TC Project RER/9/062

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INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE

ORPAS

(OCCUPATIONAL RADIATION PROTECTION APPRAISAL SERVICE)

MISSION

to the

REPUBLIC OF SLOVENIA

SLOVENIA

OCCUPATIONAL RADIATION PROTECTION APPRAISAL SERVICE
Conducted under IAEA Technical-Co-operation Project on National Regulatory Control and Occupational Radiation Protection Programme

DEPARTMENT OF TECHNICAL CO-OPERATION
Division for Europe, Latin America and West Africa

DEPARTMENT OF NUCLEAR SAFETY
Division of Radiation & Waste Safety

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REPUBLIC OF SLOVENIA

SLOVENIA

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1. INTRODUCTION

BACKGROUND

1.1. The International Atomic Energy Agency (IAEA) is responsible for the development of international standards for the safety and protection of health, environment and property against ionizing radiation. This has led to the publication, inter alia, of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources,* IAEA Safety Series No. 115 (BSS). The IAEA is also responsible for the application of the BSS in Member States. To check whether the application of the standards is appropriate, the IAEA carries out appraisal reviews. This document relates to the appraisal of one area of application of the BSS, namely occupational radiation protection.

1.2. To assist Member States in occupational radiation protection, the IAEA has published three Safety Guides which are jointly sponsored by the IAEA and the International Labour Office (ILO). These are *Occupational Radiation Protection* (IAEA Safety Standards Series No. RS-G-1.1, 1999), *Assessment of Occupational Exposure due to Intakes of Radionuclides* (IAEA Safety Standards Series No. RS-G-1.2, 1999) and *Assessment of Occupational Exposure due to External Sources of Radiation* (IAEA Safety Standards Series No. RS-G-1.3, 1999). These are the specific publications against which the appraisal described in this document is conducted. The IAEA has also published additional technical information on particular techniques.

CONCEPT OF APPRAISAL

1.3. An evaluation, or appraisal, of occupational radiation protection arrangements following a development and implementation programme, and periodically thereafter, is an effective way to ensure that those arrangements are optimized and effective. An appraisal provides an opportunity for a Member State to have its occupational radiation protection programme independently assessed and evaluated. An independent assessment is often useful to maintain or enhance the effectiveness of the programme and to identify in an objective and unbiased manner the areas where improvements may be required. A secondary benefit is that an independent appraisal allows information on best practices from the host country to be made available to other Member States. It is also the intention that in due course, countries will be able to carry out their own self-assessment using similar procedures to those described in this document.

SCOPE

1.4. This document is a report of an appraisal team's mission to Slovenia, primarily to check the regulatory and practical implementation of occupational radiation protection arrangements. It includes some background as to the appraisal methods that were used. Conclusions and recommendations are made for the Republic of Slovenia, but the document also includes recommendations to the IAEA with regard to the structure and conduct of future such appraisals.

STRUCTURE

1.5. The document consists of six chapters of main text, supported by ten Annexes that mostly provide the detailed findings of the mission.

2. OCCUPATIONAL RADIATION PROTECTION APPRAISAL

KEY OBJECTIVES

2.1. The purpose of the appraisal is to check the regulatory and practical implementation of occupational radiation protection arrangements. In other words, the review tries to answer the question "are the arrangements adequate and will they work?" given the national context in which they are applied. An appraisal also aims at identifying specific strengths and best practices that can be shared with other Member States. Finally, an appraisal provides a basis for determining where improvements may be required and for recommending actions to make such improvements.

2.2. In support of the purpose, the key objectives of the appraisal are to:

— provide Slovenia with an objective assessment of the provisions for occupational radiation protection;

— identify areas where performance should be improved to meet international standards;

— make recommendations on actions to be taken to achieve such improvements; and

— identify the strengths in the host country which are unique and worthy of bringing to the attention of others.

METHODOLOGY AND EVALUATION CRITERIA

2.3. The evaluation criteria applied are based on the performance requirements as set out in the following three Safety Guides:

— *Occupational Radiation Protection* (IAEA Safety Standards Series No. RS-G-1.1, 1999);

— *Assessment of Occupational Exposure due to Intakes of Radionuclides* (IAEA Safety Standards Series No. RS-G-1.2, 1999);

— *Assessment of Occupational Exposure due to External Sources of Radiation* (IAEA Safety Standards Series No. RS-G-1.3, 1999).

2.4. Accordingly, four questionnaires have been developed by the IAEA for the purpose of gathering the necessary information against which to judge the appraised country's provisions for occupational radiation protection. Prior to the mission, these questionnaires were made available to all persons and organizations involved in the mission for their self-assessment. Consequently, for brevity of presentation, they will not be repeated herein but are listed below for convenience:

— Questionnaire No. 1, The occupational radiation protection programme [based on RS-G-1.1];

— Questionnaire No. 2, Assessment of occupational exposure due to external sources of radiation [based on RS-G-1.3];

— Questionnaire No. 3, Assessment of occupational exposure due to intakes of radionuclides [based on RS-G-1.2];

— Questionnaire No. 4, Occupational radiation protection in facilities [based on relevant sections of all three Safety Guides].

EVALUATION OF FINDINGS – STRENGTHS WORTHY OF SPECIAL MERIT

2.5. It is far easier to criticize and point out failures than it is to identify aspects that represent best practice or are particularly good. However, throughout the mission, the appraisal team was careful to identify those aspects that they considered to be representative of good practice in particular areas. In this context, **good practice** was considered to be an approach, methodology or system which, within the framework of the overall occupational radiation protection programme, was highly likely to achieve the required objective.

EVALUATION OF FINDINGS – WEAKNESSES AND CONSEQUENT RECOMMENDATIONS

2.6. Identified deficiencies were assessed according to their perceived impact on the protection of workers, and recommendations for improvements have been made to the Republic of Slovenia.

2.7. The appraisal team considered the actual or potential consequences arising from each identified area of limited effectiveness, and have reflected this in the prioritization of the associated recommendations. The following priority categories have been used:

Essential, meaning that a delay in implementation could result in a substantial and immediate hazard to health, and/or that the recommendation addresses a serious deficiency in the occupational radiation protection programme.

Important, meaning that until the situation is corrected, occupational radiation protection

effectiveness in a certain area is significantly compromised.

Advised, meaning that the recommendation identifies a relatively minor deficiency.

2.8. This system of prioritization is coupled to the following guidelines for the suggested timing of the implementation of the recommendations:

Priority	**Timing of Implementation**
Essential	Should be immediate, certainly without undue delay.
Important	Should be as soon as can be reasonably achieved.
Advised	Implementation enhances effectiveness but may be delayed.

3. APPRAISAL PROCEDURE

SLOVENIAN REQUEST, IAEA RESPONSE

3.1. The Republic of Slovenia requested the IAEA, in accordance with Milestone 2 of the model project on upgrading radiation protection infrastructure, to carry out a review of the occupational exposure control in the country. The Government addressed their request to the Department of Technical Co-operation, clearly stating the scope of the service required and designating a national contact point. This mission was intended to provide an objective assessment of the provisions for occupational radiation protection, identify areas where performance should be improved to meet international standards, and make recommendations on actions to be taken to achieve such improvements. The mission related to all activities included in the workplan for the project RER/9/062, Milestone 2 'Occupational Exposure Control'.

PREPARATORY VISIT AND OUTCOME

3.2. A preparatory visit to Slovenia was conducted from 5 to 6 March 2001 by Mr. R. Cruz Suárez, IAEA co-ordinator for the mission.

3.3. Discussions were held with the Slovenian Nuclear Safety Administration (SNSA) and with the Health Inspectorate of the Republic of Slovenia (HIRS). Visits were made to:

— the Institute Jozef Stefan (IJS);

— the Institute of Occupational Safety (IOS);

— the Nuclear Medicine Department of the University Clinical Centre at Ljubliana (UCCL);

— the Nuclear Power Plant at Krško (NPPK).

3.4. The mission objectives given in section 2.1. of this report were agreed, as was the scope of the appraisal given in section 3.3. The duration of the mission was set at one week, 2—6 July 2001. Prior to the main mission, arrangements were made to provide each participating organization in Slovenia with copies of those questionnaires (see section 2.2.) that were relevant to their participation. It was intended that participating organizations should complete their questionnaires and return them to the IAEA by 4 May 2001 so that briefing material could be prepared for the mission team members.

AGREED SCOPE

3.5. During the preparatory visit it was agreed that the mission should involve appraisals of regulatory authorities, of service providers and of practices (i.e. users of radiation). A provisional list of organizations was drawn up and was subject to some modification prior to the mission. During the mission, visits were made to the following (with contact details given in Annex 1):

Regulatory Authorities:

- SNSA for nuclear facilities.
- HIRS for all other practices.

Service Providers:

- IJS for the assessment of occupational exposure due to external sources of radiation.
- IJS for testing of radiation monitoring instruments (Secondary Standard Dosimetry Laboratory, SSDL).
- IOS for the assessment of occupational exposure due to external sources of radiation.
- IOS for technical services other than personal monitoring for external radiation.
- Nuclear Medicine Department at UCCL, for the assessment of occupational exposure due to intakes of radionuclides.
- NPPK for the assessment of occupational exposure to external sources of radiation and due to intakes of radionuclides.

Practices:

- Institute of Oncology for the therapeutic uses of ionizing radiations.
- Nuclear Medicine Department of UCCL for the use of unsealed radioactive materials.
- Clinical Institute of Radiology and Cardiology Department at UCCL for the diagnostic use of ionizing radiations.
- Slovenian National Building and Civil Engineering Institute (SNBCEI) for industrial/research uses of radiation.
- NPPK as an operating nuclear power plant.

