

All stations are equipped with a power supply that cannot be interrupted.

5.3 MONITORING OF RADIOACTIVITY CONCENTRATION IN AIR

Concentration of particulate radioactive material in air is monitored by filtering large volumes of air through a particulate filter and then measuring the radioactivity of the filters (in the laboratory or in the measurement system itself).

One high volume air sampler (HVAS) manufactured by Physik Technik Innovation (PTI) is situated in Kordin on the roof of an abandoned government building at a height of 13 meters from ground. This is an Aerosol Sampling Station ASS — 1000 with a Petrianov type filter. The filter is changed on a weekly basis. If the value of the flow rate meter drops much below 1055 m^3/hour, then the filter is changed earlier (this sometimes happens due to dust from the Sahara). Technical specifications can be found in Appendix 2. The radionuclides assessed are ^{137}Cs, ^{226}Ra, ^{60}Co, ^{210}Pb, ^{7}Be, ^{40}K, ^{214}Pb, ^{214}Bi, particulate ^{131}I and ^{134}Cs. Reference values have been defined for each nuclide — if they are exceeded the RPB is immediately informed. There is also a procedure for additional sampling in the event of an emergency.

Besides the HVAS in Kordin, the EPD has recently acquired three RTS RAM 31-NA automatic air samplers which are coupled with detectors for alpha, beta and gamma monitoring with the following technical specifications:

- Air flow rate > 3 m^3/h
- Alpha/beta spectrum (1024 channels)
- Typical alpha/beta minimum detectable limit:
  - long lived alpha: < 0.05 Bq/m^3
  - long lived beta: < 0.3 Bq/m^3
- Gamma spectrum (1024 channels with energy range 40 keV to 3 MeV)
- Environmental gamma dose rate [µSv/h]
- Typical gamma minimum detectable limit (Confidence level: 95 %):
  - ^{137}Cs (662 keV): < 5 Bq/m^3
  - ^{60}Co (1332 keV): < 5 Bq/m^3
- Background:
  - < 0.2 µSv/h
  - radon (equilibrium): < 4 Bq/m^3
  - thoron (equilibrium): < 0.2 Bq/m^3

The locations of the new devices are the same as those for the gamma dose rate, namely Attard, Benghajsa and Gharb. Maintenance is carried out by an in-house technician with the support of the local agent responsible for the equipment. MEPA is in the process of acquiring the necessary calibration standards.

The PHL laboratory also uses a stand-alone high volume air sampling device, Aerosol Sampling Station ASS-500 which was developed and produced by the Central Laboratory for Radiological Protection in Poland. However, this device is not included in the monitoring programme (RPB-OP-S-2010-1- Environmental Monitoring). The air sampler is situated on the roof of the PHL laboratory building in Valletta and is equipped with infrared heaters to avoid filter clogging during adverse weather conditions. The device has the following technical specifications:

- Sampling height 1500 mm
- Collection area 0.20 m
- Effective filter dimensions 440 x 440 mm
- Nominal air flow rate 500 m^3/h when using Petrianov filters FPP 15-1.5
- Air flow rate range 100 – 900 m^3/hr
- Temperature range -40 — +50 °C
- Power consumption of maximum 2.2 kW
- Inlet to outlet distance 3.5 m

- Overall dimensions 885 x 875 x 1840 mm
- Total mass approximately 150 kg

An organic fibre filter (Petrianov FPP 15-1.5) is set up once a month and left to collect airborne particles for one week. Approximately 120 000 m^3 of air is sampled during this period. The sampling device itself is not equipped with a detector — the air filters are analysed in the laboratory by gamma spectrometry using an HPGe detector. The assessed gamma radionuclides are ^{7}Be, ^{40}K, ^{60}Co, ^{131}I, ^{137}Cs, ^{210}Pb, ^{214}Pb and ^{226}Ra.

There is no dry/wet deposition monitoring performed in Malta.

5.4 MONITORING OR RADIOACTIVITY CONCENTRATION IN WATER

5.4.1 Surface water

As Malta does not have any permanent surface water this category is not included in the monitoring programme.

5.4.2 Ground and drinking water

Radioactivity concentration in ground and drinking water is monitored by manually taking samples of the water at regular intervals and analysing them in a laboratory. There are no automatic sampling systems or online water radioactivity monitors in Malta.

Sampling of ground water and drinking water is performed by the EHD. This is done monthly for the main water supply networks, and reflects the different blend of water (ground, reverse osmosis or mixed) on the islands.

In past years, the sampling of tap water has been carried out by the Service Water Provider based on the different water quality zones. Since 2014, 11 water quality zones are used, compared to 14 previously (Table III below). From 2016, monitoring has been changed to reflect this, although there are still 14 samples being taken as the three major zones (numbers 6, 8 and 9) are sampled twice.

Table III. Water sampling locations

Water Quality Zone	Localities	Source	Mean flow m^3/h
WQZ 1	Ghadira, Marfa, Cirkewwa, Comino	Cirkewwa R.O Plant	44.3
WQZ 2	Mellieha, Xemxija, Selmun, Tunny Net, Mistra	Cirkewwa R.O Plant & Mizieb P/St.	117
WQZ 3	Maghtab, Burmarrad, Salina, Bugibba, St. Paul'sPaul's Bay, Manikata, Ghajn Tuffieha, Wied il-Ghasel, Qawra, Naxxar, Mosta, Parts of Lija, Parts of Balzan, Iklin, Gharghur, Madliena, Ibragg, Techno Park, St. Margerita & Fortizza Areas at Mosta, San Gwann Ta' Zwejt	Naxxar Res. Blend	547.5

