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Directorate H – Nuclear Safety & Safeguards
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TECHNICAL REPORT

VERIFICATIONS MADE UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

LISBON, PORTUGAL

14 to 17 May 2002

Reference: PT-02/1

VERIFICATIONS MADE UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES: Installations for monitoring and controlling radioactive discharges and for surveillance of the environment in Portugal during normal operations of the Reactor Português de Investigação (Portuguese Research Reactor), located on the Sacavém campus of the Instituto Tecnológico e Nuclear (Nuclear and Technology Institute) near Lisbon.

SITE: Sacavém, City of Lisbon, Portugal.

DATE: 14 to 17 May 2002.

REFERENCE: PT-02/1.

INSPECTORS: L. Hornung-Lauxmann

A Janssens (part-time)

S. Van der Stricht (Head of team)

DATE OF REPORT: 1st July 2003.

SIGNATURES:

L. Hornung-Lauxmann
(absent)

[signed]

A. Janssens

[signed]

S. Van der Stricht

[signed]

TABLE OF CONTENTS

TECHNICAL REPORT

1. ABBREVIATIONS AND DEFINITIONS

CRU	Chemistry Research Unit (at the Sacavém campus)
DPRSN	Departamento de Protecção Radiológica e Segurança Nuclear (Department for Radiological Protection and Nuclear Security)
IAEA	(United Nation's) International Atomic Energy Agency
ITN	Instituto Tecnológico e Nuclear (Nuclear and Technology Institute)
MCT	Ministério da Ciência e Tecnologia (Ministry of Science and Technology)
NEA	(OECD) Nuclear Energy Agency
RPI	Reactor Português de Investigação (Portuguese Research Reactor)

2. INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish 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 36 of the Euratom Treaty requires each Member State to periodically communicate, through a competent authority, the results from the monitoring programme referred to in Article 35 to the European Commission.

Article 35 also gives the European Commission the right of access to such facilities in order that it may review and verify their operation and efficiency.

For the purpose of such a review a verification team from the European Commission visited the Nuclear and Technology Institute (ITN) [(2)] located at Sacavém (Lisbon). The ITN is dependent on the Ministry of Science & Technology (MCT) [(3)]. The ITN houses the Department of Radiological Protection and Nuclear Safety (DRPNS) [(4)] and operates the Portuguese Research Reactor (RPI) [(5)] and radiochemical laboratories previously used for radiopharmaceuticals production (phased out in the early 90's).

The verification activities took place between the 14th and the 17th of May 2002. The verification team acted within the framework set by the 1990 Protocol on the implementation of Article 35 verifications, agreed between the Portuguese authorities and the European Commission.

The scope of the review was to provide an independent verification of the adequacy of:

- The monitoring facilities for gaseous and liquid discharges of radioactivity from the ITN to the environment.
- The analytical laboratories for effluent sample measurements, including quality assurance and control provisions as well as reporting and archiving of results obtained.
- The monitoring facilities for levels of environmental radioactivity at the ITN site perimeter, for all relevant exposure pathways.
- The analytical laboratories for environmental sample measurements, including quality assurance and control provisions as well as reporting and archiving of results obtained.
- Within the time available, and to the extent possible, part of the environmental radioactivity monitoring programme for the marine, terrestrial and aquatic environment in Portugal.

The present report contains the results of the verification team's review of relevant aspects of the radiological surveillance of the environment in and around the ITN site and of the territory of Portugal.

The report is also based on information collected from various documents referred to under section 3.3 hereafter, and from discussions with representatives met during the visit as listed under section 3.4 below.

3. PREPARATION AND CONDUCT OF THE VERIFICATION

1 Council Directive 96/29/Euratom.
2 In Portuguese: Instituto Tecnológico e Nuclear (ITN).
3 In Portuguese: Ministério da Ciência e Tecnologia (MCT).
4 In Portuguese: Departamento de Protecção Radiológica e Segurança Nuclear (DPRSN).
5 In Portuguese: Reactor Português de Investigação (RPI).

3.1 Preamble

The Commission's decision to require the conduct of a verification mission under the terms of Article 35 of the Euratom Treaty was forwarded to the Portuguese competent authorities in January 2001, proposing a verification date in June 2001. Circumstances, however, caused the verification to be postponed twice until it eventually took place in May 2002.

3.2 Programme of the visit

The Portuguese authorities proposed a verification programme covering all matters in which the Commission had expressed special interest, with the notable exception of the monitoring facilities around uranium mines. The latter were not included despite the Commission's explicit request. It was understood that in fact no such monitoring provisions are in place, the mines being no longer in operation; the absence of a representative of the responsible Ministry did not allow to check or to discuss this information. The verification activities were carried out in accordance with the proposed programme. A summary of the programme is provided in appendix 1 to this report.

3.3 Documentation

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Portuguese authorities. Additional documentation was made available during the verification visit. A list of this documentation is provided in appendix 2 to this report.

3.4 Interlocutors

During the visit the verification team met the following representatives of the ITN, the DPRSN and the RPI:

<u>The Nuclear and Technology Institute</u>

Mr Prof. José Carvalho Soares	President

<u>The Department of Radiological Protection and Nuclear Safety</u>

Mr Dr. Fernando da Piedade Carvalho	Director
Ms Dr. Maria José Bação Madruga	Environmental radioactivity
Mr Dr. António Ferro de Carvalho	Metrology
Mr João Henrique Garcia Alves	Individual dosimetry
Mr Romão Buxo Trindade	Radioactive waste management
Mr Mário João Capucho dos Reis	Atmospheric radioactivity

<u>The Portuguese Research Reactor</u>

Mr José Marques	Reactor manager
Mr Andreas Kling	Health physics

The verification team acknowledges the excellent co-operation it received from all the individuals mentioned above and others met in the various laboratories. The verification team also notes the quality and comprehensiveness of all presentations made during the visit and of the documentation provided.

It should however be noted that the verification team did not meet with representatives of the Ministries of Health and of Environment. The Ministry of Science & Technology was also not represented during the verification visit.

4. REGULATORY FRAMEWORK

4.1 Legal basis

Currently Portugal has no integrated regulatory framework controlling its nuclear sector. Instead, a set of numerous laws, decrees and regulations is in force covering various nuclear practices.

The legal basis for radiation protection in Portugal consists of:

- Decree Law n° 348/89 (Ministry of Health), the primary law for radiation protection.
- Regulatory Decree n° 9/90 (Ministry of Health), implementing Council Directives 836/80/Euratom (6) and 466/84/Euratom (7).
- Regulatory Decree n° 3/92, modifying Regulatory Decree n° 9/90.

It is noted that Portugal has not yet transposed into national law the most recent issues of the above council Directives (see footnotes 6 and 7). The transposition of both Directives has been entrusted to the Directorate General of the Ministry of Health.

4.2 Competent authorities

Two Ministries have authority in the field of environmental monitoring:

- Ministry of Health: supervision of radiological safety in Uranium mines, including environmental and individual monitoring (Regulatory Decree 34/92).
- Ministry of Environment: participation in the planning and co-ordination of emergency preparedness in case of nuclear accidents abroad (Decree Law 8/2002).

The Ministry of Health is also in charge of licensing medical and industrial practices.

4.3 The Portuguese Research Reactor

The authority having competence to license and independently control the RPI has never been clearly established. This entails that currently there is no regulatory framework within which the RPI is operated: the RPI was *de facto* never licensed nor independently controlled. Discharge authorisations and limits, dose constraints, or a statutory site-related environmental monitoring programme have never been defined. Since it started its operational life in the 60's the RPI has been (and still is) a self-regulating nuclear facility.