TEAM

3.6. It was decided that the scope and duration of the appraisal required a team of five experts, comprising:

- an experienced specialist in occupational radiation protection to act as team leader,
- an experienced specialist with a regulatory background,
- an experienced specialist in personal dosimetry, especially external dosimetry,
- an experienced specialist from the nuclear power industry,
- an IAEA co-ordinator (who also undertook the role of a specialist in internal dosimetry).

3.7. Details of the team and a brief synopsis of their background and experience are given in Appendix II.

MISSION PLANNING

3.8. After receiving the relevant information and self-assessment by the counterpart, (June), detailed planning for the mission took place during the period 19—21 June 2001, when the team leader visited the IAEA in Vienna. This included:

- detailed discussions with the IAEA co-ordinator,
- study of a large amount of relevant background material,
- creation of a g*uidance document* for team members and for the Slovenian counterpart; this included a draft programme for the main mission,
- creation of a further document, *Preparation of Final Appraisal Mission Report,* which was also sent to team members and to the Slovenian counterpart,
- compilation of an information pack that was sent to team members.

MISSION PROGRAMME

3.9. The draft mission programme required slight amendments and the following programme was followed:

Date & time	**Event**	**Team members**
Sun 1 July 1600h	Initial meeting with Slovenian counterparts	Mr. Hudson & Mr. Cruz Suárez
Sun 1 July 1700h	Initial team meeting	All except Mr. Van Dijk
Mon 2 July 0900h	Initial briefing with Slovenian counterparts	All
Mon 2 July 1000h	***Briefing meeting*** with representatives from the participating organizations	All
Mon 2 July 1300h	Visit to SNSA	Mr. Hudson, Mr. Prouza & Mr. Dobis
Mon 2 July 1300h	Visit to IJS for external dosimetry and instrument testing	Mr. Van Dijk & Mr. Cruz Suárez
Mon 2 July 1700h	Team briefing for day	All
Tues 3 July Full day	Visit to NPPK	Mr. Van Dijk, Mr. Dobis & Mr. Cruz Suárez
Tues 3 July 0900h	Visit to HIRS	Mr. Hudson & Mr. Prouza
Tues 3 July 1300h	Visit to SNBCEI	Mr. Hudson & Mr. Prouza
Wed 4 July Full day	Visit to NPPK	Mr. Van Dijk, Mr. Dobis & Mr. Cruz Suárez
Wed 4 July 0900h	Visit to Nuclear Medicine Dept, UCCL as a practice	Mr. Hudson & Mr. Prouza
Wed 4 July 1300h	Visit to Institute of Radiology & Cardiology, UCCL	Mr. Hudson & Mr. Prouza
Wed 4 July 1700h	Team briefing	All
Thurs 5 July 0800h	Meeting with Mr. Tavzes, State Secretary at the Ministry of	Mr. Cruz Suárez & Mr. Hudson

	Environment and Special Planning	
Thurs 5 July 0900h	Visit to Institute of Oncology	Mr. Hudson & Mr. Prouza
Thurs 5 July 0900h	Visit to Nuclear Medicine Dept, UCCL as internal dosimetry provider	Mr. Van Dijk, Mr. Dobis & Mr. Cruz Suárez
Thurs 5 July 1100h	Visit to IOS as external dosimetry provider	Mr. Van Dijk, Mr. Dobis & Mr. Cruz Suárez
Thurs 5 July 1300h	Visit to IOS as other services provider	Mr. Hudson & Mr. Prouza
Thurs 5 July 1600h	Team briefing	All
Fri 6 July 1000h	Team meeting, preparation for Exit Briefing	All
Fri 6 July 1315h	***Exit Briefing*** with representatives from most of the participating organizations	All
Fri 6 July 1500h	Final team meeting	All

CONDUCT OF VISITS

3.10. It was agreed at the initial team meeting that visits would focus on the compilation of information and data necessary to complete the questionnaire that was relevant to the purpose of the visit. Prior to each visit, the team members had the opportunity to evaluate the pre-mission questionnaires provided by each participating organization. This was valuable in pre-planning aspects of each visit and concentrating on important issues. However, time was a limiting factor for practically all the visits.

3.11. Visits included a tour of each facility as an aid to obtaining a full understanding of the information being gained. It was noted that the briefing meeting on the first morning of the mission had provided participating staff with a valuable introduction to the purpose and conduct of the appraisal.

3.12. During each visit, the opportunity was taken to collect readily available documentation that would be of value in the subsequent evaluation of the findings. As appropriate to each individual visit, these documents included:

- regulations and regulatory guidance material, such as codes of practice;
- procedures for dosimetry laboratories such as calibration protocols;
- annual or other reviews of occupational exposures;
- results of performance tests or intercomparisons;
- quality assurance documentation;
- examples of optimization or 'ALARA' studies;
- examples of local rules etc.;
- investigation reports on overexposures.

REPORTING SCHEDULE

3.13. The following reporting schedule was agreed at the final team meeting:

Action	**Completion Date (not later than)**
Completed questionnaires, plus summaries of findings for inclusion in the final report, sent to team leader	23 July 2001
Compilation of first draft of report by team leader and circulation to team members for comments	13 August 2001
Comments from team members back to team leader	20 August 2001

Final draft from team leader to IAEA co-ordinator for editing and internal approval	27 August 2001
Approved report back to team leader for final acceptance	3 September 2001
Report returned to IAEA by team leader	7 September 2001
Report sent from IAEA to counterpart in Slovenia	10 September 2001
Comments from Slovenian counterpart to IAEA co-ordinator	28 September 2001
Issue of final report	19 October 2001

4. MISSION REPORT

BRIEFING MEETING

4.1. This was held on the morning of Monday 2 July 2001 and attended by all, or virtually all, the organizations that would be involved in the mission. The meeting consisted of formal presentations:

— *The Appraisal Request for* the *Republic of Slovenia*, by Mr. M. Krizman (SNSA) and Ms. H. Janzekovic (HIRS);
— *IAEA Appraisal Services*, by Mr. R. Cruz Suárez;
— *The Appraisal Review in* Slovenia, by Mr. A.P. Hudson.

4.2. These were followed by questions and open discussion. It was notable throughout the remainder of the mission that this briefing meeting had provided a valuable introduction and appeared to greatly facilitate the mission process.

MEETINGS WITH REGULATORY AUTHORITIES

4.3. Mr. Hudson, Mr. Prouza and Mr. Dobis met with Mr. Gregoric and Mr. Krizman from SNSA on the afternoon of Monday 2 July. Mr. Gregoric gave a presentation on the development of new nuclear legislation in Slovenia. This was followed by an open discussion with a view to gaining information for Questionnaire No.1 (see Section 2.2).

4.4. Mr. Hudson and Mr. Prouza met with Ms. Sever, Ms. Janzekovic, Mr. Sutej and Mr. Skrk from HIRS on the morning of Tuesday 3 July. The meeting consisted of an open and frank discussion, again focused on gaining information for Questionnaire No.1.

4.5. The detailed findings of both meetings will be found in Annex 3, and the recommendations are summarized in Section 5.

VISITS TO TECHNICAL SERVICE PROVIDERS

4.6. [The visits were focused on gaining information for Questionnaires No.2 (external radiation) and No.3 (intakes) – see Section 2.2].

Visit to Institute Jozef Stefan

4.7. Mr. Van Dijk and Mr. Cruz Suárez visited IJS on the afternoon of 2 July to see and discuss the service arrangements for the assessment of occupational exposure due to external sources of radiation and to discuss the IJS's role in providing radiation protection standards. Persons met at IJS were Mr. Martincic, Mr. Stuhec, Ms. Glavic, Mr. Miklavzic.

4.8. The detailed findings will be found in Annex 4 and the recommendations are summarized in Section 5.

Visit to Krško Nuclear Power Plant

4.9. Mr. Van Dijk and Mr. Cruz Suárez visited NPPK on 3 and 4 July 2001 to see and discuss the service arrangements for the assessment of occupational exposure due to external sources of radiation and due to intakes of radionuclides. Persons met at NPPK were Mr. B. Breznik and Mr. M. Priatelj.

4.10. The detailed findings will be found in Annex 4 (external radiation) and Annex 5 (intakes), and the recommendations are summarized in Section 5.

Visit to Nuclear Medicine Department at UCCL

4.11. Mr. Van Dijk and Mr. Cruz Suárez met with Dr. M. Grmek on the morning of Thursday 5 July to see and discuss the service arrangements for the assessment of occupational exposure due to intakes of radionuclides.

4.12. The detailed findings will be found in Annex 5 and the recommendations are summarized in Section 5.

Visit to Institute of Occupational Safety

4.13. Mr. Van Dijk, Mr. Dobis and Mr. Cruz Suárez visited IOS on the morning of 5 July to see and discuss the service arrangements for the assessment of occupational exposure due to external sources of radiation. The detailed findings will be found in Annex 4 and the recommendations are summarized in Section 5.

4.14. Mr. Hudson and Mr. Prouza visited IOS on the afternoon of 5 July to discuss arrangements for the provision of technical services other than personal monitoring. The findings have been generally absorbed within the text of this report.

VISITS TO PRACTICES (USERS OF RADIATION)

[The visits were focused on gaining information for Questionnaire No.4 – see Section 2.2].

Visit to Krško Nuclear Power Plant

4.15. Mr. Dobis, Mr. Van Dijk and Mr. Cruz Suárez (partially) visited NPPK on 3 and 4 July to perform an appraisal of the occupational radiation protection provisions at the plant. They met with Messrs. I. Grlicev, B. Breznik, T. Sutej, D. Nikic, M. Pavlin and F. Pribozic. The detailed findings will be found in Annex 6 and the recommendations are summarized in Section 5.