WQZ 4	Mgarr, Zebbiegh, Wardija, Pitkali Area	Cirkewwa R.O Plant and Collection of Ta' Falka, Mgarr, Bingemma, Macedonia & Speranza	35
WQZ 5	Rabat, Dingli, Mdina, Bahrija, Mtarfa, Bidnija, Kuncizzjoni + Mtahleb + Santi	Ta' Qali Group Blend & Fiddien/Chadwick	128.7
WQZ 6	Ta' Qali + Crafts Village, Zokkrija, Zebbug Village, Siggiewi, Farzina, Handaq, Attard, Santa Venera, Parts of Lija, Parts of Balzan, Hamrun (excl. Rabbat area), Valletta, Floriana, Albert Town (Excl. Wasteserv, Civil Abattoir, and Marsa Open Centre), Gwardamangia, Pietà, Lower Parts of Msida, Parts of Ta' Xbiex, Parts of B'KaraB'Kara, Marsa (Excl. Upper + Race Course)	Ta' Qali Group Blend	601.1
WQZ 7	Parts of Zebbug (Laurenti Area included), Ghar Lapsi, Siggiewi (Previdenza Area)	Siggiewi B/H collection system	10
WQZ 8	Qrendi, Mqabba, Kirkop, Zurrieq, Safi, Gudja, Ghaxaq, B'BugiaB'Bugia, Zejtun, Zabbar, Isla, Bormla, Birgu, Kalkara, Xghajra, Marsaxlokk, Marsaskala, Fgura, Paola, Tarxien, Hal- Far, Free Port, Luqa, Hal-Farrug, Kordin Ind Est, Qormi (excluding Handaq + Farzina), Drydocks, St. Vincent de Paule, Marsa Ind. Est, Hamrun Rabbat area, Parts of Marsa (Upper + Racecourse, Wasteserv, Civil Abattoir, and Marsa Open Centre), Tar-Rabbat Area.	Qrendi Res. Blend	870

WQZ 9	Bahar ic- Caghaq, St. Andrews, Pembroke, Swieqi, Paceville, St. Julians, Sliema, Gzira, Mater Dei, University Heights, San Gwann (Excl. Ta' Zwejt), Parts Birkirkara (Ta' Paris), Swatar & Upper Parts of Msida (including Msida Circus & Lautier Aluminium area), Parts of Ta'XbiexTa'Xbiex	Pembroke R.O Plant	688.2
WQZ 10	Ghajnsielem, Mgarr, Qala, Xaghra, Nadur, Xewkija (lower), Victoria (upper), Fontana.	Predominantly Cenc 3	150
WQZ 11	Sannat, Munxar, Xlendi, Gharb, Ghasri, Kercem, M'FornM'Forn, Victoria (Lower), San Lawrenz, Xewkija (upper), Zebbug.	Predominantly Cenc 4	210

Since 2016, the sampling points are as follows:

Month	**Drinking Water**
January	**Gozo:** Aussie House, Zgħawri Str, Munxar, Gozo **Malta:** L-Immakulata, Sir Temi Zammit Rd., Zebbiegħ
February	South Region, c/o Civic Centre, Convent Str., Zabbar
March	Seracino's Pjazza Tal-Knisja, Attard
April	Dar tal-Providenza, Siggiewi
May	Mellieha Local Council, Triq il-Madonna ta' Fatima, Mellieha
June	Health Office, 101 Sir Adrian Dingli Str., Sliema
July	**Malta:** Health Office, 509, St. Paul's Str, St. Paul's Bay **Gozo:** Local Council, 8th September Avenue, Xaghra
August	Bukkun Snack Bar, Dawret Ħal Għaxaq, Għaxaq
September	Paradise Bay Hotel, Cirkewwa
October	Rabat (Malta) Health Centre
November	St. Luke's Hospital, G'Mangia
December	Mater Dei Hospital, Msida

Figure 5. Drinking water sampling points

Samples are taken by regional environmental health officers authorised under the Food Safety Act (Act XIV of 2002) and the Public Health Act (Act XIII of 2003). 20 litres of water are collected in regular, rinsed plastic bottles. All samples are placed in bags which in turn are sealed by an individually numbered tamperproof seal for traceability purposes.

The following parameters are assessed: activity concentration of ^{137}Cs, ^{90}Sr, ^{3}H, gross alpha and gross beta. Reference values for each activity have been determined, and the RPB is informed of any activity exceeding the reference value more than 10 %. There is also a procedure for additional sampling in the event of an emergency.

5.4.3 Sea water

Radioactivity concentration in sea water is monitored by manually taking samples of the water at regular intervals and analysing them in a laboratory. Sampling of coastal sea water is performed quarterly in three locations around the Maltese islands (Figure 6). Sampling procedures (methodologies, quantities and sampling periodicity) are described in the document SOP WATER V2. Samples are analysed for ^{137}Cs, ^{40}K, and ^{60}Co. Reference values for each nuclide have been determined, and the RPB is informed of any activity exceeding the maximum more than 10 %. There is also a procedure for additional sampling in the event of an emergency.

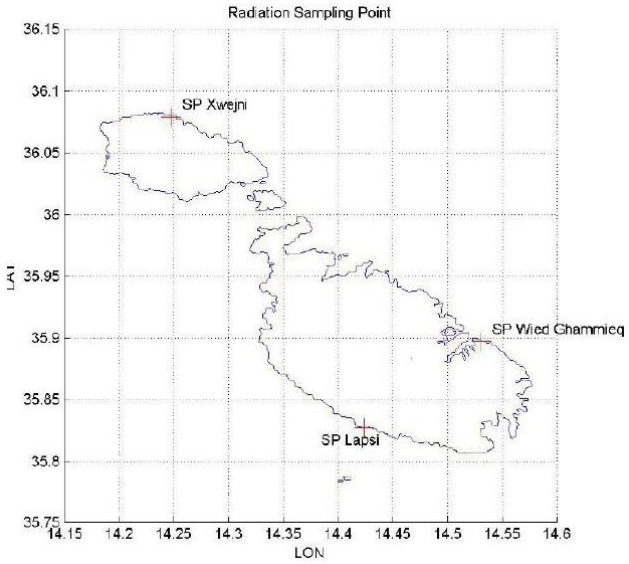

Figure 6. Sea water sampling points

5.5 MONITORING OF RADIOACTIVITY CONCENTRATION IN SOIL

Radioactivity concentration in soil is monitored by manually taking samples of the soil at regular intervals and analysing them in a laboratory. Samples are collected in four locations every year (Figure 7). Sampling procedures (methodologies, quantities and sampling periodicity) are outlined in the document SOP SOIL V3. Samples are analysed for ^{7}Be, ^{210}Pb, ^{212}Pb, ^{214}Pb, ^{226}Ra, ^{228}Ac, ^{212}Bi, ^{214}Bi, ^{208}Tl, ^{40}K, ^{60}Co, ^{131}I and ^{137}Cs. Reference values for each nuclide have been determined, and the RPB is informed of any activity exceeding the maximum more than 10 %.

No sediment sampling is carried out in Malta.