4.4 The Department for Radiation Protection and Nuclear Safety

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6 Council Directive of 15 July 1980 amending the Directives laying down the Basic Safety Standards for the health protection of the general public and workers against the dangers of ionising radiation (OJ L-246 of 17/09/80); repealed with effect from 13/05/2000 and replaced by Council Directive 96/29/Euratom (OJ L-159 of 29/06/96).

7 Council Directive of 3 September 1984 laying down the basic measures for the radiation protection of persons undergoing medical examination or treatment (OJ L-265 of 05/10/84); repealed with effect from 13/05/2000 and replaced by Council Directive 97/43/Euratom (OJ L-180 of 09/07/97).

Similarly Portugal has not clearly defined a regulatory authority whose responsibility it is to implement a National Environmental Monitoring Programme as required under Art.35 and Art.36 of the Euratom Treaty. The DPRSN however, created by Decree Law n° 311/98 (Ministry of Science & Technology), has through its legal mandate received competence in this area, not as a regulatory body but as an executive body. Furthermore, it also transpires from its mandate that the DPRSN should ensure that Portugal meets the technical and scientific requirements derived from international treaties and conventions in the area of radiation protection.

In the absence of a regulatory framework or competent authority, the DPRSN has started to develop and implement such a National Environmental Monitoring Programme on a voluntary basis.

It is noted that Decree-Law n° 311/98 recognises, in its text, that Portugal has not designated a national regulatory authority in radiation protection.

4.5 Conclusions

In light of the above situation:

The Portuguese government should therefore

- *Designate a competent authority that shall, for to the Portuguese Research Reactor, forthwith implement the provisions as laid down in §4 and §44(c) of the Basic Safety Standards [(8)]:*
  - *By delivering an operating licence with appropriately justified discharge limits.*
  - *By ensuring that the operator of the reactor implements a statutory discharge monitoring programme as well as a statutory site-related environmental monitoring programme.*
  - *By putting in place provisions for an independent regulatory control and enforcement of the operator's statutory obligations.*
- *Designate a competent authority that shall forthwith develop a regulatory framework for a National Environmental Monitoring Programme and to implement such a Programme to discharge Portugal's legal obligations as laid down in Article 35 and Article 36 of the Euratom Treaty, including Commission Recommendation 2000/473/Euratom [(9)].*

5. THE NUCLEAR AND TECHNOLOGY INSTITUTE

The ITN, dependent on the Ministry of Science and Technology since 1995, is a Research State Laboratory.

The ITN houses on its campus located at Sacavém (Lisbon) the following departments:

- The Portuguese Research Reactor (see section 6 below).
- The Department for Radiation Protection and Nuclear Safety (see section 7 below).
- A Chemistry Research Unit (CRU) performing radiopharmaceutical chemistry research.

[8] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation (OJ L-159 of 29/06/1996).

[9] Commission Recommendation 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 (OJ L-191 of 27/07/2000).

Production of radiopharmaceuticals for use by the medical sector has been phased out in the early 90's.

A fourth department, the Physics Research Unit, has no further relevance with respect to the verification visit. This unit operates:

- An Ion Beam Laboratory, with a 3.1 MV van de Graaff Accelerator and a 210 kV high-fluence Ion Implantor. This infrastructure is used in the fields of material science, environment, health, atomic and nuclear physics.
- A 300 kCi Co-60 Gamma Radiation demonstration facility whose main activities are centered on research, but also on radiosterilisation of medical devices and of pharmaceuticals.

The ITN is the only such laboratory present in Portugal.

6. THE PORTUGUESE RESEARCH REACTOR

The RPI started operations in the 1960's. It is a nominal 1 MW light-water pool-type research reactor, the only nuclear reactor in Portugal. Between 1987 and 1990 the facility underwent a refurbishment and modernisation programme.

Currently the RPI is operated by ITN staff and mainly used for neutron activation analysis, but also in the areas of materials testing, detector calibration and isotope production.

Reactor characteristics are given in appendix 3 to this report.

7. THE DEPARTMENT FOR RADIOLOGICAL PROTECTION AND NUCLEAR SAFETY

7.1 Mandate

The DPRSN inherits the legacy and experience of the former Service of Radiological Protection created back in 1964 within the Nuclear Energy Commission and, later, successively transferred to the National Laboratory for Engineering and Industrial Technology (1978) and the Ministry of Environment (1993). The DPRSN was created within the Nuclear and Technology Institute (ITN) by Decree 311/98 of 14 October 1998.

7.2 Statutory responsibilities

According to Decree 311/98, the mandate of the DPRSN includes, between others, the following activities:

- To carry out scientific research and training in the areas of radiological protection and nuclear safety.
- To perform radiological risk assessment for workers and the population from nuclear facilities or activities.
- To propose corrective measures to protect workers as well as the population from exposure to ionising radiation.
- To maintain a national database with dosimetric data from radiation workers.
- To ensure the implementation of radioecological monitoring and environmental surveillance actions.

- To perform radioecological impact assessment studies.
- To collect, pack and ensure the temporary storage of solid radioactive waste originating from within the country.
- To assess and check the safety of transport of nuclear fuel and radioactive waste from nuclear facilities.
- To ensure the application of appropriate ionising radiation metrology including calibration of instruments and measurement devices.

It should be noted that nuclear safety figures in the department's name but that this competence is not listed in the mandate.

The Decree also mentions that the DPRSN should ensure that Portugal complies with international treaties and conventions in the area of radiation protection. The DPRSN is however not supervised by any regulatory authority setting a legal framework within which to operate. The competencies listed in the mandate are subsequently perceived as general guidelines to activities carried out. It is thus on a voluntary basis that the DPRSN developed a National Environmental Monitoring Programme in order to attempt compliance with Article 35 of the Euratom Treaty and to provide the EC with environmental data as required under Article 36 of the Euratom Treaty. It should be noted here that, with respect to Article 36 requirements, the Ministry of Environment communicates the Portuguese ambient gamma dose rate data to the EC.

8. DISCHARGES TO THE ENVIRONMENT AND THEIR MONITORING

Two entities on the ITN site are at the origin of gaseous and liquid radioactive waste discharges into the environment: the RPI and, to a much lesser extent, the Chemistry Research Unit (CRU) and other laboratories.

Since it started its operational life in the 60's the RPI has been (and still is) a self-regulating nuclear facility. Discharge limits (for liquid effluents only) were internally established about 25 years ago, taking into account the liquid discharges of the then operational radiochemicals production unit (phased out in the early 90's). This limit has not been modified since. However, during its visit, the verification team was told that the document entitled "Operational limits and conditions of the RPI", referenced ITN/RPI-R-97/46 and describing the current limitations on radioactive discharges, was under revision.

8.1 Atmospheric discharges

Gaseous discharges from the RPI are released through a stack of 20m height with a nominal stack flow rate of 3700 m^3/h. Gaseous discharges from the CRU are released via a smaller and separate stack. Prior to release into the stack the air extracted from both the RPI and the CRU is passed through absolute filters.

The RPI stack is equipped with an IAEA AIR-MON91 continuous monitoring system for beta/gamma particulates, iodine and noble gases. Particulates and gaseous iodine are sampled and measured in continuous mode. The iodine and particulate filters are exchanged twice a year. No integrating measurements are performed. Carbon-14 and Tritium are neither measured nor calculated.

The monitors for particulates and iodine are located in a secured housing adjacent to the stack, the noble gas monitor being positioned inside the chimney (schematics and technical details are given in appendix 4 to this report).