Visit to Slovenian National Building and Civil Engineering Institute (SNBCEI)

4.16. Mr. Hudson and Mr. Prouza visited SNBCEI on the afternoon of 3 July to undertake an appraisal of the occupational radiation protection provisions at the institute. They met with Mr. S. Ziberna, the Radiation Protection Officer. The detailed findings will be found in Annex 7 and the recommendations are summarized in Section 5.

Visit to the Department of Nuclear medicine at UCCL

4.17. Mr. Hudson and Mr. Prouza visited the Department of Nuclear Medicine at UCCL on the morning of 4 July to undertake an appraisal of the occupational radiation protection provisions in the department. They met with Prof. S. Hojker and Mr. M. Grmek. The detailed findings will be found in Annex 8 and the recommendations are summarized in Section 5.

Visit to the Departments of Radiology and Cardiology at UCCL

4.18. Mr. Hudson and Mr. Prouza visited the Departments of Radiology and Cardiology at UCCL on the afternoon of 4 July to undertake an appraisal of the occupational radiation protection provisions in the department. They met with Prof. V. Jevtic and Messrs. I. Kocijancic, A. Nincevic and M. Kofjac. The detailed findings will be found in Annex 9 and the recommendations are summarized in Section 5.

Visit to the Institute of Oncology

4.19. Mr. Hudson and Mr. Prouza visited the Institute of Oncology on the morning of 5 July to undertake an appraisal of the occupational radiation protection provisions in the department. They met with Messrs. B. Casar, J. Marolt and T. Verk. The detailed findings will be found in Annex 10 and the recommendations are summarized in Section 5.

EXIT BRIEFING

4.7. The exit briefing was held on the afternoon of Friday 6 July and was attended by representatives of most of the organizations that had been involved in the mission.

4.8. The meeting consisted of an informal presentation, by the team leader, of the appraisal team's preliminary conclusions and recommendations, followed by an open discussion.

4.9. The presentation was similar in content to the final conclusions and recommendations that appear in Section 5 of this report.

5. CONCLUSIONS AND RECOMMENDATIONS TO THE REPUBLIC OF SLOVENIA

CONCLUSIONS

5.1. The appraisal team concluded that many provisions were worthy of special merit, and those relating to specific visits will be found in Annexes 3 to 10. Provisions that were more generally applicable to the Republic of Slovenia's approach to occupational radiation protection were considered to be:

1. the high presentational standards that were found throughout all visits, giving the impression of good management control of quality of the work;
2. the 'good feeling' of general co-operation that pervaded all meetings, giving the Impression that everyone was working together as a team with similar objectives;
3. the widespread international connections at both a personal level and in terms of participation in committees. The appraisal team concluded that this was probably the main reason why, at a practical level, occupational radiation protection was considerably more advanced in its approach than the relatively out-dated current legislation in Slovenia. The appraisal team believes that this reflects great credit on the personnel involved in occupational radiation protection;
4. the high level of widespread compliance with the current legislative requirements in the Republic of Slovenia;
5. the organization of the week of the mission was very efficient in all respects – from the administrative arrangements (e.g. transportation) to the thorough preparation of all involved in the visits;
6. finally, the superb hospitality shown to the appraisal team throughout the mission.

5.2. Notwithstanding the above, the appraisal team makes the recommendations that follow below as an aid to further strengthening the occupational radiation protection arrangements in the Republic of Slovenia.

RECOMMENDATIONS

5.3. ***[See section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]***

5.4. The appraisal team has made recommendations relating to each of the visits and these will be found in Annexes 3 to 10. The recommendations that are more generally applicable to the Republic of Slovenia's provisions for occupational radiation protection are listed below:

1. The Republic of Slovenia urgently needs new legislation to reflect both the requirements of the BSS and the requirements of the current, relevant EU Directives (although the latter are not strictly the focus of this mission). The appraisal team wishes to emphasize, again, that current occupational radiation

protection practice in Slovenia is rather better than the current legislation. ***[Essential]***

2. The Republic of Slovenia urgently needs new mechanisms either for approving or for setting appropriate standards that must be met by:
   — dosimetry services, for the assessment of occupational exposure to external sources of radiation and due to intakes of radionuclides;
   — calibration/testing services for radiation protection survey instruments for the measurement of dose rate and radioactive contamination;
   — the providers of training courses. ***[Essential]***
3. The entire irradiation and radiation standards system at IJS should be converted to the current ICRU operational quantities and irradiation conditions should comply to ISO 4037-1, -2 and -3. This includes radiation qualities or sources, geometry, use of build-up sheets and conversion coefficients. ***[Essential]***

4. The Republic of Slovenia urgently needs a national disposal route and a depository for radioactive waste. A facility is currently available but at the time of the mission was under renovation and therefore operable only for cases of intervention. It should be commissioned at the earliest opportunity. ***[Essential]***

5. Service providers should be instructed to commence the testing of sealed radioactive sources for leakage of radioactive material (often known as *leakage testing*), without awaiting the implementation of new legislation. ***[Important]***

6. HIRS requires additional qualified inspectors if they are to adequately fulfil all their statutory roles. *[Important]*
7. The Institute of Oncology urgently requires additional qualified physicists, with particular reference to their patient care responsibilities. *[Important*
8. The proposed new legislation should place greater responsibility at the level of the users of radiation, with particular reference to:

— overall responsibility for radiation protection and safety;
— design and ongoing surveillance of the radiation protection programme;
— application of the principles of optimization;
— operational decisions in both the short and longer term;
— workplace monitoring; and
— development of a safety culture. *[Advised]*

Appendix I
ORGANIZATIONS TAKING PART IN THE MISSION – WITH CONTACT DETAILS

I.1. REGULATORY AUTHORITIES

Slovenian Nuclear Safety Administration (SNSA)
Vojkova 59
1000 Ljubljana
Tel: 01 - 47 21 100
www.sigov.si/ursjv/uvod.htmlanguage=iso2

Health Inspectorate of the Republic of Slovenia (HIRS)
Parmova 33
Ljunljana
Tel: 01 - 43 62 298
www.gov.si./mz/

I.2. SERVICES PROVIDERS

Institute Jozef Stefan (IJS)
Jamova 39
1000 Ljubljana
Tel: 01 – 47 73 900
www.ijs.si/

Institute for Occupational Safety (IOS)

Bohoriceva 22a
1000 Ljubljana
Tel: 01 – 43 20 253
www.zvd.si/

Nuclear Medicine Department of the University Clinical Center Ljubljana (UCCL)
Zaloska 2
1000 Ljubljana
Tel: 01 – 54 31 458
www2.kclj.si/

Nuclear Power Plant at Krško (NPPK)
Vrbina 12
8270 Krško
Tel: 07 – 48 02 000
www.ne-krsko.si/

I.3. PRACTICES

Institute of Oncology
Zaloska 2
1000 Ljubljana
Tel: 01 – 43 14 225
www.onko-i.si/

Nuclear Medicine Department of UCCL
As A1.2 (c) above

Institute of Radiology at UCCL
Zaloska 2
1000 Ljubljana
Tel: 01 – 54 31 530
www2.kclj.si/

Institute of Cardiology at UCCL
Zaloska 2
1000 Ljubljana
Tel: 01 – 23 02 455
www2.kclj.si/

Slovenian National Building and Civil engineering Institute (SNBCEI)
Dimiceva 12
1000 Ljubljana
Tel: 01 –28 04 250
www.zag.si/eng/index.html

Appendix II
APPRAISAL TEAM DETAILS (FIG. 1)

II.1. TEAM LEADER – EXPERIENCED IN OCCUPATIONAL RADIATION PROTECTION

A. P. HUDSON — Team Leader

Mr. Hudson obtained a special honours degree in Physics at the University of Bristol in 1961. He commenced work as a trainee health physicist in the Health Physics and Safety Department at the then United Kingdom Atomic Energy site at Windscale (now British Nuclear Fuels at Sellafield). In 1964 he moved to the Radiological Protection Service (RPS) of the Medical Research Council, initially at Sutton in Surrey but soon moving to the newly formed Leeds Regional Centre as deputy to the Regional Physicist. Early work was concerned with establishing a range of radiation protection services, including film badge monitoring, workplace surveys and advice, instrument testing, leakage testing of sealed sources and training courses.

In 1971 the Leeds Regional Centre of the RPS became the Northern Centre of the newly formed National Radiological Protection Board (NRPB). Mr. Hudson became Head of the Northern Centre in 1976. In 1999 he took new responsibilities as co-ordinator of radiation protection services across the whole of NRPB.

For over 40 years, Mr. Hudson has been involved in providing and managing a full range of technical radiation protection services and advice principally to users of ionizing radiation in industry, medicine, research and teaching, but also with peripheral contacts in the nuclear industry. This has provided the opportunity to play an significant role in applying practical experience to the development of national and international standards. In the early 1970s he was responsible for development of a postal based technique for evaluating radiation protection in dental surgeries. In the early 1980s he was heavily involved in the development of the NRPB's Radiation Protection Adviser Service. By the 1990s a special interest was the application of the principles of Optimization to operational, occupational radiation protection.

Since 1985, Mr. Hudson has been regularly involved in work with the IAEA, including the drafting of reports concerned with occupational exposure, lecturing commitments and participation in the development and operation of the model project. The latter has involved peer reviews in a number of countries.

Mr. Hudson is a member of the Society for Radiological Protection (SRP) and is secretary of the SRP's Qualifications and Professional Standards Committee. He is also secretary of RPA 2000, a company that provides a certification service for radiation protection advisers.