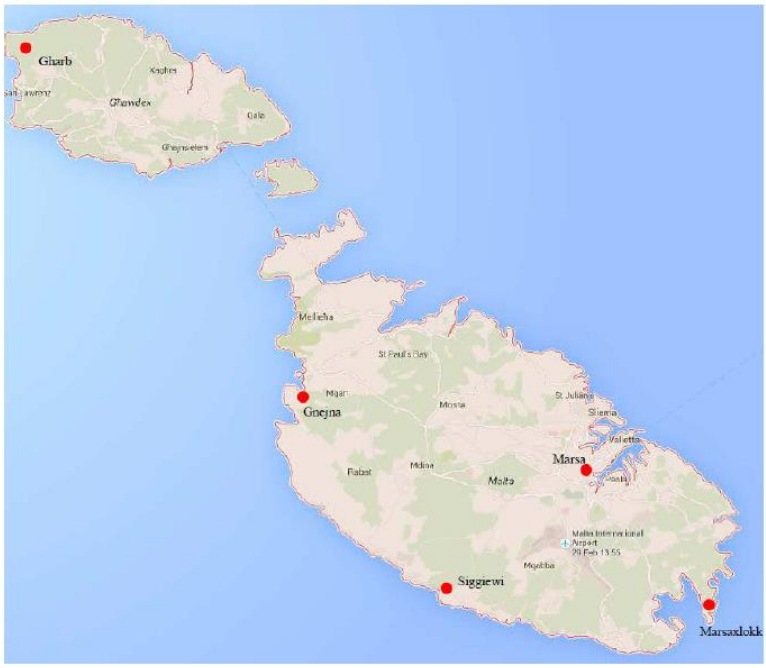

Figure 7. Soil sampling locations

5.6 MONITORING OF RADIOACTIVITY CONCENTRATION IN FOODSTUFFS

5.6.1 Introduction

In order to monitor radionuclide activity levels in different categories of foodstuffs and beverages, two sampling programmes are run in Malta each year. These are:

- The national environmental radioactivity surveillance plan, in which (as suggested in Commission Recommendation 2000/473/Euratom) three categories of samples have been established (milk, mixed diet and drinking water).
- The national environmental radioactivity surveillance plan in which various staple foods are sampled. Samples tested during the year 2015 are shown in Table IV below.

At present, there is no monitoring animal feeding materials.

Table IV. Samples of foodstuffs analysed in 2015

Commodity	Number of samples
Cereals and baked goods	87
Dietetic foods, food supplements, fortified foods	19
Fruits / vegetables	35
Milk and dairy products	1
Beverages (non-alcoholic)	36
Nuts and seeds	20
Meals / snacks	13
Soups, broths and sauces	6

5.6.2 Milk

Radioactivity concentration in milk is monitored by manually taking samples of milk at regular intervals and analysing them in a laboratory. Malta has only one approved milk production plant (Malta Dairy Products) which produces pasteurised milk with different fat content. Every year, staffs from Unit 2 of the EHD collect four samples of two litres each from retail shops in the Hamrun area. This unit is responsible for most of the food-related sampling programmes in Malta. Samples are placed in bags which in turn are sealed by an individually numbered tamperproof seal for traceability purposes.

The milk samples are analysed for ^{137}Cs, ^{90}Sr and ^{40}K. Reference values for each nuclide have been determined, and the RPB is informed of any activity exceeding the maximum more than 10 %. There is also a procedure for additional sampling in the event of an emergency.

5.6.3 Mixed diet

Radioactivity concentration in a mixed diet is monitored by manually taking samples of the food ingested by one person on one day at regular intervals and analysing the mixed sample in a laboratory. 12 samples are taken every year (one per month). The mixed diet sample represents the daily average intake of a normal person; samples are based on representative meals sampled in different establishments. Monitoring is based on all the meals and drinks that may be ingested over 24 hours. This implies that for hotels samples are taken from buffet breakfast tables, lunch and dinner, whilst for school canteens samples include all meals served throughout the day including sandwiches, desserts, etc.

Samples of breakfast, lunch and dinner are clearly marked and placed in separate bags. The various elements that make up each meal are placed in separate bags, which are in turn all sealed in another clearly labelled bag. For example, if breakfast consists of toast, egg, baked beans and bacon, the egg, toast, baked beans and bacon are placed in separate bags (no need for labelling) and all bags are placed together in another plastic bag which is clearly labelled as breakfast and sealed.

Mixed diet samples are sampled by Unit 2 and the Gozo Region, both working within the EHD. Samples are analysed for ^{137}Cs, ^{90}Sr and ^{14}C. Reference values for each nuclide have been determined, and the RPB is informed of any activity exceeding the maximum more than 10 %. There is also a procedure for additional sampling in the event of an emergency

5.6.4 Other foodstuffs

Radioactivity concentration in foodstuffs is monitored by manually collecting samples of different foodstuffs and analysing them in a laboratory. Samples are analysed for gamma emitters (^{40}K and ^{137}Cs) at the Public Health Laboratory facility situated at St. Luke's Hospital. This sampling is not a requirement under the national programme.

In 2015, 210 samples were analysed, including breakfast cereals, cereal products, flour, bread, pasta, baby food, canned food, vegetables such as potatoes, carrots and lettuce, food supplements and soft drinks.

5.7 MONITORING OF RADIOACTIVE DISCHARGES FROM MEDICAL FACILITIES

There are two operating nuclear medicine sites in Malta:

- The main state hospital Mater Dei has a diagnostic nuclear medicine department including Positron Emission Tomography, Computed Tomography (PET/CT) imaging and a therapeutic nuclear medicine department used for ^{131}I treatments.
- A private hospital with PET/CT imaging

Both facilities have decay storage tanks and are required to keep records and to have procedures in place for their operation. The hospitals take steps to ensure that the ALARA principle (As Low As Reasonably Achievable) is applied to their radioactive discharges to the environment. Each hospital has limits on the activity levels they can discharge (RPB Authorisation issued under LN 44 of 2003).

Under Sewer Discharge Control (Amendment) Regulations 2002[19], as amended by Sewer Discharge Control (Amendment) Regulations 2005[20], the RPB specifies which discharges are of radiological significance. These discharge limits are designed to protect the environment and critical groups of members of the public. The RPB uses operating procedure RPB-OP-S-Control of Radioactive Discharges-2014-1 to calculate the discharge values. There are no actual arrangements for measuring the amount of radioactivity discharged into the environment. This is justified, since the amount of radioactivity used in hospitals is well known and its half-life is short, i.e. the amount of discharged radioactivity is small.