The three monitoring devices of the AIR-MON91 system are controlled by dedicated software on a single IBM PC/XT type 8088 running under DOS-3 with 5¼-inch diskette drives and 14-inch monitors.

The PC also links into the RPI control in order to display the discharge values on a dedicated monitor. The control room monitor simultaneously displays the calculated emitted average activity in Bq/m³ for iodine (each hour), the calculated emitted activity in Bq/m³ for particulates (each minute and average each hour), and the calculated emitted activity in Bq/minute for noble gases. Date and time are also displayed, as are stack flow, sampling flow rate and functionality status of the vacuum pump feeding the samplers at the stack.

Alarm levels are pre-adjustable and are continuously displayed on the control room monitor. For each detector two pre-alarm (warning) levels are set as well as the alarm level proper, expressed as threshold levels of emitted activity. Stack and sampling flow rate variations beyond pre-set values will flash warnings. All types of alarms and warnings are of visual and audible nature.

Total and average activity released in the years 2000 and 2001 are presented in appendix 4 to this report.

8.2 Liquid discharges

The RPI liquid radioactive effluents consist mainly of washing waters, treatment waters from ion exchange resins and leakage waters. At origin the effluents are split into an active and a non-active stream. The former is collected into two 2.5 m³ retention tanks, the latter into two 7.5 m³ retention tanks. The four tanks are located 10m below ground level in a bunker accessible for maintenance and sampling purposes.

The CRU effluents are basically washing waters. Two retention tanks of 2.5 m³ are located 2 m below ground level in a bunker accessible for maintenance and sampling purposes.

When full the retention tanks are sampled (50 ml grab samples) after homogenisation through tank content recirculation. Samples are submitted to gross beta counting and gamma spectrometry analysis. If above 740 Bq/l then dilution of the tank contents or retention to allow further decay is envisaged. When below 740 Bq/l the content of the tanks can be transferred to one of the four 50 m³ discharge tanks.

The discharge tanks are sampled and assessed in a similar fashion and their contents may be discharged when showing an activity concentration below 740 Bq/l. Where in the past the discharge went directly in the river Tagus and more recently into the public sewer, nowadays the discharge is directed towards the municipal water treatment plant. There are no monitoring provisions in this plant.

A block diagram of the liquid discharge system is given in appendix 5 to this report.

9. VERIFICATION OF ENVIRONMENTAL DISCHARGES

9.1 Atmospheric discharges

9.1.1 Verification activities

The verification team checked the adequacy and functionality of the monitoring and sampling provisions and control systems of the site's stack extracting air from the RPI.

The verification team visited the RPI control room where the operator demonstrated the functionality of the various control systems present.

Finally the verification team visited the analytical laboratory measuring the discharge samples in order to assess its activities (see section 9.3).

9.1.2 Findings and recommendations

-- Monitoring and sampling provisions.

The operator demonstrated the functionality of the monitoring and sampling provisions (IAEA AIR-MON91 system). Upon enquiry the operator stated that all provisions had been taken to guarantee isokinetic sampling. In this context the team noted that the length of the sampling ducts is kept straight and as short as feasible.

The verification team noted that the assessment of particulate Iodine-131 is not performed. Carbon-14, which is a significant dose contributor is not measured nor calculated.

> *The verification team recommends the ITN to perform nuclide-specific measurements.*
>
> *The verification team recommends the ITN to consider the implementation of a routine assessment of Carbon-14 and Tritium, at least by calculation.*

-- Quality assurance.

The team requested and received printouts of emission values as displayed on-line in the control room. From these documents, and more in particular with respect to the iodine data [(10)], it transpired that the AIR-MON91 system is not adequately quality assured and controlled. Although the operator performs a daily functionality check-list, the calibration of the system has, since its commissioning in 1992, never been submitted to verification. Hence, the reliability of the measurement results is questionable. Written quality assurance and quality control procedures are not in place. The operator declared however that such procedures are currently being developed.

> *The verification team recommends the ITN to put in place adequate quality assurance and control procedures for its AIR-MON91 system, including assessment of background and verification of the calibration at set intervals.*

-- Control systems.

The operator demonstrated the functionality of the various control systems. However, the team observed that the hardware and the software underlying the stack control systems is somewhat out of date (IBM PC/XT type 8088 running under DOS 5 with 5 ¼ inch diskettes drivers and 14-inch monochrome monitors). When questioned on this issue the operator mentioned that replacement of the current software with a more robust application is intended for the year 2003.

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[10] Reported values for I-131 are nearly systematically negative, indicating that detector set-up is not sufficiently sensitive or, that the calibration of the system is not correctly performed.

In view of the risk of a possible breakdown of the hardware underlying the RPI stack control systems and the probable difficulties in obtaining spare parts should such a breakdown occur, the verification team recommends that the ITN pay particular attention to this issue and consider an upgrading of the systems.

The verification team endorses the operator's intention to upgrade the current software underlying the stack control systems.

The verification team noted the elevated alarm thresholds for airborne releases. Upon enquiry with the operator it transpired that the values for pre-alarms and alarms had been set at arbitrary levels.

The verification team recommends the ITN to set the alarm thresholds for airborne releases from the RPI at levels that ensure adequate early warning capability.

-- Record keeping and archiving.

The verification team was not made aware of any structured record keeping and archiving procedures with respect to monitoring data.

The verification team recommends the ITN to implement a comprehensive system of record keeping and archiving with respect to discharge data of airborne radioactive effluents from the RPI.

-- Regulatory control.

In the absence of a regulatory body, the verification team noted that independent samples for control measurements are not taken.

The verification team recommends the Portuguese government to implement a control sampling and measurement programme for airborne radioactive discharges from the RPI.

9.2 Liquid discharges

9.2.1 Verification activities

The verification team visited the bunkers containing the retention (decay) tanks and the location of the discharge tanks. The presence of sampling and monitoring devices was verified. Subsequently the analytical laboratory for effluent sample measurements was visited in order to assess its activities (see section 9.3).

9.2.2 Findings and recommendations

Retention tanks

During the visit the verification team noted that the bunkers were well maintained and that sumps are present to recuperate any leaks that may occur. Provisions have been made to allow the pumping of the contents of the sump into any tank, according to necessity.

The verification team notes that, for the purpose of activity release control, the sampling procedures of the retention tanks are satisfactory.

Discharge tanks

-- Sampling provisions and sample analysis.

The verification team observed that the sampling system for these tanks consists of a manually operated pumping device. A sample is taken after homogenisation (recirculation) of the tank to be discharged. Written work instructions (procedures) for sampling the discharge tanks do not exist.

The verification team recommends the ITN to put in place working instructions (procedures) for the operation of the discharge tanks.

The sample taken is gross beta counted to verify the activity concentration against the self-imposed discharge limit of 740 Bq/l [11]. Spectrometric data are available at a later stage, after the tank had been discharged.

The verification team observed that the level indicators of the individual tanks were non-functional. When questioned the operator stated that levels are visually checked. Independently from this visual check a tank is always recorded as being at nominal capacity (50 m^3) when discharged. The verification team notes that this approach generates an overestimation of the amount of activity discharged.

The verification team recommends the ITN to restore the functionality of the level indicators on the discharge tanks.

If the activity concentration is below the detection limit, then the value of this detection limit (multiplied with the nominal tank capacity) is recorded as activity discharged. The verification team notes that this approach generates an overestimation of the amount of activity discharged.

The verification team recommends the ITN to avoid overestimation of activity discharged and to perform more realistic assessments by substituting measurement results below detection limit with an appropriate fraction of the detection limit value actually achieved.