II.2. SPECIALIST WITH REGULATORY BACKGROUND

Z. PROUZA — Team Member

Mr. Prouza was educated at the Faculty of Nuclear and Physical Engineering, the Czech Technical University Prague 1957-62 (Dipl. Ing) and at the Biophysical Institute of Faculty of General Medicine, Charles University Prague 1965-89 (PhD). He has membership of The Czech Medical Society J. E. Purkyne, and The Czech Radiation Protection Society.

As Deputy Chairman for Radiation Protection at the State Office for Nuclear Safety, he is an expert in the field of dosimetry and radiation protection. He has been particularly involved with dosimetric experiments at the Joint Nuclear Research Institute, Dubna, Russia. Work with the IAEA has included missions to Ukraine, Armenia, Uzbekistan, Kazakhstan, Lithuania and Estonia, including Peer Reviews of the regulatory structure in some of these countries.

His professional appointments have been at:

- Veterinary Research Center Prague (1963 – 1968), working on Radiobiological Dosimetry and Internal Contamination;
- Biophysical Institute of the Faculty of General Medicine, Charles University Prague (1968 – 1989), where he was a research worker in the fields of Neutron (Accidental) Dosimetry, Activation Analysis and Radiation Protection (evaluation of exposure);
- Center of Radiation Hygiene Prague (1989 – 1995), where he was Deputy Director involved with Radiation Protection (monitoring networks, evaluation of exposure, ALARA programs, emergency planning);
- State Office for Nuclear Safety Prague (1995 – present), where he is Deputy Chairman for Radiation Protection involving Radiation Protection (legislation, licensing process, evaluation of exposure, ALARA programs, emergency planning, decision making).

Some 150 papers have been produced, including presentations on National and International Conferences. During the last three years these have included:

- Prouza, Z., Stuller, J.: Czech Republic Regulatory Framework for ALARA, Training Workshop on Implementation of ALARA in NNP Operation, Vienna, 22-23 April 1998;
- Prouza, Z.: Radiation Protection, IAEA Regional Training Course on Safety of Research Reactor, NRI

Rez plc, Czech Republic, 28 Sept. – 16 Oct. 1998;
- Prouza, Z.: Radiation Protection Aspects of the Trafficking Radionuclides Contaminated Metal Scrap, Workshop on Radioactive Contaminated Metallurgical Scrap, Prague, 26-28 May 1999;
- Prouza, Z., Petrova, K.: Objectives for Individual Monitoring, IAEA Regional Training Course on Design, Implementation and Management of Individual Monitoring Programme, Prague, 14-25 June 1999;
- Prouza, Z. NPP Temelin - Severe Accidents, Czech Republic - Austria - Melk Agreement, Hearing, Vienna, 26 June 2001.

II.3. SPECIALIST IN EXTERNAL PERSONAL DOSIMETRY

J. VAN DIJK — Team Member

Mr. van Dijk was educated at the Faculty for the Natural Sciences at the State University of Leiden (1963-1971) and obtained his PhD at the University of Nijmegen in 1978. After a research position at the Institute for Dental Research of the Dutch Organization for Applied Scientific Research (TNO), he took responsibility for the Individual Monitoring service of the same organization. In January 2000, the institute running the Individual Monitoring Service became part of the Nuclear Research and Consultancy Group (NRG). Since its establishment in 1989, the Individual Monitoring Service has operated the National Dose Registration and Information Service on behalf of the Ministry for Social Affairs and Employment.

Mr. van Dijk has published several papers on TLD glow curve analysis and on the performance and the QA and QC of TLD systems. He regularly participates in International Solid State Dosimetry conferences and is currently a member of the ISSDO. Recently he participated, as one of the co-ordinators, in the EURADOS working group on 'Harmonization and Dosimetric Quality Assurance in Individual Monitoring for External Radiation'. Currently, he chairs the second EURADOS working group on individual monitoring.

Mr. van Dijk was involved in the preparation of the questionnaires for the current IAEA Appraisal Service.

II.4. SPECIALIST IN THE NUCLEAR POWER INDUSTRY

L. DOBIS — Team Member

Mr. Dobis graduated (in 1979) from the Faculty of Nuclear and Physical Engineering in Prague, having studied Dosimetry. He commenced work with the Bohunice Nuclear Power Plant. He started as a radiation protection technician at V1 NPP and after one year he changed to V2 NPP. In 1987 he became a Head of RP section at V2 (2 Units VVER 440 MW_e) and since 1996 he has been in his present position as the Head of RP Department for whole Bohunice NPP site. He has responsibility for radiation protection at two different NPP (V1 and V2) with four VVER reactors. This includes dosimetry (external & internal), radiation protection monitoring systems, gas and liquid effluent monitoring including the spectrometry

and counting laboratories, calibration facility, laundry, cloak rooms and environmental monitoring.

He has participated, as a radiation protection reviewer, in 4 WANO Peer Review Missions (Koeberg NPP, Balakovo NPP, Paks NPP, Kalinin NPP) and in three OSART missions (Ulchin NPP, Laguna Verde NPP, Kozloduy NPP).

Mr. Dobis worked for the IAEA as an expert for the preparation ALARA training material in Russian and also for the modification of the OSART Guidelines. He is national co-ordinator for IAEA project RER/9/048 and also for ISOE activities in Slovakia.

On several occasions he has lectured at international and national undertakings (IAEA Regional Workshop on Implementation and Management of ALARA in NPP Operation, national ALARA workshops, etc.). He has organized several national and international meetings and workshops on radiation protection.

Mr. Dobis is a member of the Slovak Nuclear Society.

II.5. IAEA CO-ORDINATOR AND SPECIALIST IN INTERNAL DOSIMETRY

R. CRUZ SUAREZ — Team Member

Mr. Cruz Suárez graduated (in 1986) as Nuclear Engineer from the Faculty of Nuclear and Physical Engineering in Prague, having studied Dosimetry and Application of Ionizing Radiation. He commenced work at the High Institute for Nuclear Science and Technology in Havana, Cuba, teaching physics, nuclear safety and radiation protection.

In 1990 he moved to the Center for Hygiene and Radiation Protection in Havana, Cuba, as Head of the Individual Surveillance Department. His main tasks were related to the organization and control of the Personnel Monitoring Services (external and internal dosimetry at national level) and in the Radiological Protection Evaluation Section. During this period he also co-ordinated the dosimetric and biomedical studies conducted in Cuba of children from areas of the former USSR affected by the radiological consequences of the Chernobyl

accident.
Mr. Cruz Suárez has a Master of Science degree in Nuclear Engineering from the Technical University of Prague and a Master of Science degree in Nuclear Physics from the University of Havana.
Since 1996, Mr. Cruz Suárez has worked at the IAEA with the Radiation Monitoring and Protection Services Section. His main tasks are to carry out the occupational monitoring of the IAEA staff, safety missions and TC experts by means of external dosimetry, whole-body counting and bioassay techniques. He participates in the preparation of safety publications related to occupational protection and assists IAEA Member States in the implementation of the technical co-operation programme in the field of occupational radiation protection. He is a co-ordinator of an Agency project on harmonization of radiological quantities, which includes several intercomparison exercises for the techniques used in individual monitoring and exposure assessment. Currently he is the Agency liaison officer with the ISO for radiation protection issues.
Mr. Cruz Suárez is a member of the Cuban Physics Society, the International Radiation Protection Association (IRPA), the Society for the Promotion of Quality Control in Medical and Radiotoxicological Analysis. (PROCORAD) and the Health Physics Society (HPS). He participated in different advisory bodies at national and international level: Advisory Council for Radiological and Nuclear Safety at the Executive Secretariat for Nuclear Affairs (Cuba), Advisory Group for the preparation of IAEA safety publications on occupational monitoring. He is a Member of the IAEA Emergency Response Teams and participated in several response missions.
Mr. Cruz Suárez has published a number of papers related to individual monitoring and exposure assessment. He has participated in several international conferences covering radiation protection and nuclear safety issues. He has organized several national and international training courses and workshops on individual monitoring within the frame of the IAEA technical co-operation programme.

Mr. Cruz Suárez was involved in the design and organization of the Occupational Radiation Protection Appraisal Service and the co-ordinator of this mission.

FIG. 1. Members of the Appraisal Team. Left to right: Mr. Z. Prouza, Mr. A.P. Hudson (Leader), Mr. L. Dobiš, Mr. J. Van Dijk, Mr. R. Cruz-Suárez (IAEA).

Appendix III

DETAILED FINDINGS: OCCUPATIONAL RADIATION PROTECTION PROGRAMME – REGULATORY AND MANAGEMENT ASPECTS

[Based on Questionnaire No. 1]

III.1. LEGISLATION - ACTS AND REGULATIONS

Criterion

Each country shall establish and maintain a legislative and regulatory framework for nuclear safety and radiation protection.

Findings

Comprehensive information was provided on the legislative framework in the Republic of Slovenia for nuclear and radiation safety, which comprises Acts and related Regulations (Fig. 2). For historical reasons, the legislation currently in place in Slovenia has evolved from the former Yugoslavia legislation. Since independence of the Republic of Slovenia in 1991, the legislation ensured continuity of the legal system by adopting all federal Acts in so far they could be applied to Slovenia.

A list of the Acts and Regulations covering nuclear safety and radiation protection currently in force in the Republic of Slovenia is given at the end of this annex. Act (A1) of 21 November 1984 on *Radiation Protection and the Safe Use of Nuclear Energy* (Off. Gaz. SFRY 62/84) is the most important of these documents; it is based on the principles of radiation protection presented in ICRP Publication 26 (1977).