All nuclear medicine facilities are required to send an annual discharge report to the RPB by 31 January of each year.

[19] Malta Resources Authority Act XXV, Sewer Discharge Control Regulations, 2000 http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lp&itemid=17979&l=1

[20] Malta Resources Authority Act (CAP. 423), Sewer Discharge Control (Amendment) Regulations, 2005 http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lp&itemid=18990&l=1

6 LABORATORIES PARTICIPATING IN THE NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

6.1 PUBLIC HEALTH LABORATORY

6.1.1 Introduction

The Public Health Laboratory, which falls under the Environmental Health Directorate within the Ministry for Energy and Health, is situated in Valletta. It has a radionuclide laboratory at St Luke's Hospital to process samples and analyse gamma radionuclides.

The Public Health Laboratory is responsible for the collection of environmental samples, mainly air and soil. It also acts as a subcontracting body to MEPA for the analysis of soil samples and air filters.

6.1.2 Sample reception, identification and registration

Samples received by the Public Health Laboratory are accompanied by a sample request form. The request form refers to a particular sample via unique identification of the customer, including the tamper-proof seal number and the Environmental Health Officer number.

A laboratory officer checks the sample's condition and then packs it in an adequate container or bag or in its original packaging. This is to ensure that samples to be analysed are protected from unnecessary contamination. The laboratory officer also verifies if there is enough weight/volume of the sample to perform the analysis.

Once these checks are performed, a unique laboratory reference code is assigned to both the sample and the accompanying request form. The reference code and the sample type are then logged in the sample reception information logbook. Information from the sample request form is then recorded in a registration database which is later updated with analysis results.

6.1.3 Sample preparation

Different samples require different preparation methods as follows:

Mixed diet

Individual items are weighed and their mass is recorded in a database. All items are then mixed and homogenised in one lot and put in a suitable container. The homogenate is frozen until it is sent to a subcontracted laboratory for radioactivity analysis.

Milk and drinking water

The analysis of these samples is subcontracted, so no preparation is required. Milk is kept frozen whilst water is kept at ambient temperature.

Staple foods

Dry foodstuffs are homogenised using food processors and a representative sample is analysed. Liquid samples are concentrated to a maximum volume of 1 litre under infrared lamps.

Wet samples, e.g. tuna are first separated from their brine/oil, put in a suitable container and left to dry in an oven at a temperature of approximately 80 °C until the volume decreases sufficiently to fit in a Marinelli beaker. Samples are mixed from time to time whilst in the oven. Once in the Marinelli beaker, oil removed from the original sample is added. Brine is discarded. The dried sample and its oil are weighed and this is used as the mass of sample analysed.

Soil

Prior to analysis moist soil is left to air dry for 2-4 days, and is then sieved through a 4.75 mm sieve. The moisture content of a 5-10 g representative sub-sample at a temperature of 105 °C is determined, after which consecutive readings are obtained. Soil samples are analysed in a Marinelli beaker using an HPGe detector. The dry weight is used for analysis.

Air filters

Air filters are removed from the sampling device after the stipulated time has elapsed and are left standing for one to two days before the radionuclide content is measured. This allows the decay of radon progenies thereby reducing the latter's influence on the low level detection limit for other radionuclides, as well as allowing the humidity of the filter to be restored to that of a clean filter. The filter is then pressed into a disc and the activity concentration deposited on it is measured.

6.1.4 Sample measurements

Sample measurements are taken using a gamma spectrometer equipped with an HPGe detector, for which details are found in the table below. The radionuclides assessed vary depending on the sample type, as shown in the table. The counting time varies but is usually between 5 and 18 hours.

Table V. Gamma nuclides analysed in different sample types

Type of sample	**Radionuclides detected**
Staple foods	^{40}K, ^{137}Cs and sometimes ^{131}I
Soil	^{40}K, ^{137}Cs, ^{238}U (^{214}Bi + ^{214}Pb), ^{232}Th (^{208}Ti + ^{228}Ac)
Other gamma radionuclides analysed for subcontracted soil samples	^{7}Be, ^{60}Co, ^{131}I, ^{137}Cs, ^{210}Pb, ^{212}Bi, ^{212}Pb, ^{226}Ra, ^{228}Ac
Air filters	^{7}Be, ^{40}K, ^{60}Co, ^{131}I, ^{137}Cs, ^{210}Pb, ^{214}Pb, ^{226}Ra

6.1.5 Measurement devices

There is only one gamma spectrometry system in Malta, located at the PHL St Luke's hospital radionuclide laboratory. The system is composed of a Canberra model GC-2518 coaxial HPGe detector with a relative efficiency of 25 %. This is mounted inside a lead/copper low background shielding. The detector is cooled by a Canberra model 7500 SL low background vertical dipstick cryostat. The latter is connected to a Nuclear Instrumentation Module containing the power supply, a programmable analogue-to-digital converter (Canberra Model 8076) together with a spectroscopy amplifier (Model 2002/C/CSL). Spectrum analysis is carried out using the Genie 2000 (Version 3.2) software package.

The spectra produced for each sample are compared to standard spectra libraries of particular radionuclides. A multi-nuclide standard solution consisting of an ampoule of 5 – 10 ml is used to perform the detector calibration. The current standard being used was obtained from the National Physical Laboratory (Product Code: R08-04-2012090144-1). For all Marinelli geometries used (Marinelli 1 kg, Marinelli 0.5 kg, Marinelli 0.2 kg), the standard solution is diluted into an intermediate solution from which a working standard is prepared such that the final ^{137}Cs activity is around 600-700 Bq/kg.

For air filters, a grid of 1 cm squares is drawn on an air filter with the same size as that used for sampling. The corner of each square is then spiked such that the final ^{137}Cs-activity of the air filter is around 200 Bq. This procedure is done every 2-3 years when a new multi-nuclide standard solution is obtained.

Energy and efficiency calibrations as well as background checks are performed periodically. The efficiency calibration of the detector is a dual curve. There is a cross-over energy at 165.85 keV at which the maximum efficiency is obtained. For high energies (energies greater than that of the cross-over), the curve is an exponential decay, while for lower energies the efficiency curve is nearly a first order linear polynomial curve.