-- Control systems.

The team observed that the actual discharge of a tank is not alarmed and that a transient contamination is likely to go unnoticed. However, the infrastructure to do so is partially available: pipelines, valves, shielding to receive a detector, racks to install electronics. Detector and counting electronics are not installed. When questioned the operator stated that due to budgetary problems the detector and electronics had been allocated to activities with higher priority.

The verification team recommends the ITN to consider fitting the liquid discharge tanks with a continuous monitoring device alarming the operator in case an activity concentration limit transgression occurs during discharge operations.

-- Regulatory control.

In the absence of a regulatory body, the verification team noted that independent samples for control measurements are not taken.

The verification team recommends the Portuguese government to implement a control sampling and measurement programme for liquid radioactive discharges from the RPI.

9.3 The analytical laboratory for discharge sample measurements.

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11 This corresponds with a discharge limit of 3.7E+07 Bq per tank (at nominal capacity).

9.3.1 Verification activities

Atmospheric discharge samples

Verification activities did not apply because the AIR-MON91 provides continuous measurement data.

Liquid discharge samples

The verification team requested the operator to submit sample and analysis records for audit. For the discharge tanks the records covering the years 1995 to 2000 were made available. However, the operator stated that records also exist for the period prior to 1995, discharge values are reported annually to the Commission of the OSPAR Conventions since the mid-1980s.

9.3.2 Findings and recommendations

Liquid discharge samples

Liquid discharge samples are analysed by DPRSN staff. The discharge samples are submitted to analysis in the same premises used for the assay of environmental samples. The verification team however noted that a new laboratory room for samples with higher activity contents is being commissioned. The team was told that liquid effluent samples would systematically be measured in the new laboratory room, once it becomes operational.

Scrutiny of the various working documents and records submitted revealed that there is room for improving quality assurance and quality control with respect to the measurement systems used. For instance, measurement results obtained from a gamma spectrometry device showed K-40 detection limits departing from standards, indicating that staff had not noticed detector or analysis software problems.

> *The verification team recommends the ITN and the DPRSN to put in place adequate quality assurance and control procedures for the measurement systems for RPI liquid effluent samples, including assessment of background and verification of the calibration at set intervals.*

The team also noted that measurement results are not systematically validated. These data may be used for publication and are also transmitted to international organisations in the framework of conventions. The absence of data validation could for instance be remedied by systematic peer review of results obtained.

> *The verification team recommends the ITN and the DPRSN to put in place adequate data quality validation procedures for the analytical results pertaining to liquid radioactive effluents from the RPI.*

The verification team noted that the Tritium content of the discharge samples is not measured.

> *The verification team recommends the ITN and the DPRSN to regularly assess, at least by calculation, the Tritium content of samples taken from the liquid radioactive effluents from the RPI.*

The verification team was not made aware of any structured record keeping and archiving procedures.

> *The verification team recommends the ITN to implement a comprehensive system of record keeping and archiving with respect to discharge data of liquid radioactive effluent from the RPI.*

10. THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

10.1 Introduction

As stated previously (section 4 above) Portugal has no regulatory framework or competent authority setting out a national environmental radioactivity monitoring programme.

The DPRSN through its competencies as laid down in Decree-Law n° 311/98 has started to develop and implement a national environmental monitoring programme on a voluntarily basis. The programme developed aims at discharging Portugal from its obligations under Articles 35 and 36 of the Euratom Treaty.

10.2 Site-specific environmental monitoring

10.2.1 Airborne particulates

Since May 2000 the DPRSN is monitoring atmospheric radioactivity by means of a high-volume aerosol sampler type ASS-500, located at the ITN Sacavém campus [(12)]. The device operates in continuous mode with a mean flow rate of 800 m³/h. The flow rate is continuously recorded with a data logger that can be downloaded to a hand-held computer. The sampling filters (G-3 type polypropylene filters, 44x44cm) are replaced weekly; in which period about 100000 m³ of air are filtered.

After each sampling period, the filters are incinerated at 450°C for 24 hours, the resulting sample being analysed for Cs-137 by gamma spectrometry (Canberra GCW2522). For a typical measurement time of 3 hours, the detection limit for Cs-137 is ≈ 3 µBq/m³.

Activity concentrations of the natural radionuclides K-40 and (if detected) Be-7 are also determined.

10.2.2 Rain water

Samples are taken over a period of 30 days using a total atmospheric deposition collector, located at the ITN Sacavém campus. The collector has a truncated pyramid shape with a 1m² in cross-section and a 60-litre receptor flask.

1-litre sub-samples are analysed for Cs-137 using gamma spectrometry (ORTEC Model GLI 25210, TENELEC Model CPVDS 30-35200, SILENA Models PRG e5521 and IG-C 20) with Marinelli geometry.

For a typical measurement time 15 hours, the limit of detection for Cs-137 is 0.2 Bq/l or 0.1 Bq/l depending on the detector used.

Activity concentrations of the natural radionuclides K-40 and (if detected) Be-7 are also determined.

10.2.3 Grass

Monthly grass samples [(13)] were, until 2002, taken from a single 1m² area located on the Sacavém campus.

Samples, after homogenisation, are measured for I-131 and Cs-137 using gamma spectrometry (ORTEC Model GLI 25210, TENELEC Model CPVDS 30-35200, SILENA Models PRG e5521 and IG-C 20) with Marinelli geometry.

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12 Before May 2000, a low-volume sampler (22 m³/h) had been in operation. The device did not collect in continuous mode but took 24 h spot-samples on a glass fibre filter type Anderson G810.

13 The sampling of grass has been discontinued in the year 2002.

For a typical measurement time 15 hours, the limits of detection for I-131 and Cs-137 range from 0.1 Bq/kg to 1.1 Bq/kg depending on the detector used.

Activity concentrations of the natural radionuclides K-40 and (if detected) Be-7 are also determined.

10.2.4 Ambient gamma dose rate

Since early 2001 two thermo-luminescent detectors (TLD) are located within the Sacavém campus. These are evaluated twice a year.

10.3 National environmental monitoring

The following description of the environmental monitoring as performed by the DPRSN was in place since 1997 until 2001 (the programme is summarised in appendix 6).

For the year 2002 the DPRSN is planning to further develop its environmental monitoring activities. This upgraded programme is presented in appendix 7.

10.3.1 Surface waters

Surface water samples are taken from the river Tagus (receiving liquid effluents from Spanish nuclear installations) and from the river Zêzere (which does not receive such effluents). Water samples are collected monthly from the river Tagus at Vila Velha de Rodão (where the river enters Portugal) and from the river Zêzere at the collector for the Lisbon public water supply system on the Castelo do Bode dam.

Total beta activity is measured on particles in suspension ($\leq$ 0.45µm) and on dissolved matter, according to the procedure set out in Portuguese Standard NP4330. The samples are measured during 100 minutes with a low-level counting system with Canberra HT1000 gas ionisation detectors. The limits of detection for suspended particles and dissolved matter are 20 mBq/l and 26 mBq/l respectively.

The water samples are also specifically analysed for Tritium (H-3), Sr-90 and Cs-137 activity.

The determination of H-3 is performed according to Portuguese Standard NP4362 using a Beckam LS6500 liquid scintillation spectrometer, with a typical measurement time of 300 minutes. The limit of detection for H-3 is 0.2 Bq/l.

Sr-90 and Cs-137 are radiochemically separated and purified, then measured during 100 minutes with a RISO low-level beta counting system incorporating Geiger-Muller flow detectors. The limit of detection is 0.5 mBq/l for both isotopes.