Act (A1) requires particular measures to be taken, including***:***

Detection and monitoring of the presence, type and level of radiation and contamination. Definition of the conditions for different types of practice. Specific conditions are given for nuclear and uranium industry facilities, including those for siting, construction, operation, decommissioning and physical protection (details are given in the Sections 28—45, 57—59).

The applicant for a construction licence is obliged to attach, during the licensing process, technical documentation for construction including:

— the ***safety report***, which should contain information on the plant and its impact on the environment;

— the ***project description*** including analysis of the design accident and risks for the workers and people;

— he ***monitoring programme*****,** for monitoring releases of radionuclides from the plant and for monitoring the surrounding environment (specific provisions for individual and workplace monitoring are given in Regulation Z6 for all type of practice);

— arrangements for the ***disposal*** and safety of rad-waste.

The applicant for a commissioning licence is obliged to provide the results of successfully performed ***pre-operation tests*** and evidence of the ***quality*** of the installed equipment and material (Section 33).

The licence should be issued only if the management of the work with radiation sources complies with the technical, health, and other requirements for environmental protection from radiation and contamination (Section 15), namely:

— ***registration and recording*** of sources in use and of the exposure of radiation workers and the public;

— ***limitation*** on the production, distribution and use of products and raw materials that are contaminated by radionuclides;

— ***management*** of nuclear material and rad-waste (Section 46 – 56, 57 – 59);

— ***protection*** of workers and the public (provision of measuring and protective equipment, devices, etc.);

— ***emergency preparedness and implementation*** of protective countermeasures during accident situations;

— ***health examination*** of radiation workers (health requirements are prescribed for persons working with sources – Section 15-17, Regulation Z5);

— ***education and training*** of radiation workers.

Special sections of Act (A1) are aimed at:

— ***limitation*** of occupational exposure (the requirements include the prohibition of work with sources for persons younger than 18 years and for pregnant women); however, the principle of ***optimization is not included in the Act, but does appear in Z6 (occupational) and Z7 (medical)***;

— ***notification*** of all occasions when dose limits are exceeded;

— ***surveillance and competent authorities*** (Sections 60 – 69);

— ***penal provisions*** (Sections 70 – 75).

Act (A1) places obligations on applicants or licensees to:

— provide workers with personal dosimeters and protective devices (and to ensure the testing of their accuracy and proper use) — Section 21;

— take measures for the protection of workers (including medical examination, or treatment if necessary) — Section 21;

— record and notify specified occurrences, including exposure of workers, shipment of sources, unusual events, accidents — Sections 26 – 27.

FIG. 2. Mission meeting with the counterparts.

Conclusions

The appraisal team is of the opinion that, at present, Act (A1) and related legislation provide basic empowerment to the national authorities with responsibility for regulating radiation and nuclear safety. In particular, a system of licensing and authorization based on the current legislation is functioning in the Republic of Slovenia.

However, there are many lacks and deficiencies in Act (A1), principally because it relates back to ICRP Publication 26 (1977). In particular, the proposed new legislation in Slovenia will need:

a. to establish a new system of dose limitation;

b. to implement the principle of optimization of radiation protection in all practices, including medical exposure;

c. to require the implementation of QA/QC programmes in daily practice, especially in the medical sector;

d. to place clear obligations on registrants and licensees, depending on factors such as the type of practice and the categorization of sources and workplaces;

e. to declare clear and unambiguous licensing and registration conditions;

f. to include requirements for the categorization of workers undertaking intervention;

g. to implement a system of exposure registration for 'outside workers' (contractors).

Recommendation:

[See section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The Republic of Slovenia has advanced plans for the introduction of new legislation for radiation protection and nuclear safety. This new legislation is intended to conform to the requirements and recommendations of both the BSS and the relevant European Directives. These, in turn, relate to ICRP Publication 60 (1991).

The appraisal team strongly recommends that:

1. the new Act and associated legislation should be finalized, adopted and implemented at the very earliest opportunity ***[Essential]***. The twelfth draft of the proposed new Act has been reviewed by Mr. Prouza and he has commented that it appears to him to be acceptable. However, the appraisal team concluded that it was not within their remit to make formal comment on what is still only a draft of proposed new legislation ***[Essential].***

2. the Republic of Slovenia should consider whether or not it requires formal IAEA advice once agreement has been reached as to the content of their final draft of the new legislation ***[Advised].***

III.2. REGULATORS

Criterion

The legislation shall provide effective empowerment to the regulatory authority, and regulations shall implement the *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources* (BSS).

Findings

Two national regulatory authorities discharge regulatory control of peaceful uses of nuclear energy and practices involving radiation sources:

— The Slovenian Nuclear Safety Administration (SNSA) of the Ministry for Environment and Regional Planning (MERP); and

— The Health Inspectorate of the Republic of Slovenia (HIRS) of the Ministry of Health (MH).

The SNSA is authorized by legislation as the regulatory authority for nuclear safety and radiation protection in nuclear installations. The SNSA is responsible for the regulation of handling, trade and transport of nuclear and radioactive material, safeguards of nuclear material, physical protection of nuclear installations and material, and liability for nuclear damage. It is responsible for co-ordination of territorial radiological monitoring, early notification in the case of a nuclear or radiological accident and international co-operation in that field. The SNSA was empowered to license operators of nuclear installations, to inspect, and to approve QA programmes and other documentation.

HIRS is also authorized by legislation as the regulatory authority for radiation protection for practices in industry, medicine, research and teaching. It is responsible for the evaluation, licensing, authorization and inspection of radiation practices introducing sources of exposure or exposure pathways; it has appropriate enforcement powers. It also performs inspections outside nuclear installations related to the safe use, transport and storage of radioactive sources and material. It plays an active role in civil emergency plans for responding to nuclear and radiological emergencies.

The authorization of twin regulatory authorities in the Republic of Slovenia has a historical background and relies upon co-ordination and co-operation between the two authorities.

The reviewers were informed that, in practical terms, the SNSA has enough effective independence from MERP and other national agencies to fulfil its role as the regulatory authority on matters within its purview. There have been no cases of intervention by the Ministry to overrule or influence regulatory functions, decisions and/or enforcement action taken by the SNSA. However, a recent change has seen the energy sector (including the NPPK) integrated into MERP and this may warrant a review of whether or not the independence of the SNSA could be compromised. The necessary independence of HIRS is less clear as it is working under the Chief Inspector, who is responsible for occupational, traffic and sport medicine. It was, however, explained that, according to legislation, each HIRS inspector is professionally independent.

As technical support organizations, the Institute Josef Stefan (IJS) and the Institute of Occupational Safety (IOS) co-operate with the SNSA and HIRS and are authorized for the education and training of radiation workers and for the control of radioactive sources. They effectively have statutory functions within the current legislative system.

According to the Country Radiation and Waste Safety Profile (Dec. 2000), the number of radiation protection staff includes eight inspectors at the SNSA, three inspectors at HIRS, 20 experts at the IJS, and 14 at the IOS. About 13% of the staff are for administrative support. The appraisal team concluded that three inspectors within HIRS were insufficient to adequately fulfil the role expected and required of HIRS.

The Republic of Slovenia has established a national inventory of radiation sources and users, which is maintained by HIRS and the SNSA. More than 800 X-ray machines, three electron accelerators (in medicine), two particle accelerators (in research) and about 500 sealed sources are used in industry, medicine, research and teaching. About 40 enterprises work with unsealed radioactive material (including one for the interim storage of low and intermediate level rad-waste). The inventory has not been transferred to RAIS but another computer-based system is in operation. About 99% of sources are currently believed to be included in the inventory (except smoke detectors and low activity calibration sources). Both HIRS and the SNSA are giving priority to the need to complete the inventory of sources.

External individual monitoring in Slovenia seems to be well established. It is provided to 4500 workers from about 500 enterprises by three different organizations. It is believed that about 99% of occupationally exposed workers are monitored for external exposure.

There is currently no complete legislation for the control of medical exposure although this is partially addressed in Z7 and Z10. There are about 680 X-ray diagnostic devices in about 150 medical institutions around the country. An IRRT mission in 1999 recommended that the Republic of Slovenia should establish a programme to determine typical patient doses from diagnostic radiological and nuclear medicine procedures. HIRS has started a pilot research programme, which aims to determine the reference values for the most frequently used medical exposures.

Conclusions

The ***appraisal team*** concludes that:

— radiation sources in the country are under control and radiation practices are generally in compliance with the current (admittedly outdated) legislation;

— the national registry of sources is operating satisfactorily;

— a system of regulation of occupational exposure exists;

— both regulatory authorities, the SNSA and HIRS, make use of their enforcement powers for ensuring compliance with regulatory requirements.

Recommendations

[See section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. present human resources should be reviewed with a view to ensuring optimal distribution of radiation protection specialists across the involved organizations, with particular reference to providing adequate numbers of inspectors. ***[Advised]***

2. in implementing new legislation in the Republic of Slovenia, thought should be given to the establishment of a single authority for radiation protection and nuclear safety, combining the present roles of the SNSA and HIRS. The independence of operation of the new regulatory authority(ies) should be effectively ensured. ***[Advised]***

III.3. RESPONSIBILITIES OF REGISTRANTS, LICENSEES AND EMPLOYERS

Criterion

The authorization system functions so that radiation source practices are likely to be safe and in compliance with regulatory requirements.