For air filters, a peak to total calibration is performed prior to the efficiency calibration. The four point sources used for this calibration are ^{57}Co, ^{65}Zn, ^{137}Cs and ^{241}Am.

6.1.6 Data handling and reporting

Results are reported in Bq/kg or Bq/m^3 as appropriate. Results below the detection limit are reported as less than the minimum detectable activity. The actual activity is reported for results above the minimum detectable activity. For environmental samples (soil and air monitoring), the activity uncertainty is also reported when activity results are above the minimum detectable activity.

All data concerning samples received is archived in a registration database. After the analysis, the laboratory officer reports the findings to the technical officer who in turn verifies the results which are then sent to the relevant customers.

There are no statutory accounting or reporting obligations related to environmental sample results.

6.1.7 Sample storage

Analysed samples are sealed in adequate containers or plastic bags. Each sample is properly labelled. Labelling includes the unique identification code, date of analysis and initials of the laboratory officer who performed the analysis. These are stored in designated areas until the test results are issued or as agreed with the customer. Samples are disposed of safely using appropriate means.

6.1.8 Quality assurance and control

The Public Health Laboratory is not accredited for any method in this field of analysis. In order to evaluate performance, it participates in selected international proficiency testing activities. Table VI below provides two examples (soil and wild berry comparisons carried out by the Institute for Reference Materials and Measurements (IRMM) of DG Joint Research Centre).

Table VI. Details of international proficiency tests

Proficiency Scheme	Lab. Ref.	Date	Matrix	Radionuclide	Assigned Value	Mean	Uncertainty	Officer	Reported Value 1	Reported Value 2	Z-Score
ILC - IRMM 0031	FC173	31-Aug-10	Soil	U-235	1.1	4.2	±0.11	CHS	10.09 Bq/kg	10.01 Bq/kg	
				Bi-214		20			25.66 Bq/kg	25.46 Bq/kg	
				Pb-214		20			20.09 Bq/kg	19.81 Bq/kg	
				Bi-212		21			10.86 Bq/kg	11.09 Bq/kg	
				Pb-212		21			19.57 Bq/kg	20.60 Bq/kg	
				Cs-137	3565	3390	±134		3739.36 Bq/kg	3737.88 Bq/kg	
				K-40	410	439	±21		484.72 Bq/kg	485.62 Bq/kg	
ILC - IRMM 426	FC253	15-Sep-11	Wild Berries	Cs-137	779 Bq/kg		±24	CHS	828.5 Bq/kg		
				K-40	253 Bq/kg		±15		256.5 Bq/kg		

6.2 OVERSEAS LABORATORIES

Aside from the limited number and types of samples analysed at the Public Health Laboratory, the rest is outsourced on the basis of contracts concluded following a tendering process. The following laboratories provide such services:

Water samples (drinking and seawater)

CEFAS Lowestoft Laboratories
Pakefield Road
Lowestoft Suffolk, NR33 0HT UK

Mixed diet, milk and drinking water samples

Public Health England[21]
(An Executive Agency of the Department of Health)
Centre for Radiation, Chemical and Environmental Hazards (CRCE) Scotland
155 Hardgate Road
Glasgow G51 4LS
Scotland

Mixed diet, milk and drinking water samples

Central Laboratory for Radiological Protection[22]
Konwaliowa St. 7
Warsaw 03-194
Poland

7 MOBILE MEASUREMENT SYSTEMS

Malta does not have a mobile radiation measurement laboratory vehicle or the capability to carry out airborne radiation monitoring. The EHD has the following hand-held monitoring equipment:

- Herfurth MicroCont Instruments (α + β and β + γ surface detectors)
- Berthold dose rate meter LB 133
- Genitron Instrument Alpha Guard Professional Radon monitor
- Alpha guard radon meter

In addition, the Office of the RPB's Executive Chairperson has a number of hand-held survey and contamination monitors, as well as a hand-held radioisotope identification device (NaI detector low resolution device).

[21] Independent of the present verification, the Public Health England laboratory in Glasgow was part of the Art. 35 verification in Scotland 2016 (Technical report UK 16-04).

[22] Independent of the present verification, the Central Laboratory for Radiological Protection in Warsaw was part of the Art. 35 verification in Poland 2016 (Technical report PL 16-03).

8 VERIFICATIONS

8.1 GENERAL

Verification activities were carried out in accordance with the agreed verification programme. Some aspects of the programme could not be fully verified since the practical implementation had been outsourced to a foreign analysis provider (laboratory measurements).

The verification team notes that the online radiation monitoring data is not made directly available to the Maltese public, although it is available through the EURDEP website. This arrangement is not optimal, since in the event of an emergency the Maltese general public would expect to find information on the website of the Maltese authority.

It was noted that there are no statutory accounting or reporting obligations with respect to routine environmental sample radioactivity results in Malta. Therefore, the general public has very limited access to information concerning the radioactivity status of their environment.

Moreover, the verification team notes, that the Maltese environment radiation monitoring programme does not include monitoring of feeding stuffs.

Verification team recommends that the RPB investigates methods for making the on-line dose rate data available to the public in Malta via its own website.

Furthermore, the team recommends that the RPB investigates methods to make information on routine environmental radioactivity monitoring programme results more accessible to the general public via an annual report or on-line reporting.

Finally, the verification team suggests that the RPB consider inclusion of feeding stuffs in the regular monitoring programme.

8.2 FOLLOW-UP OF THE RECOMMENDATIONS OF 2009

The verification team carried out a follow-up of the recommendations issued in 2009[23]. The table below summarises the recommendations and their follow-up.

Follow-up of the recommendations of 2009

Recommendation 2009	Follow-up 2016
Environmental radioactivity surveillance plan *The verification team recommends that the RPB develop the programme towards a more detailed and comprehensive monitoring system and consider including monitoring of precipitation/dry deposition and biota.*	**Completed.** Document 'Radiation Protection Board Operation Procedures, RPB-OP-S-2010-1-Environmental monitoring' of 28 June 2013 outlines the current programme.
PHL gamma-spectrometry facility at St. Luke's Hospital *The verification team suggests updating the operating procedure and addressing quality related matters such as control of peak location, peak width and detector efficiency.*	**Partially completed.** The operating procedure has been updated, but there is a need to follow long-term trends in peak location and peak width.