10.3.2 Drinking water

Monthly samples are taken from the water supply networks in areas with higher population density: the metropolitan areas of Lisbon and Porto. In addition, the samples collected from the Castelo do Bode dam, as described in 10.6, may also be regarded as drinking water samples.

After acidification of the samples their total alpha and total beta activity content are determined, according to Portuguese Standards for non-saline water NP4332 (total alpha) and NP4330 (total beta).

Total alpha activity is measured during 100 minutes with a Novelec counting system with two counting channels and two zinc sulphide scintillators. The limit of detection for total alpha is 15 Bq/l.

Total beta activity is measured using the low-level counting system mentioned in section 10.6, with a limit of detection of 35 mBq/l.

10.3.3 Milk

Monthly milk samples are taken from commodities bought on the Portuguese market (supermarkets). In order to guarantee national coverage the staff buying the product refers to the label on the packing material that mentions regional origin and name of the dairy. Occasionally samples are also taken from EU brands that are sold on the Portuguese market.

Levels of Sr-90, Cs-137 and K-40 are routinely measured.

To determine Cs-137 and K-40 activity levels, a gamma spectrometry (ORTEC Model GLI 25210, TENELEC Model CPVDS 30-35200, SILENA Models PRG e5521 and IG-C 20) using a 1000ml Marinelli geometry is performed directly on the milk.

For a typical measurement time 15 hours, the limit of detection for Cs-137 is 0.2 Bq/l or 0.1 Bq/l, depending on the detector used.

The Sr-90 measurement is performed using the same methodology and equipment as described in section 10.6, with a limit of detection of 20 mBq/l.

10.3.4 Mixed diet

Mixed diet samples are based on the main constituents of the Portuguese diet. These constituents are sampled separately, based on mean “per capita” intake, and taken from regional market places. In order to ensure national coverage the sampling plan requires that samples be taken from each agricultural region as delimited by Portuguese law.

At the same time, samples of food products of the same kind are taken from markets in the greater Lisbon area.

Each of these dietary constituents homogenised before being analysed for Cs-137 activity levels by gamma spectrometry (ORTEC Model GLI 25210, TENELEC Model CPVDS 30-35200, SILENA Models PRG e5521 and IG-C 20) with Marinelli geometry.

For a typical measurement time of 15 hours, the limit of detection for Cs-137 is 0.2 Bq/kg or 0.1 Bq/kg, depending on the detector used.

Activity concentrations of the natural radionuclides K-40 and (if detected) Be-7 are also determined.

Complete meal samples are taken from the ITN canteen.

11. VERIFICATION OF THE ENVIRONMENTAL MONITORING PROGRAMME

11.1 The environmental laboratory

11.1.1 Verification activities

The verification team visited the laboratory premises where it audited record keeping and archiving, quality assurance procedures (equipment and methodology), and verified the traceability of historical data (for the latter see section 11.2). Finally a courtesy visit was paid to the metrology and dosimetry departments of the DPRSN [(14)].

11.1.2 Findings and recommendations

-- Environmental laboratory infrastructure.

The visit to the environmental laboratory demonstrated that the DPRSN is expanding its laboratory infrastructure: extensions to the laboratory premises are currently being built. These extensions include a low-background laboratory with a ventilated basement and a new laboratory for medium-activity sample analysis.

> *The verification team endorses the efforts currently made to enhance infrastructure and capacity of the DPRSN laboratory.*

-- Record keeping.

The verification team noted the absence of an integrated system of record keeping. Each member of staff is responsible for managing his own paperwork; records are not centralised.

A comprehensive environmental samples database with unique sample identifier, relevant sampling and sample preparation data, and analysis results is not present.

> *The verification team recommends the DPRSN to create a database-type management tool for its environmental sampling activities.*

The verification team noted that working documents, pertaining to measurement results below detection limit or pertaining to results invalidated by staff as not being plausible, are not kept. Independent controls cannot be performed to their full extent when source documents are not available.

> *The verification team recommends the DPRSN to ensure that all source documents with respect to measurements performed on environmental samples are adequately filed.*

-- Equipment quality control.

The verification team noted that in general the detection limits are well below the reporting levels recommended in European legislation [(15)].

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14 The visit of the National Calibration and Metrology Laboratory and the Personnel Dosimetry Department allowed the verification team to collect background information on these infrastructures and activities. Both topics are beyond the scope of the verification activities proper. The team was impressed however with the efforts made by the DPRSN to have state-of-the-art equipment installed.

15 Reporting levels as laid down in the Commission Recommendation of 8 June 2000 on the application of Article 36 of the Euratom Treaty (OJ L-191 of 27/07/2000).

On the other hand the verification team noted that insufficient attention is paid to quality assurance. Calibration of the various instruments, as well as background measurements, are not subject to well-defined procedures.

The verification team recommends the DPRSN to put in place adequate quality assurance and control procedures for the measurement systems for environmental samples, including assessment of background and verification of the calibration at set intervals.

-- Data validation.

The team noted that measurement results are not systematically nor independently validated. Environmental measurement data are transmitted to the EC in the framework of Article 36 of the Euratom Treaty and may be used for publication or may be transmitted to international organisations in the framework of conventions. The absence of data validation could for instance be remedied by systematic peer review of results obtained.

The verification team recommends the DPRSN to put in place adequate data quality validation procedures for the analytical results pertaining to environmental samples.

-- Archiving.

The verification team noted the absence of a comprehensive archiving infrastructure.

The verification team recommends the DPRSN to create a comprehensive archiving system.

-- Reporting.

Despite the absence of a regulatory authority, the results of the site-specific and the national environmental monitoring as described under sections 10.2 and 10.3 above, are put in the public domain with ISBN codes. This openness started in 2002 (appendix 2, references 4 and 5).

The verification team noted that the publicly available reports suffer from a lack of quality control, a number of inconsistencies were detected. Upon enquiry DPRSN staff informed that the reports were not submitted to peer review prior to publication.

The verification team recommends the DPRSN to submit its environmental monitoring reports to an adequate internal quality control prior to publication.

Furthermore, in order to achieve better transparency and reach a larger audience, the verification team believes it to be necessary that such reports are also publicly made available on the Internet.

The verification team recommends the DPRSN to improve the information of the public by making available the environmental monitoring reports on its Internet site.

-- Accreditation.

The verification team stresses the importance of achieving accreditation, as it will provide the laboratory with an internationally approved certificate of excellence. Accreditation may add to the public perception of the activities performed by the laboratory and the reports it issues and therefore be beneficial to the DPRSN as a whole.

Furthermore the verification team noted during its visit that the metrology department of the DPRSN is certified. Quality assurance, bookkeeping and archiving of measurement results are performed according to highest standards. Staff of the environmental laboratory could seek advice from the metrology department in order to improve its current practice.

The verification team recommends the ITN to consider giving the DPRSN environmental laboratory the means to obtain accreditation.

The team also underlines the importance of regularly taking part in intercomparison exercises so as to maintain feedback on levels of performance. A number of intercomparison reports were handed out to the verification team (appendix 2, references 18 and 19).

Despite the DPRSN regularly participating in intercomparison exercises the verification noted a series of shortcomings with respect to internal quality assurance and control for routine operations (see above).

-- The environmental monitoring plan for the year 2000.

The verification team notes that over the years the national environmental monitoring programme has improved in its scope. The plan for the year 2002 addresses the marine environment for the first time and designates new media for sampling such as sediments, seaweeds and mussels.

The verification team welcomes the continued effort of DPRSN staff to further develop and improve its voluntary activity with respect to the implementation of a national environmental monitoring programme.