Findings

The current legislation of the Republic of Slovenia has no definition of registrant and licensee, and requires that all sources be licensed. Similarly, all facilities require to be licensed. This process can place a large work burden on staff in HIRS and the SNSA. However, the appraisal team was informed that technical support could be provided during the licensing process by the IJS and the IOS to review specific applications and carry out related safety assessment tasks. Relevant documentation was made available to the reviewers, including copies of licences issued by HIRS. Types of licences are not specified in Act (A1), but priorities can be set during the licensing process to reflect the degree of radiological hazard of a given practice. Similarly, policies, procedures, and arrangements are established in Act (A1) on only a general level, but specific requirements (e.g. with priority given to design) can be implemented during the licensing process. Adequate facilities, equipment and services, commensurate with extent of exposure, are specified for important sources (NPP, UCCL, Institute of Oncology). Protective devices and monitoring equipment are generally prescribed by Law and so become the responsibility of the employer. Maintaining records is not required by Law, except for medical and dose records.

During the mission, it was noted that in several organizations (KNPP, UCCL, Institute of Oncology), radiation protection practice was based more closely on the principles of ICRP Publication 60 rather than the current legislation. This appeared to work well but was lacking in some respects because it did not have the backing of the legislation.

Recommendations

The appraisal team considers that recommendations in this area would be inappropriate until new legislation has been implemented.

III.4. DOSE LIMITS, OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES, RADIATION PROTECTION PROGRAMMES

Criterion

Dose limits should be determined and interpreted in the quantities given in the BSS, and should be assessed by requirements given in the BSS.

The principle of optimization of radiation protection should be implemented in all practices.

Findings

The system of dose limitation is based on requirements of ICRP Publication 26 (1977), but does not include specific requirements related to the principle of the optimization of protection. As such, it varies in many important details from what is needed to meet the requirements and recommendations of ICRP Publication 60. In some instances, the current legislation is more restrictive.

Occupational doses in the uranium industry are controlled. Also, on the basis of the national surveillance programme, radon exposure has been evaluated in selected workplaces (kindergarten, schools, caves, non-uranium mines). Where radon concentrations of 1000 Bq/m^3 are reached, the workers (teachers, guides, miners) are placed under control and remedial actions are enforced by HIRS. Their occupational exposures are evaluated (through workplace monitoring), and the monitoring of internal exposure is carried out according to licence requirements.

The legislation requires that the assessment of occupational exposure provided by approved dosimetric services and workplace monitoring be ensured by the user (licensee) and by technical support organizations. In the case of an overexposure, it is the responsibility of the approved dosimetry service to report this to the appropriate regulatory authority. The appraisal team was informed that in some cases, monitoring and evaluation of radionuclides released into environment is not of an adequate standard.

The specific requirements for individual and workplace monitoring are given in Regulation Z6 for all types of practice. The monitoring programmes are based on reaching specified intervention levels (e.g. surface activity of 400 kBq/m2, and worker doses of 20 mSv/year). The regulatory authority may specify different conditions under which it requires measurements to be made.

Conclusions

The appraisal team concludes that:

A system for the regulation of occupational exposure exists and is functioning. It is the joint responsibility of the users of sources and the approved dosimetry services to ensure the adequacy of operation.

All radiation workers are subject to individual monitoring.

Recommendations

The appraisal team considers that recommendations in this area would be inappropriate until new legislation has been implemented.

III.5. TECHNICAL SUPPORT ORGANIZATIONS

Criterion

Appropriate and effective technical support organizations are available to both the users of radiation sources and to the regulatory authority.

Findings

Note that technical support in relation to occupational monitoring is not a part of this Annex, but is covered in Appendices IV and V.

Technical support to users of radiation sources and to the regulatory authorities is provided by the IJS and the IOS, and also by KNPP but principally only in relation to its own plant. These services relate to most aspects of radiation protection advice and to the provision of training and other services, including calibration services, workplace and environmental monitoring, and QA/QC programmes. Leakage testing of sealed radioactive sources is not provided, probably because it is not required by the current legislation.

The appraisal team was informed that HIRS plans to improve the control of medical exposure in the future. At the larger medical facilities (UCCL, Institute of Oncology) some QA/QC programmes for medical sources and exposures exist and are functioning. However, monitoring of the basic parameters of all existing X-ray devices is not yet established. Instrumentation is needed for this purpose. The IJS and the IOS appear to have the capabilities and expertise needed to support regulatory authorities in this process.

The Appraisal Team was not able to evaluate exposure to environmental radon, but was informed that three institutions assess doses related to radon exposure (Zirovski Vrh Uranium mine, IJS and IOS).

Conclusions

The IJS and the IOS would appear to have the necessary expertise, equipment and resources to be able to provide appropriate and effective technical support services and to be able to extend this support rather further than is currently required by the current legislation.

Recommendations

The appraisal team considers that positive recommendations in this area would be inappropriate until new legislation has been implemented.

III.6. TRAINING

Criterion

The regulatory authority has a programme for information and training of workers.

Findings

A national system of training for workers exists at an appropriate level. The IJS and the IOS provide training for workers and it is based on requirements given in the Regulation Z5 (based on Act A1) and in the Regulation Z12 (based on Act A2). This includes both initial training before commencing work with radiation sources and periodic retraining. There are differing levels of training depending on individual workers' levels of responsibility.

Recommendations

None.

III.7. INTERVENTION IN EMERGENCIES

Findings

The basic organizational and technical requirements for emergency situations are given in Act A1, A17, Regulation Z9 and Regulation Z14. A notification centre has been established at the Administration for Rescue and Disaster Relief and the rescue and disaster relief plans of the competent planning bodies have been harmonized. The emergency plans regulate the notification procedure and the activities of responsible organizations in order to fulfil their functions in the event of nuclear emergency.

The appraisal team was not able to evaluate whether the Regulatory Authorities have established investigation procedures for incidents and accidents, including the review of documentation and follow-up procedures for such cases.

The Appraisal Team obtained information that a system for specialized medical care of irradiated workers is formally established. The decontamination facilities are at the Krško NPP, including the special decontamination 'bath tub' for the decontamination of injured persons (persons who must be lying in a horizontal position). For

the injured persons from the Krško NPP the contract between the Clinical Hospital Centre Rebro in Zagreb, Croatia, and the Krško NPP exists. This contract provides for the treatment of irradiated workers in case of a serious overexposure.

In 1998, an ad-hoc group prepared a set of *Criteria for Intervention in Case of a Nuclear and Radiation Accident.* These criteria were later proposed by an Expert Commission on Nuclear Safety for endorsement by the Director of the SNSA. These intervention criteria are included in the national radiological emergency plan. The criteria are in fact the transposition of the recommendations given in the IAEA SS-109, *Intervention Criteria in a Nuclear or Radiation Emergency.* For intervention workers the turn back dose guidance follows the IAEA-TECDOC-955, *Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident*. There are two tables: one for the dose limits of intervention workers (Table 6 – razpredelnica 6), the other for the external doses as the turn back guidance (i.e. reading displayed on an electronic dosemeter) (Table 7 – razpredelnica 7).

Recommendations

[See section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. Emergency plans should include limits and intervention levels and appropriate operational procedures, based on the principle of 'optimization of intervention' ***[Important].***

2. A system of specialized medical care should be established for overexposed workers and this should include a system for the categorization of workers involved in intervention ***[Advised].***

III.8. HEALTH SURVEILLANCE

Findings

Act (A3) and Regulation Z5 determine the rules for appropriate health surveillance, but the legislation does not precisely define the information data flow (confidential data). The dose records should be available to the physician in charge.

Recommendations

None.

III.9. LEGISLATIVE DOCUMENTS OF THE REPUBLIC OF SLOVENIA RELATED TO NUCLEAR SAFETY AND RADIATION PROTECTION

Act (**A1**) on Radiation Protection and the Safe Use of Nuclear Energy (Off. Gaz. SFRY, 62/84; 21 Nov. 1984),

Act (**A2**) on Implementing Protection Against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. RS, 56/99),

Act (**A3**) on Safety and Health at work (Off. Gaz. RS, 56/99),

Act (**A4**) on Standardization (Off. Gaz. RS, 59/99),

Energy Act (**A5**) (Off. Gaz. RS, 79/99, 8/00),

Act (**A6**) on Environmental Protection (Off. Gaz. RS, 32/93, 1/96),

Act (**A7**) on Administration (Off. Gaz. RS, 67/94),

Act (**A8**) on Administrative Procedure (Off. Gaz. RS, 80/99, 70/00),

Act (**A9**) on Mining (Off. Gaz. RS 56/99),

Act (**A10**): On Cessation of Exploration off the Uranium Mine (Off.Gaz.RS, 36/92,28/00),

Act (**A11**) on Post for which the Pension Insurance is Benefit (Off. Gaz. SFRY, 17/68,20/69,29/71),

Act (**A12**) on Health Inspection (Off. Gaz. RS, 99/99),

Act (**A13**) on Organization and Field of Activities of the Ministries (Off. Gaz. RS, 71/94,47/97,60/99),

Act (**A14**) on Third Party Liability for Nuclear Damage (Off. Gaz. SFRY, 22/78,34/79),

Act (**A15**) on Insurance of Liability for Nuclear Damage (Off. Gaz. SRS, 12/80),

Act (**A16**) on the Fund for Financing Decommissioning of the Krško NPP and Disposal of Rad-Waste from the Krško NPP (Off. Gaz. RS, 84/98),

Act (**A17**) on Protection against Natural and Other Disasters (Off. Gaz. RS, 64/94),

Regulations based on the A1, A2 related to the radiation protection and nuclear safety:

Z1: On Places, Methods and Frequencies of Monitoring of the Contamination with Radioactive Materials (Off.Gaz.SFRY,40/86),

Z2: On Mode, Extent, and Frequencies of Monitoring of Radioactive Contamination in the Surroundings of Nuclear Facilities (Off.Gaz.SFRY,51/86),

Z3: On Mode of Collecting, Accounting, Processing, Storing, Final Disposal and Release of Radioactive Waste into the Environment (Off.Gaz.SFRY,40/86),

Z4: On Trading and Utilization of Radioactive Materials Exceeding Certain Limits, X-ray Machines and Other Apparatus producing Ionizing Radiation as well as Measures for the Protection from Radiation of Such Sources (Off.Gaz.SFRY,40/86 and 45/89),

Z5: On Education, Health Conditions and Medical Examinations of Workers dealing with Ionizing Radiation (Off.Gaz.SFRY,40/86),

Z6: On Dose Limits of the Public and the Workers, Individual Monitoring of Workers and Workplaces (Off.Gaz.SFRY,31/89 and 63/89),

Z7: On Conditions for the Application of Sources of Ionizing Radiation for Medical Purposes (Off.Gaz.SFRY,40/86 and 10/87),

Z8: On Terms under which Drinking Water, Foodstuffs and Articles in Common Use May be Traded if they Contain Radioactive Materials Exceeding the Prescribed Limits of Activity (Off.Gaz.SFRY,23/86),

Z9: On Maximum Established Limits for Radioactive Contamination of the Environment and on Decontamination (Off.Gaz.SFRY,8/87 and 27/90),

Z10: On Mode of Keeping Records Accounting for Sources of Ionizing Radiation and Irradiation of the People and Workers (Off.Gaz.SFRY,40/86),.