[23] Verifications under the Article 35 of the Euratom Treaty, Technical report MT 08-07, 2009

PHL Valletta laboratory *The verification team suggests that in the longer term it would be beneficial to develop national radio analytical capabilities in order to increase the level of radiological expertise in Malta.*	**Partially completed.** There has been a radiation expert employed at the PHL, but during the verification this expertise was again lacking. The PHL staff has received additional training on radiation monitoring. There has been no significant improvement in the radiological equipment situation at the PHL laboratory – most of the measurements are still outsourced.
Kordin Ambient gamma dose rate monitor *The verification team recommends installation of a UPS system for electrical power back-up of the monitoring device.*	**Completed.** The station has electrical back-up.
As a matter of transparency, the verification team suggests providing the public direct access to the dose rate data.	**Not completed.** The dose rate data is not available to the public on-line.
The verification team suggests increasing the number of dose rate monitors in Malta and supports the intention to install a dose rate monitor on the island of Gozo.	**Completed.** Three new automatic monitoring stations have been installed.
Kordin high-volume air sampler *The verification team suggests giving consideration to the installation of an activated charcoal filter for iodine activity measurements in the event of a reactor emergency.*	**Not completed.** There is no provision for installing activated charcoal filters in any of the air sampling equipment in Malta.
Sampling of coastal waters *The verification team recommends that MEPA bring its sampling activities for coastal waters into line with what is set out in the national monitoring programme.*	**Completed**. Sampling of coastal water is carried out according to the national programme.
Nuclear medicine facility of the Mater Dei hospital *The verification team recommends that the discharge tanks be sampled and analysed prior to discharge.*	No follow-up in 2016.
The verification team recommends that a running total of discharges throughout each calendar year be maintained in order to ensure that discharge limits are not exceeded.	No follow-up in 2016.

8.3 AMBIENT GAMMA DOSE RATE MONITORING

8.3.1 Kordin

The ambient gamma dose rate is measured continuously in four locations (Kordin, Attard, Benghajsa and Gharb). The verification team checked the multi-function gamma monitor MFM203, manufactured by AMES (Slovenia), which is installed on the roof (about 13 meters above ground) of an abandoned government administration building in Kordin for continuous monitoring of the external ambient gamma dose rate. The instrument comprises two Geiger counters of different sensitivities, providing a very wide measuring range (from 50 nSv/h to 10 Sv/h). There is an automatic routine for sending the hourly average ambient dose rates to the EURDEP system twice a day.

The Kordin station is configured to send an SMS to certain numbers when the gamma dose rate exceeds twice the annual average. EURDEP sends an automated alert to specified contacts if the dose rate value in any of the stations exceeds 300 nSv/h. There is a back-up electrical supply.

It was noted that in 2015-2016 there were frequent interruptions in EURDEP data transmissions from the Maltese dose rate monitoring stations.

> *The verification team recommends that the RPB investigates the reasons for the interruptions in the EURDEP data transfers and takes corrective action to ensure reliability of the data exchange.*

8.4 AIR RADIOACTIVITY MONITORING

8.4.1 Kordin

The verification team checked a high-volume air sampler installed on the roof (about 13 meters above ground) of an abandoned government administration building in Kordin for continuous sampling of air particulates. The sampler's nominal air flow rate is 1055 m^3/h. It is equipped with a permanently operating filter heater in order to avoid condensation. Airflow is measured using a pressure difference flowmeter. A Pitot-static tube measures pressure difference, which is used to derive the air flow velocity. This is multiplied by the cross-section of the tube to obtain the flow rate. The pump frequency is increased to keep the flow rate steady when the filter is clogged. The system was calibrated by the Physikalisch Technische Bundesanstalt, the German National Metrology Institute.

The sampler is old and it is equipped for particulate sampling only, there is no provision for the installation of activated charcoal cartridges for iodine measurements during an emergency situation.

The sampler is operated on a continuous basis and the filter is changed once per week. There is no back-up electrical supply. Sometimes sand blown from the Sahara causes the filter to clog thereby necessitating more frequent filter changes.

Filters are Petranoff glass fibre type. At the end of the sampling period the filters are pressed and sent to the Public Health Laboratory for gamma spectroscopy measurements. Filters are returned to MEPA after analysis.

> *The verification does not give rise to recommendations. If the Kordin air sampler is kept in operation, it should be equipped with electrical back-up.*

8.4.2 Benghajsa

The verification team was shown the new automated aerosol radioactivity monitoring station located at the Benghajsa Freeport. There are three systems of this type in Malta (Attard, Benghajsa and Gharb). The system is located in an air-conditioned locked container. This RTS RAM 31-NA system comprises alpha and beta monitoring of an air filter paper, which is changed automatically at 24-hour intervals. The system has a filter storage capacity of 30 filters. Filter air flow is measured by an air

flow meter and recorded in the system database for each filter. In addition, there is a solar-shielded GM-detector for gamma dose rate monitoring and meteorological sensors (temperature and humidity) on the roof of the container. There is electrical back-up for the measurement system and communications, but not for the air pump.

Air filters from this system are measured on the spot by the system itself, they are not routinely sent to a laboratory. Filters are discarded after measurement. Data from the system is transferred to a central server via ftp.

The verification does not give rise to recommendations. Nevertheless it is suggested that the RPB investigates possibilities to include the air radioactivity concentration results produced by the automatic stations in the Maltese EURDEP data.

8.4.3 Valletta

The verification team checked the operation of the ASS-500 high-volume air sampler on the roof of the Public Health Laboratory in Valletta. The airflow through the Petranoff filter is about 1000 m^3/h.

Verification does not give rise to remarks.

8.5 DRINKING WATER RADIOACTIVITY MONITORING

The verification team discussed the arrangements for monitoring drinking water in Malta. There is only one drinking water utility in Malta — most of the drinking water comes from small private wells. There are three reverse osmosis plants producing drinking water from sea water. In practice, most of the water supplied in Malta is a mixture of ground water and water from these reverse osmosis facilities. A drinking water sample for radioactivity concentration analysis is taken six times a year directly from the tap. Analysis of these samples is outsourced to overseas laboratories (section 6.2).

Directive 2013/51/Euratom requires the Member States to establish a strict control system for radioactivity in drinking water. The verification team notes that the RPB needs to ensure the drinking water sampling frequency in Malta complies with the requirements of the Annex II of this Directive.