-- DPRSN staff.

The verification team was told that the DPRSN is the only body in Portugal having the necessary specialised equipment and competent staff in the area of radiological environmental impact assessment. However, the DPRSN is currently facing a continuous reduction in staff due to retirements without replacement.

The verification team recommends the ITN to ensure that DPRSN staff and competence are maintained at adequate levels.

11.2 Audit of published data

11.2.1 Verification activities

The verification team performed an in depth audit of a series of published environmental monitoring data (appendix 2, references 4 and 5). The verification team chose to scrutinise the following datasets:

- Milk samples: April 1999 / March & July 2000 / September & November 2001.
- Mixed diet: Cabbage, February 1999 & August 2001
- River water: October & November 2001

Additionally not yet published data were scrutinised:

- Drinking water: Tritium determination February 2002

For the samples under scrutiny the verification team requested the operator to provide all records in its possession so as to allow verification of consistency and traceability of data.

11.2.2 Findings and recommendations

-- Milk samples.

The verification team noted that milk samples are taken from supermarkets. In doing so knowledge about the exact date and location at which the milk was produced is not available. This lack of information can result in the analysis software returning significantly biased measurement results, especially when it comes to assess the short-lived radionuclides, more in particular Iodine-131.

The current milk sampling procedures are not providing sufficiently representative samples for activity trend analysis.

> *The verification team recommends the DPRSN to take representative milk samples from dairies. For activity trend analysis it is recommended to sample one and the same representative dairy for each region.*

-- Mixed diet.

The verification team noted that a third party, the Portuguese Food Agency, collects the mixed diet samples for the national monitoring programme. This activity takes place without it being duly formalised. Strictly defined sampling procedures with which the third party has to comply are not in place.

> *The verification team recommends the DPRSN to ensure that sampling activities devolved to third parties are duly formalised and that responsibilities are clearly defined.*

-- River water.

Current practice consists of taking spot samples. River flow-rates at the sampling point are not measured.

> *The verification team recommends the DPRSN, in order to achieve representativeness, to sample surface waters to the extent possible over defined periods of time and to record river flow rates during the sampling periods.*

-- Drinking water.

The former environmental monitoring programme (valid until 2001) did not differentiate between surface and drinking water. In the new environmental monitoring programme for the year 2002 this shortcoming has been rectified. Drinking water is now sampled at 9 locations on a monthly basis, and measured for total beta, total alpha, Cs-137, Sr-90 and H-3. The verification activity could be performed to satisfaction.

> *The verification activity performed did not give rise to any further comment.*

11.3 Site-specific monitoring

11.3.1 Verification activities

The verification team verified the adequacy and functionality of the various environmental monitoring devices situated on the premises of the Sacavém campus.

11.3.2 Findings and recommendations

-- The ASS-500 high-volume air sampler.

The verification team noted that the ASS-500 is state-of-the-art equipment and was told that the ASS-500 also serves the purpose of monitoring air in the framework of the national environmental monitoring programme.

However, as a site-specific monitoring device the ASS-500 is not optimally positioned in relationship to the location of the RPI stack and prevailing local wind directions.

The verification team recommends the ITN, in order to implement effective site-related monitoring, to consider relocating the ASS-500 to a site where the dispersion of the releases from the RPI stack may contribute to the dose to the population through inhalation.

-- The rainwater collector.

The verification activity performed did not give rise to any comment.

-- The TLD dose meters.

The TLD meters, as site-specific monitoring devices are not optimally positioned in relationship to the location of the RPI stack and prevailing local wind directions. Basically the same recommendation as for the ASS-500 is applicable to the TLD meters, but in this case in relationship to external exposure.

-- Regulatory control.

In the absence of a regulatory body, the team noted that independent monitoring does not take place.

The verification team recommends the Portuguese government to implement a comprehensive site-related environmental monitoring programme for the Sacavém campus.

11.4 The national monitoring programme

11.4.1 Verification activities

The verification team verified airborne particulate monitoring provisions and facilities for external ambient gamma dose rate assessment. Environmental sample analysis of different media has been discussed in section 11.3 above.

11.4.2 Findings and recommendations

The verification team notes that Portugal has made efforts to develop a monitoring programme comparable to those in place in other Member States, but that while priority was given to the installation of monitoring stations for a “sparse” network, the establishment of a “dense” network is lagging behind. Provisions for airborne particulate and external ambient gamma dose rate monitoring are missing or unsatisfactory.

Continuously operating monitoring systems for airborne particulates still need to be installed throughout the Portuguese territory so as to provide the ability to make the necessary assessments, particularly in case of radiological emergencies.

The verification team was briefed that only a few dose rate monitors, operated by the Ministry of Environment, have been installed along the border to Spain. There is, however, no exchange of measurement data between the Ministry of Environment and the DRPNS.

The Portuguese government should therefore

- *Implement a national programme as detailed in Commission Recommendation 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 (OJ L-191 of 27/07/2000).*

- *Ensure that ambient gamma dose rate assessments are made throughout the territory of Portugal and to put in place communication channels between relevant ministries so as to ensure that efficient data exchange is made possible.*

12. CONCLUSIONS

All verifications that had been proposed by the Portuguese authorities were completed. In this regard, the information supplied in advance of the visit, as well as the additional documentation received during and after the verification, was useful.

The information provided and the outcome of the verification activities led to observations and recommendations that are presented in the Main Findings and that have been forwarded to the Portuguese Permanent Representation to the European Union.

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Appendix 1

THE VERIFICATION PROGRAMME

Tuesday 14 May	- - -	Introduction meeting and discussions at the DPRSN. The RPI and its atmospheric and liquid discharge monitoring and control systems. The analytical laboratory for discharge samples.
Wednesday 15 May	- - -	The environmental monitoring laboratories, (instrumentation, QA/QC). Environmental monitoring on the ITN site. Short visits to the DPRSN Dosimetry and Metrology departments.
Thursday 16 May	- - -	The environmental monitoring laboratories, (analytical procedures, data management, QA/QC). In-depth verification of randomly chosen environmental monitoring samples. Various activities to complete the verification mission.
Friday 17 May	- -	Wrap-up meeting with all parties involved. Closing meeting with the ITN President.

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Appendix 2

DOCUMENTATION

Received prior to the verification visit.

1. Radioactive liquid discharges from ITN (1995-2000).
2. The environmental monitoring programme (planning for the year 2002).
3. Radiological monitoring at national level (report 1997-1998).
   DPRSN report Series A, n° 21/99 of October 1999.
4. Radiological monitoring at national level (report 1999-2001).
   DPRSN report Series A, n° 18/2002 of 4/4/2002 ISBN 972-95401-9-5.
5. Radiological monitoring around the ITN site (report 1997-2001).
   DPRSN report Series A, n° 20/2002 of 4/4/2002 ISBN 972-8660-19-7.

Received during the verification visit.