Z11: On Mode and Frequencies for Keeping Records and for Reporting to the Regulatory body by the Authorized TSOs and by the Organizations Operating Nuclear Facilities (Off.Gaz.SRS,12/81),

Z12: On Education, Experience and Compulsory Qualification and Training of Personnel Working with Ionizing Radiation Sources or in Radiation Protection Services and on the Procedure of Verifying their Qualification (Off.Gaz.SRS,9/81),

Z13: On Siting, Construction, Commissioning, Start-up and Exploitation of Nuclear Facilities (with Appendix on QA) (Off.Gaz.SFRY,52/88),

Z14: On Preparation and Content of Safety Analysis Report and Other Documentation Relevant for the Assessment of Safety of nuclear Facilities (Off.Gaz.SFRY,68/88),

Z15: On Education, Experience, Examination and Certification of Personal Conducting Specific Work at the Nuclear Installation (Off.Gaz.SFRY,86/87),

Z16: On Material Balance Areas and the Mode of Keeping Records Accounting for Nuclear Raw Materials and Nuclear Materials as well as to the Submission of Data contained in Such Records (Off.Gaz.SFRY,9/88),

Z17: On Trade of Fodder (Off.Gaz.SFRY,6/88),

Z18: On Establishment of Public Agency for Rad-Waste Management (Off.Gaz.RS, 65/91,45/96,32/99,38/01),

Z19: On Establishment of the Amount of Limited Operator`s Liability for Nuclear Damage and on Establishment of the Amount Insurance for Liability for Nuclear Damage (Off.Gaz.RS, 84/98).

Appendix IV

DETAILED FINDINGS : ASSESSMENT OF OCCUPATIONAL EXPOSURE TO EXTERNAL RADIATION

[Based on questionnaire No. 2]

IV.1. INTRODUCTION

IV.1.1. Aspects common to all individual monitoring services

a. Legal requirements

The operation of the three individual monitoring services in Slovenia is based primarily on the good will of competent and motivated staff. There are no clear legal requirements for approval at present, but requirements are currently being drafted. Thus all questions in the questionnaire No.2 that contain phrases like "Do the requirements for …" should strictly have been answered with "No". However, in many cases the systems in operation do comply with the intended requirements. Therefore, in the detailed findings given below, reference to legal requirements has been omitted.

b. Dose registration

The individual monitoring services send their dose data to the national dose register operated by HIRS. The doses assessed by the nuclear industry are also sent to the central register at the SNSA.

c. Calibration

The calibration of the three dosimetric systems reviewed depends on the services provided by the SSDL operated by the IJS. From the visits to the three services, it became apparent that the conditions during the calibration irradiations did not comply with the relevant standards, ISO 4037-1, -2 and -3. In particular it is highly probable that the condition of electronic equilibrium is not satisfied. Consequently, there is a large uncertainty in the actual dose given to the dosemeters to be calibrated. (e.g. During the EURADOS 1998 inter-comparison, 17 different TLdosemeter types were exposed under non-equilibrium conditions resulting in responses ranging from 0.87 to 2.35 which, if used for calibration, could lead to a dose underestimation of more than a factor of two).

IV.1.2. Recommendations

[See section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

The calibration procedures of the three services should be modified such that they conform to the three standards ISO 4037-1, -2 and -3, in particular with regard to the use of the correct phantom, irradiation geometry, amount of buildup material, dosimetric quantities and conversion coefficients ***[Essential].***

IV.2. INDIVIDUAL MONITORING FOR EXTERNAL RADIATIONS SERVICE PROVIDED BY THE INSTITUTE JOZEF STEFAN (IJS).

IV.2.1. Introduction

The IJS acts as an approved dosimetric service, monitoring about 500 persons of whom 250 are IJS staff members. The dosimetric system, both the TLD reader and the TL dosemeters, is of their own development (Fig. 3). The dosimetric service operates as a largely independent unit within the IJS organization. The approval of the IJS is based on federal legislation of the former SRFJ.

IV.2.2. Dosimetric quantities

The dosimetric quantities for monitoring external radiation doses as recommended in the BSS are not used. For both individual and workplace monitoring photon dose equivalent (H_x) is used.

IV.2.3. Calibration

The calibration conditions are defined in procedure LMR-DN-24 and LMR-DN-25. The dosemeters contain CaF_2:Mn detectors of the IJS's own production. The sensitivity of each production batch is determined relative to that of a set of reference dosemeters. The calibration irradiations are done using a ^{60}Co source of which the dose rate is traceable to the IAEA Laboratory at Seibersdorf. Irradiations are free in air at 1 m from the source. The reference dose is 500 mSv (H_x). Fig. 4 shows the calibration facilities.

The detectors are filtered by approximately 3 mm plastic. The energy dependence of the response is corrected by applying a customer dependent correction factor. This factor, which is called the recalibration or energy quality factor, is based on the radiation qualities used by that customer.

IV.2.4. Type test and performance criteria

There are no type test results available. The type A uncertainty component due to batch inhomogeneity and calibration error is estimated to be 15%. From the dosemeter design (CaF_2:Mn detectors), it can be inferred that the type B uncertainty caused by the energy dependence of the response between 15 keV and 1.5 MeV photons will be such that the dosemeters will not meet the requirements (ICRP Publication 60 and IAEA Safety Guide RS-G-1.3, Chapter 4). It is unlikely that applying a correction factor based on the sources used by the user can sufficiently reduce the uncertainty due to the variability of workplace fields (ref. Ambrosi). The detection limit is stated to be of the order of 1 or a few μSv. Details of the dosemeter, the energy response correction and the detection limit are given in a paper presented at the YRPA meeting on Low Level Radiation Achievements, Concerns and Future Aspects of 1990.

IV.2.5. Pre-use, periodic and performance testing

There is no system for pre-use, periodic or performance testing in the sense of IAEA Safety Guide RS-G-1.3, Chapters 6 and 7. Incidental testing and recalibration is done, for example, after high dose measurements.

IV.2.6. Dose record keeping and reporting

The dosimetric service of the IJS is not a record keeping service. The responsibility rests with the user for linking the dose and dosemeter-identification to an individual. The measurement data are archived for 10 years, both in electronic form and as hard copy.

IV.2.7. Quality assurance

The operational procedures of the service are described in the following documents:

— DN 21 Issuing of dosemeters

— DN 22 Reading of dosemeters

— DN 23 Documentation and archiving of measurement results

— DN 24 Reader calibration and maintenance

— DN 25 Dosemeter calibration

All abnormal findings or results and customer complaints are to be reported to the head of the department and are archived in an annual report.

IV.2.8. Conclusions

The appraisal team concludes that the following provisions are worthy of special merit:

— Good housekeeping of the TLD laboratory is done by competent technicians*;*

— Well organized and, at the relevant locations, procedures and work instructions are readily available;

— A system of procedures and work instructions seems to be ready for integration into a QA system that can comply with ISO 9001 or 17025 and is maintained by a qualified and motivated member of staff.

Notwithstanding the above, the appraisal team concludes that the service at the IJS is currently failing to meet essential technical standards and makes the recommendations that follow as an aid to strengthening the occupational radiation protection arrangements.

IV.2.9. Recommendations

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. The dose should be assessed in terms of personal dose equivalent $H_p(10)$ and where relevant $H_p(0.07)$ ***[Essential*]***.

2. The calibration of the dosemeters should be based on ISO 4037-1, -2 and -3 (see Section A4.1.2) ***[Essential*]***.

3. The dosemeter should be type tested according to IEC 1066. The type test results should be compared with the criteria given in the standard ***[Essential*]***.

4. An analysis of the performance based on the Chapters 4 and 5 of IAEA Safety Guide RS-G-1.3 should be carried out ***[Important]***.

5. The results of type testing and performance analysis should be made available to the users ***[Advised]***.

6. The dosimetric system should be periodically re-evaluated according to ISO 14146 ***[Important]***.

7. A system of performance assessment should be put in place, as required by sections .14 to 9.16 of the HSE Safety Guide RS-G-1.3 ***[Important]***.

8. It is appreciated that the prioritization as ***Essential*** implies (from Section 2.4) immediate action, but that the above asterisked recommendations will inevitably take some time to implement. Nevertheless, the appraisal team is of the opinion that the recommendations are so fundamental that the ***Essential*** prioritization is the most appropriate in the circumstances.

FIG.3. TLD reader and dosemeters developed at Josef Stefan Institute and currently in use for personnel monitoring.