8.6 ANALYTICAL LABORATORIES

8.6.1 Public Health Laboratory facility at St. Lukes hospital

The Public Health Laboratory holds ISO 17025 quality accreditations for certain analysis procedures, but not for the radiation measurements. Therefore, the measurement of Public Health Laboratory samples taken under the national monitoring programme has been outsourced.

St. Luke's hospital has been closed, but the gamma spectroscopy facility in the building continues to be maintained by the Public Health Laboratory. There is no permanent staff; staff bring samples from Valletta to carry out the measurements. The facility is used on an ad-hoc basis for taking the gamma measurements of air filters (from the Kordin sampler) and for samples of imported food, milk and water.

The only instrument at the Public Health Laboratory St. Luke's facility is a gamma spectrometry system composed of a Canberra model GC-2518 coaxial HPGe detector (relative efficiency 22 %) mounted inside a lead/copper low background shielding, cooled by a Canberra model 7500SL low background cryostat and connected to an instrument rack containing the power supply, amplifier and an ADC. Spectrum analysis is carried out using Genie 2000 software. The measurement room temperature is maintained at 25˚C. A UPS system is available for electrical back-up.

Air filters are pressed to 500 bar (40×40 cm filter) and measured for 24 hours, then discarded. Food and liquids are weighed into 500 ml, 700 ml or 1000 ml Marinelli beakers for measurement. The samples are kept until the results are reported to the customer. When samples are being measured, a blank measurement is also performed as a check of the instrument's operation.

There is a written procedure (dating from 2004) covering sample preparation and gamma spectrometric measurements. However, the procedure concentrates on how to run the software and makes no mention of quality related matters such as checks on the spectrum, e.g. FWHM of a peak, blanks or calibration.

Five members of the Public Health Laboratory staff have received training from the IAEA on using the instrument. The system is only used rarely for measuring samples. Nonetheless, it is kept in an operational state throughout the year – the instrument's Dewar flask is filled weekly and the instrument's energy calibration is checked monthly using a ^{60}Co-source and every six months using a certified standard multi-energy source acquired in 2013. The manufacturer's source activity certificate was presented to the verification team.

The verification team notes that the system is the only gamma spectroscopy system in Malta and it is already quite old. In the event of an emergency or other radiological concern, its measurement capacity could not cope with an increased number of incoming samples. Therefore, it is essential to pay attention to its technical stability and also consider acquiring a second system.

The verification team was informed that the Public Health Laboratory has considered relocating the gamma spectroscopy facility to Valletta. So far, this has not been possible due to lack of space in the Valetta laboratory.

The verification team recommends that the PHL follows the long-term trend of the detector energy and resolution stability (location and FWHM of ^{60}Co peak at 1332 keV). It also suggests allocating funds to acquire a second gamma spectroscopy system as soon as possible.

Furthermore, the team supports the initiative to relocate the gamma-spectroscopy laboratory to the PHL-laboratory in Valletta.

8.6.2 Public Health Laboratory in Valletta

The Public Health Laboratory in Valletta has 25 members of staff. It is well equipped and was recently extensively refurbished. However, it is not equipped to measure radioactivity and therefore its role in the monitoring programme is limited to preliminary sample preparation and sample management.

The verification included examination of the management of imported foodstuff- and environment samples. The Health Inspectorate provides the environment samples to the laboratory; imported foodstuff samples are provided by the importing companies.

The management of outsourced analyses was verified from sample receipt to reporting. Measurement reports were made available to the verification team for examination. Upon receipt, the samples are registered, weighed, homogenised and if necessary frozen before being sent to a contracted laboratory for gamma spectroscopy, total-α/β, ^{90}Sr and ^{14}C analysis as per the monitoring programme. It is clear that the fact that samples must be shipped away for analysis means a longer wait for results. Typically, the whole process from sampling to reporting of results may take uptakes four to five months, which is clearly too long for certain sample types. After analysis and reporting, the samples are discarded.

The laboratory database used for sample management was presented to the team. The Public Health Laboratory does not have a LIMS-system; it uses an Excel-based database, which contains the sample information and the associated analysis results for all samples handled in the laboratory, including the outsourced radiological samples (200-300 samples per year).

Currently there is no radiation expert employed at the laboratory.

The verification team recommends reducing the number of outsourced measurements and developing in-house radioactivity measurement capacity in the laboratory instead.

The team supports the efforts to recruit a radiation specialist for the laboratory.

If the number of annual samples handled in the laboratory increases, it would be advantageous to acquire a LIMS system for sample and results management.

8.7 EMERGENCY MONITORING ARRANGEMENTS

The RPB has drafted emergency procedures to prepare for possible nuclear or radiological emergency situations. The verification team was provided with an overview of the current emergency monitoring capabilities. The new dose rate monitors and the new air radioactivity monitoring containers in Attard, Benghajsa and Gharb are a significant improvement in the Maltese monitoring capability in the event of a radiological emergency, in particular in terms of alerting elevated dose rate levels (SMS-alerting if 300 nSv/h is exceeded). The Maltese Civil Protection Department has a few hand-held dose rate meters and one low-resolution nuclide identification device (Canberra FieldSpec). The civil protection staff has been trained by the IAEA on using these systems. In addition, Maltese customs service has an Ortec battery operated trans-SPEC-DX-100T Portable HPGe Gamma Spectrometer.

There is no capability to carry out monitoring of gaseous radioactivity (^{131}I in particular) in air. This capability would be significant in the event of a nuclear reactor emergency affecting the Maltese islands.

There is a need for additional mobile monitoring capabilities, i.e. capacity to carry out quick monitoring of the dose rate, nuclide identification and sampling (air, food and water) anywhere on the Maltese islands and in its territorial waters (including the future increased off-shore oil exploration activities). In addition, more gamma spectroscopy capacity is needed to provide back-up for the aging system at St. Luke's hospital and to provide additional measurement capacity in case the number of incoming samples increases significantly.

The verification team recommends acquisition of additional hand-held dose rate meters, one portable air sampler and one mobile HPGe gamma spectroscopy system for emergency monitoring purposes. The staff of the RPB and PHL should have sufficient training to use the equipment.

Additionally, it is recommended that the RPB investigates possibilities to include monitoring of gaseous and particulate ^{131}I activity in air in the emergency monitoring arrangements.

Furthermore it is suggested that the laboratory facility at St. Lukes hospital should be equipped with an additional gamma spectroscopy system for urgent sample analysis needs in the event of an accident or emergency.