6. Decree law n° 348/89 (Ministry of Health) – main law related to radiation protection.
7. Regulatory decree n° 9/90 (Ministry of Health) – Directives 836/80/Euratom and 466/84/Euratom.
8. Regulatory decree n° 34/92 (Ministry of Environment) – Uranium mining and milling.
9. Decree law n° 311/98 (Ministry of Science & Technology) – DPRSN mandate.
10. Decree law n° 243/2001 (Ministry of Environment) – Directive 98/83/EC.
11. Technical file of the ASS-500 aerosol sampling station.
12. Technical specifications of the measurement devices present in the DPRSN environmental lab.
13. Analytical lab procedures for measuring H-3, Cs-137 and Sr-90 in water.
    Analytical lab procedures to determine Sr-90 in milk.
14. Portuguese Standard 4330 (September 1996) laying down the measurement of gross beta activity in non-saline water.
15. Portuguese Standard 4332 (January 1997) laying down the measurement of gross alpha activity in non-saline water.
16. Portuguese Standard 4362 (September 1997) laying down the determination of H-3 activity concentration in water, using the liquid scintillation counting methodology.
17. All relevant laboratory working papers and analysis/measurement results for all environmental samples that have been subjected to scrutiny during the verification visit.
18. A set of intercomparison result reports (IAEA-368 - 1991, IAEA-300 – 1994, IAEA-315 – 1997, IAEA-384 – 2000, IAEA-414 – no date, WHO/IRC n° 65 SR 300).
19. IAEA report on DPRSN results in the 1st ALMERA proficiency test – February 2002.
20. RPI reactor specifications and technical specifications of the AIR-MON 91 stack monitoring system.
21. RPI: overview of particulate/iodine/noble gas airborne activity releases – 2000-2001.
    Gamma spectrum analysis report on liquid release sample TC200519.
22. Radiological surveillance programme performed during the mooring of the USS aircraft carrier "ENTERPRISE" in the Tagus river estuary near Lisbon, between 2 and 7 June 2001.
    DPRSN report Series C n° 24.
23. Phosphate industry residues and radioactivity in the Tagus river estuary.
    DPRSN report Series A, n° 7 of 22/10/1999 ISBN 972-8660-06-5.

24. Radioactive contamination in Uranium mining areas.
DPRSN report Series B, n° 15/2001 of 14/12/2001 ISBN 972-95401-5-2.

Other documentation consulted.

Environmental remediation of Uranium production facilities, a joint report by the OECD/NEA and the IAEA – 2002. ISBN 92-64-19509-2

The Portuguese Research Reactor – 40 years in the service of science and technology
http://www.spq.pt/boletim/83/bl83_artigo4.htm

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Appendix 3

RPI - REACTOR SPECIFICATIONS

Type:	Pool
Thermal power:	1 MW
Manufacturer:	AMF Atomics, USA
Fuel:	93% U-235 enriched U-Al
Thermal flux:	2×10^{13} n/cm²/s (max.)
Moderator:	H_2O
Reflector:	Be blocks, H_2O and graphite
Shielding:	H_2O, Pb, barytes and regular concrete

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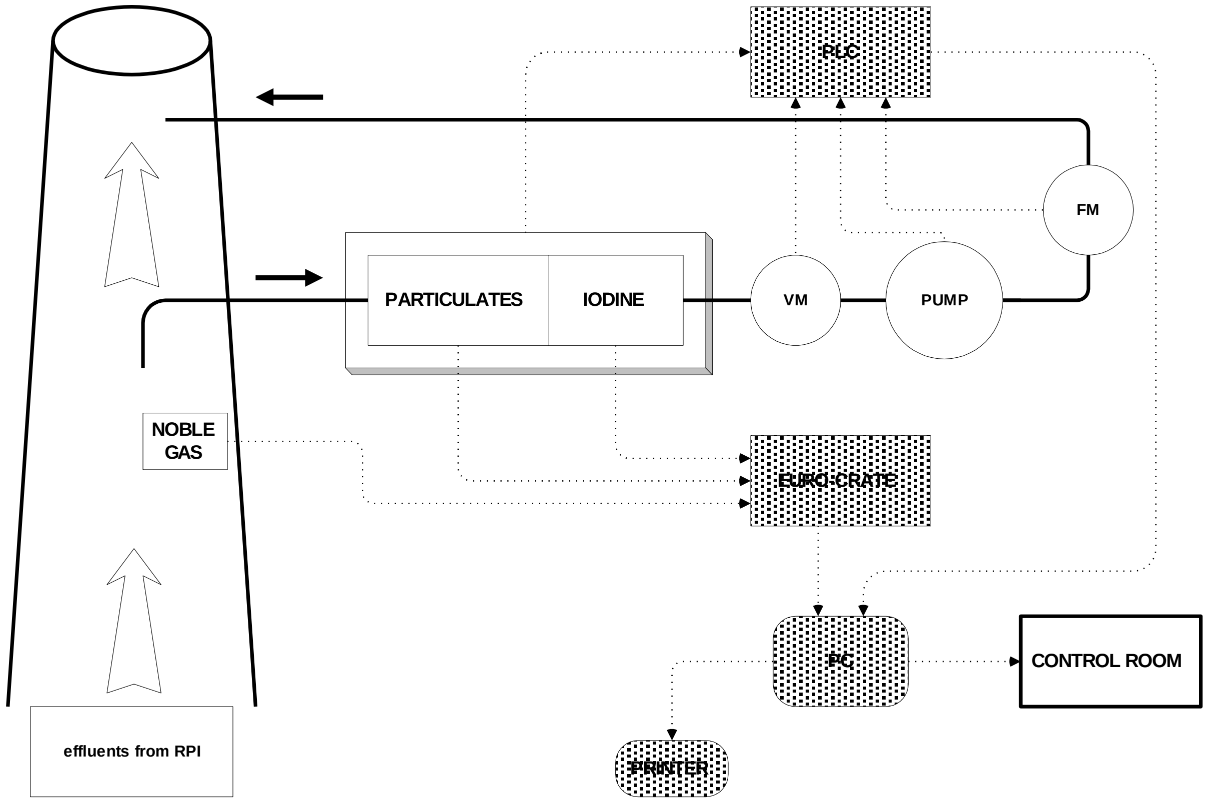
Appendix 4

RPI – MONITORING DEVICES FOR AIRBORNE RADIOACTIVE DISCHARGES

1. Schematic



2. AIR-MON 91

Particulates

Filter: 2 inch Ø Millipore SM fixed filter
Detector: 2 inch Ø NE 107A plastic scintillator for betas with a 1mm thick Be window
gap between detector & filter of 13.2mm
Sensitivity: 0.19 ± 0.02 cps/Bq at a flow rate of 3.2 m³/h
Background: ca. 28 cpm
Detection limit: ca 0.034 Bq/m³

Iodine

Cartridge: 2.27 inch Ø x 1.04 inch with 5% TEDA treated charcoal
Detector: 2 inch Ø x 2 inch NaI(Tl) scintillator
gap between detector & filter of 5mm
Sensitivity: 0.073 ± 0.003 cps/Bq at a flow rate of 3.2 m³/h
Background: ca. 42 cpm
Detection limit: ca. 0.11 Bq/m³

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Noble gas

Detector: 7 inch ∅ x 1mm NE 102A plastic scintillator for betas with a 0.3mm thick Al window
Background: ca. 500 cpm
Detection limit: ca. 1000 Bq/m³

3. Activities released

	2000		2001	
	Average	**Total**	**Average**	**Total**
Particulates	0.60 Bq/m³	3 MBq	0.69 Bq/m³	2.9 MBq
Iodine	0.66 Bq/m³	3 MBq	0.67 Bq/m³	2.9 MBq
Noble Gas (Ar-41)	5.7 MBq/min	410 GBq	4.4 MBq/min	329 GBq