9 CONCLUSIONS

All verification activities that had been planned were completed successfully. The information supplied before the visit, as well as the additional documentation received during and after the verification activities, was useful.

The information provided and the verification findings lead to the following observations:

(1) In general, the national environmental radioactivity monitoring programme in Malta is in compliance with the requirements of Article 35 of the Euratom Treaty.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of radioactivity levels in the air, water and soil in Malta are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(3) Most of the recommendations issued by the Commission in 2009 have been followed and implemented to a satisfactory degree, but there still remain a few items where the 2009 recommendations cannot be considered as fully implemented. The Commission requests the Maltese authorities to implement the remaining recommendations of 2009 without delay.

(4) A few new recommendations are being made, in particular as regards laboratory equipment, public availability of data, and monitoring during an emergency situation. Notwithstanding these recommendations the verified parts of the national monitoring system for environmental radioactivity in Malta are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(5) The recommendations are detailed in the 'Main Conclusions' document that is addressed to the Maltese competent authority through the Maltese Permanent Representative to the European Union.

(6) The Commission services request a report on the implementation of the recommendations by the Maltese authorities, in particular on the corrective actions implemented to ensure compliance with the legal obligation mentioned in point 8.5 with regard to the drinking water sampling frequency and about any significant changes in the set-up of the monitoring systems before the end of 2017. Based on this report the Commission will consider the need for follow-up verification in Malta.

(7) The verification team acknowledges the excellent cooperation it received from all people involved in the activities it undertook during its visit.

APPENDIX 1

THE VERIFICATION PROGRAMME

Day/date	Time/Venue	Activity	Maltese participants
Tuesday 15 March	9:00-10:00 OHSA, Pieta	Opening meeting with the Maltese authorities and the verification team	Paul Brejza Joe Cremona Nadine Mercieca Mark Zammit Hadrian Bonello Albert Gambin Doris Gambin Michael Nolle Sandro Sammut Charles Bonnici Tilluck Bhikha
	10:00-12:00 OHSA, Pieta	Discussion on the control of radioactivity in water	Paul Brejza, Joe Cremona Hadrian Bonello Sandro Sammut Charles Bonnici Tilluck Bhikha
	13:00- 17:00 Benghisa Kordin	Verification of gamma dose rate monitors and air samplers	Nadine Mercieca Kevin Mercieca Michael Nolle Paul Brejza Joe Cremona
Wednesday 16 March	9:00 – 10:30 St Lukes, Pieta	Gamma spectrometry facility at St Luke's Hospital	Albert Gambin Doris Gambin Paul Brejza Joe Cremona
	11:00 -13:00 Public Health Lab, Valletta	Public Health Laboratory	Albert Gambin Doris Gambin Paul Brejza Joe Cremona
	14:00-15:00 OHSA, Pieta	Verification of the emergency monitoring arrangements	Mark Zammit Paul Brejza Joe Cremona
	15:00 OHSA, Pieta	Closing meeting	Paul Brejza Joe Cremona Nadine Mercieca Mark Zammit Hadrian Bonello Albert Gambin Doris Gambin Michael Nolle Sandro Sammut Charles Bonnici Brian Farrugia

APPENDIX 2

AMES automatic measuring system technical specifications

RANGE OF DOSE RATES	standard version with Probes A and B: 50 nSv/h ($50*10^{-9}$ Sv/h) to 1000 mSv/h (1 Sv/h) version with Probe A only: 50 nSv/h ($50*10^{-9}$ Sv/h) to 600 µSv/h ($600*10^{-6}$ Sv/h)
RANGE OF DOSES IN µSv	limited to 5-digit display and 1-digit decade exponent
ENERGY RESPONSE OF PROBES	equal in the energy interval from 60 keV to 1.3 MeV within ± 20 %
LINEARITY	deviation less than 7 % within stated range
PROBES	aluminium weather-proof housing with the exchangeable plastic cap; weatherproof connector, operating temperature range -40 °C, + 70 °C, over-range output signal, audible indication of pulses; power supply: 12 V DC, internal high-voltage generator
DIAGNOSTICS	programmed, with 10 malfunction warnings and their combinations
PRINTER (OPTION)	dot matrix, two-colour ink ribbon, 69 mm paper roll
CONNECTION TO THE COMMUNICATIONS NETWORK	over buffer memory and RS-232-C port
POWER SUPPLY	220 V 50 Hz / 12V DC (option) from built-in rechargeable battery approx. 2 days
POWER CONSUMPTION	without printer and display illumination 0.4 W (12 V, 30 mA)
DINENSIONS AND WEIGHT	Monitor: L 30xW 20xH 10cm; 4.5 kg Printer (option): L 24.0xW 176xH 8.0 cm; 1.2 kg Probe (1): L 31 cm x Ø 5 cm; 0.8 kg

APPENDIX 3

PTI air sampler technical specifications

AEROSOL FILTER

- Petrianov Filter type FPP-15-1.5

  Aerosol adsorption collection efficiency of the filter is higher than 95.600 % and varies between 95.600 % and 99.998 % for aerosols with diameters between 0.3 and 1.25 µm at the linear air velocity through the filter varying from 0.25 to 4 ms^{-1} with pressure drop through the filter (Δp) 500 – 9300 Pa.

INFRARED (IR) HEATERS Type 13245X

- Operating voltage [V]	:	220-230
- Power [W]	:	3x770
- Permanency minimum [h]	:	5000

FLOW METER DPFM 95E

- Nominal diameter [mm]	:	106
- Accuracy at calibration point	:	≤ ≠ 1 %
- Accuracy over measurement range	:	≤ ≠ 3 %
- Power supply [V]	:	220
[mA]	:	50

AIR PUMP — HIGH PRESSURE FAN WPMA-125F (Engine 1LAS106-2AA16)

- Power [kW]	:	3.0
- Number of revolution [min^{-1}]	:	max. 3600
- Weight [kg]	:	56

TECHNICAL DATA

- Sampling height [mm]	:	1390
- Collection area [m^2]	:	0.297
- Filter dimensions [mm]	:	595x595
- Nominal airflow rate [m^3h^{-1}]	:	800 – 1350
- Temperature range [°C]	:	-40 — +50
- Power consumption max. [kW]	:	ca. 6
- Overall dimensions [mm]	:	885x885x1870
- Inlet to outlet distance [m]	:	min. 2.0
- Total weight [kg]	:	190
- Filter exchange	:	daily — weekly