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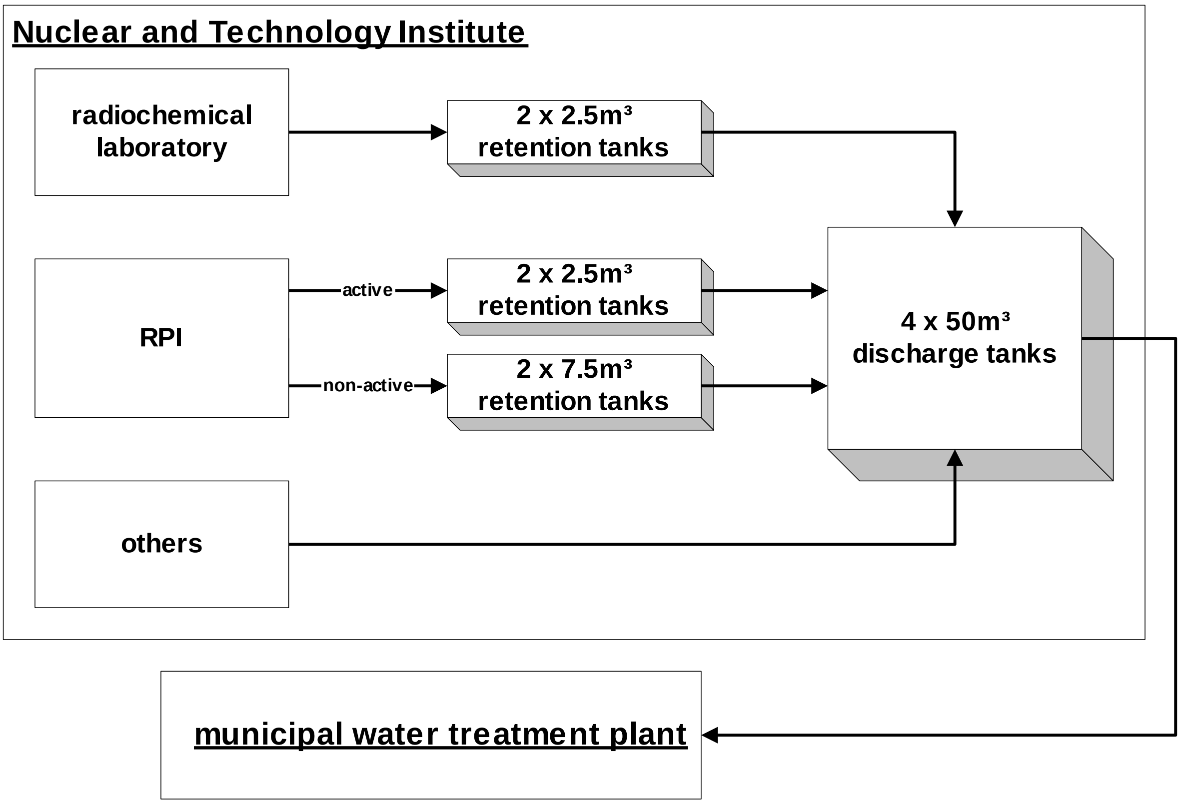
Appendix 5

RPI - LIQUID DISCHARGES SCHEMATIC



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Appendix 6

ENVIRONMENTAL MONITORING PROGRAMME – up to 2001

1. FREQUENCIES OF SAMPLING

Medium	Number of locations	Sampling frequency	Measurements
Aerosols	1 (Sacavém)	monthly	Cs-137, K-40, Be7
Surface waters	2(Rio Tejo and Rio Zêzere)	monthly	total beta Cs-137, Sr-90, H-3
Drinking water	2 (Lisbon and Porto)	monthly	total alpha total beta
Rain water	1 (Sacavém)	monthly	Cs-137, K-40, Be7
Milk	8	monthly	CS-137, Sr-90, K-40
Mixed diet	8	monthly	Cs-137, Sr-90, Be-7
Grass	1 (Sacavém)	monthly	I-131, Cs-137, K-40, Be-7

2. SAMPLING DEVICES AND SAMPLING PROCEDURES

2.1 Aerosols

- Between 1997 and 2000:

  24 Hour spot sampling through a glass-fibre filter (Anderson G810 – 95% retention efficiency). Average flow of 22 m³ per hour.

  Ge(Hp) spectrometry on compacted filter.

- Since May 2000:

  High-volume air sampler (type ASS-500) with an average flow of 800 m³ per hour.
  Polypropylene filter (type G-3, 44x44 cm).
  Continuous operation with a weekly exchange of the filter.

  Filter incineration at 450 °C for 24 hours.
  Ge(Hp) spectrometry on filter ashes.

2.2 Surface waters

See section 2.4 below.

2.3 Rainwater

1 m² total deposition collector.
30-day sampling time.

Ge(Hp) spectrometry on 1 litre sub-sample (Marinelli geometry).

2.4 Drinking water

Monthly sampling according to ISO 5667-5.

Separation of suspended matter (>0.45µm) from dissolved matter.

H-3 assessment according to the Portuguese Standard NP4362.
Liquid scintillation counter.

Beta total assessment according to the Portuguese Standard NP4330.
Low background counter.

Alpha total assessment according to Portuguese Standard NP4332.

Zinc sulphide scintillator (Novelec counting system).

Cs-137 & Sr-90 assessment after purification and radiochemical separation.
Low background counter.

2.5 Milk

Monthly sample.

Ge(Hp) spectrometry on 1 litre sub-sample (Marinelli geometry).

Sr-90 assessment after purification and radiochemical separation.
Low background counter.

2.6 Mixed diet

Monthly samples of various origin.

Ge(Hp) spectrometry on “wet” sample (Marinelli geometry).

2.7 Grass

1 m^2 sample location.

Ge(Hp) spectrometry on the “wet” sample (Marinelli geometry).

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Appendix 7

ENVIRONMENTAL MONITORING PROGRAMME – planning 2002

1. LOCATIONS OF THE SAMPLING AND MONITORING STATIONS

Map 1

Mixed diet (market places)	ref.1
Drinking water	ref.2 [(16)]
Milk	ref.3
Complete meals	ref.4
Mixed diet (supermarkets)	ref.5

cont'd on next page

16 And 24 additional locations spread over the Portuguese territory.

Map 2

Surface waters	ref.1 ([17])
Rain water	ref.2
Aerosols	ref.3
Soil	ref.4
Marine samples	ref.5

17 Annual samples on the Douro, Mondego and Guadiana rivers. Two monthly and two quarterly samples on the Tejo river. Monthly samples on the Zêzere river.

2. FREQUENCIES OF SAMPLING

Medium	Number of locations (ref. on map)	Sampling frequency	Measurements
Mixed diet (market places)	9 (map 1 ref.1)	monthly	gamma spectrometry
Drinking water	2 (map 1 ref.2) 2 (map 1 ref. 2) 24 (country-wide)	monthly monthly monthly (2 samples)	total beta/alpha Cs-137, Sr-90, H-3 total beta/alpha H-3 total beta/alpha
Milk	9 (map 1 ref.3)	monthly (2 samples)	gamma spectrometry Sr-90
Complete meals	1 (map 1 ref.4)	quarterly	gamma spectrometry
Mixed diet (supermarkets)	1 (map 1 ref.5)	half-yearly	gamma spectrometry
Surface waters [18]	8 (map 2 ref.1)	monthly quarterly annually	total beta Cs-137, Sr-90, H-3
Rain water	2 (map 2 ref.2)	monthly	gamma spectrometry Cs-137, Sr-90, H-3 total beta
Aerosols	1 (map 2 ref.3)	monthly	gamma spectrometry
Soil (organic, sandy)	4 (map 2 ref.4)	annually	gamma spectrometry
Marine samples (sediment, seaweed, mussels)	5 (map 2 ref.5)	annually	gamma spectrometry Plutonium Americium

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18 Annual samples on the Douro, Mondego and Guadiana rivers. Two monthly and two quarterly samples on the Tejo river. Monthly samples on the Zêzere river.