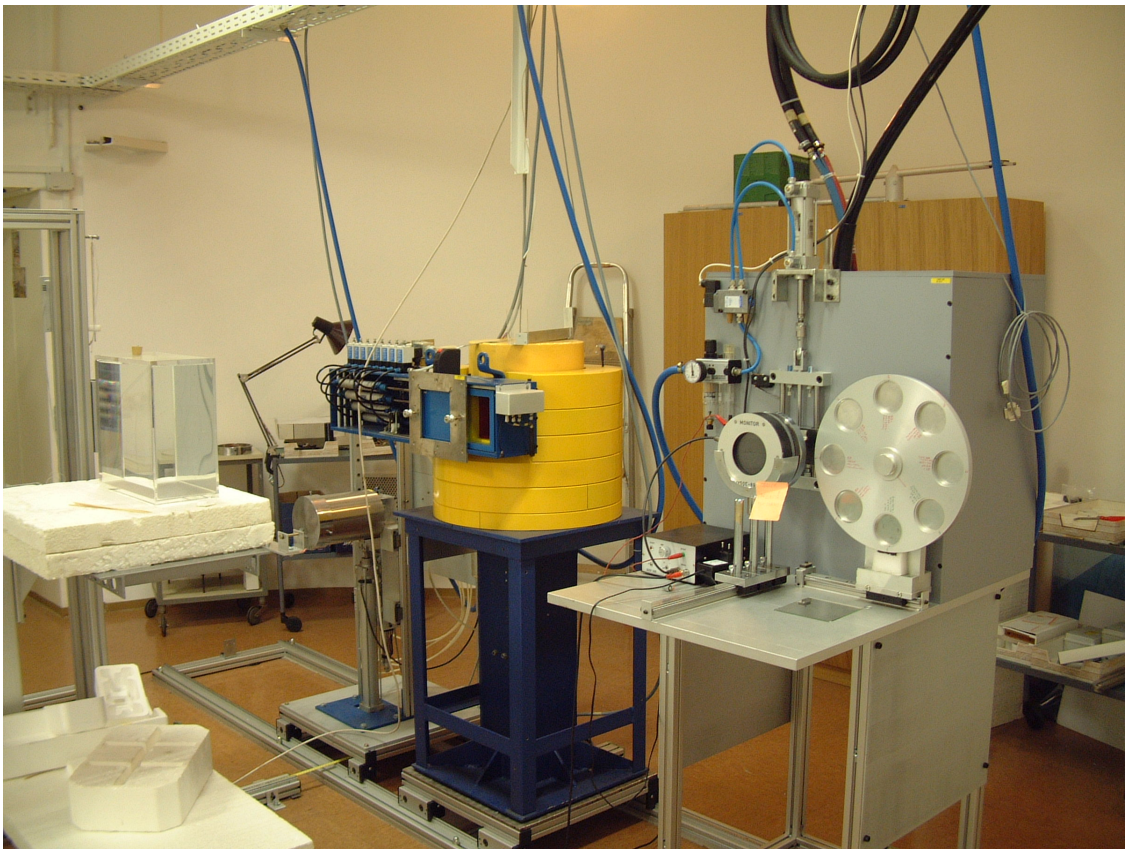

FIG.4. Calibration facilities at the SSDL, Josef Stefan Institute.

IV.3. INDIVIDUAL MONITORING FOR EXTERNAL RADIATION SERVICE PROVIDED BY THE KRSKO NUCLEAR POWER PLANT (NPPK)

IV.3.1. Introduction

The dosimetric service of NPPK acts as an approved dosimetric service providing individual monitoring for external radiation for NPPK personnel (approximately 350) and for contractors (approximately 630). The dosimetric system is based on RADOS hot gas TLD readers and RADOS TL dosemeters together with a RADOS irradiator. The service has no formal approval but has applied for approval. In view of the new legislation being drafted, the approval is pending.

IV.3.2. Dosimetric quantities

The dosimetric quantities for monitoring external radiation doses are personal dose equivalent, Hp(10) and $H_p(0.07)$, and ambient or directional dose equivalent, H*(10) or H'(0.07).

IV.3.3. Calibration

The calibration of the RADOS system is done by sending a set of reference dosemeters to the SSDL operated by the Institute Jozef Stefan (IJS) where they are irradiated with ^{60}Co to a predefined dose in terms of $H_p(10)$. With these readings of these dosemeters and a second reading after irradiation in the RADOS irradiator, a correction factor for the radiator is obtained. The doses measured at NEK are thereby traceable to the SSDL. However, the attached reports from the IJS reveal that the IJS does not follow the ISO 4037 standard conditions (see section A4.1).

Calibration of the albedo dosemeters is performed in-situ by reference to a Bonner sphere which is calibrated in the USA. For beta radiation the photon calibration factor is used.

IV.3.4. Type test and performance criteria

Criteria for the dosemeters are laid down in document SRZ 7.102. The dosimetric system has been type tested by the manufacturer, RADOS Technology Oy, with reference to the standard ISO DP8034. An extensive study on the system by RISØ National Laboratory in Denmark is also available. Both reports show that the dosimetric system complies with the recommendations in IAEA Safety Guide RS-G-1.3.

IV.3.5. Pre-use, periodic and performance testing

The criteria for pre-use and periodic testing are found in procedure SRZ 7.102, which includes procedures for ordering new dosemeters and criteria for the manufacturer. Routine performance tests are performed on a monthly basis by the IJS. The results are stated to be always within 5%, the criteria being set at 10%. An annual performance test is also done by the IJS with reference to ISO 14146.

IV.3.6. Dose record keeping and reporting

Doses from internal and external exposure are combined in the NPP dose register. The dose records are kept conforming to the requirements of the BSS. Doses are reported monthly and an annual dose report is produced. Dose limits are monitored with reference to the calendar year.

Dose information is sent to the national registers at HIRS and the SNSA.

IV.3.7. Monitoring programme

The organizational aspects of the monitoring programme are described in the radioprotection manual (procedure number ADP1.7.002) and the procedures on personal dosimetry (ADP 1.7.006). The procedure PRZ 7.100 defines the types of dosemeters to be used under what conditions. The procedure PRZ 7.303 defines additional measures during outages and procedure PRZ 7.307 deals with external exposure resulting from contamination of the skin.

IV.3.8. Quality assurance

NPPK has an extensive QA system in place. It appears that the QA system almost complies with international standards, with only minor non-conformities.

IV.3.9. Conclusions

The appraisal team concludes that the following provisions are worthy of special merit:

The power plant shows excellent housekeeping at all places visited.

All systems and procedures reviewed were well documented and documents were readily available to the staff at relevant places.

The staff appeared to have great pride in performing in accordance with international standards and recommendations.

Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

IV.3.10. Recommendations

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. NPPK should require from the SSDL (IJS) that the appropriate international standards for calibration be used. Irradiations should be requested to conform to ISO 4037-1, -2 and -3 (see Section A4.1.2) ***[Essential].***

2. The service should establish a quality management system based on the ISO 17025 standard.

FIG. 5 RADOS TLD reader and dosemeters use for personnel monitoring at the NPP Krško.

IV.4. SERVICE PROVIDED BY THE INSTITUTE OF OCCUPATIONAL SAFETY (IOS)

IV.4.1. Introduction

The dosimetric service at the IOS is based on Panasonic TLD readers and TL dosemeters. The IOS monitors approximately 3000 persons. Approval of the IOS is based on federal legislation of the former SRFJ.

IV.4.2. Dosimetric quantities

In routine individual monitoring, only the exposure to penetrating radiation is assessed. The quantity used is personal dose equivalent ($H_p(10)$), conforming to the BSS. Exposure to weakly penetrating radiation is not monitored. Dosemeters for workplace monitoring are not calibrated in terms of the recommended quantities ambient dose equivalent H*(10) or directional dose equivalent H'(10). Photon dose equivalent is used instead.

IV.4.3. Calibration

The calibration of the system is done by sending a set of reference dosemeters to the SSDL operated by the IJS, where they are irradiated with ^{137}Cs to a predefined dose in terms of $H_p(10)$. Element correction factors for the routine dosemeters are obtained by irradiations of routine and reference dosemeters in the IOS's own irradiation facility. The dose measurements are thereby traceable to the SSDL. It was, however, observed that the irradiation conditions at the SSDL do not conform to ISO 4037 (see section A4.1).

IV.4.4. Type test and performance criteria

The dosimetric system in use is a standard commercial system manufactured by Panasonic and can, by reputation, be considered to comply with most international standards and recommendations. No additional and independent type test results are available.

IV.4.5. Pre-use, periodic and performance testing

Pre-use, periodic and performance testing is part of the QA programme. The quality of the service is monitored by sending dosemeters to the SSDL for irradiation on the water phantom. This procedure complies with the recommendations given in the IAEA Safety Guide RS-G-1.3 (However, see also section A4.1). Recalibration of workplace monitors at two yearly intervals is a legal requirement.

IV.4.6. Dose record keeping and reporting

Dose data have been archived since 1961 as hard copy documents and since 1991 in electronic form. The dose registration is part of a radiation protection information system called SEVANJE. This system not only contains the dose information of the monitored persons but also other information relevant for radiation protection such as sources of exposure. The information system contains only dose data on external exposure ($H_p(10)$). All dose reports are checked and signed. Unexpected dose values are reported immediately.

IV.4.7. Quality assurance

There has been a QA programme in place for about 10 years. The IOS has an ISO 9001 accreditation for several activities. Extension to all activities is planned and includes ISO 17025 accreditation for the dosimetric service. There is a specially appointed QA manager who reports directly to the IOS Director. The service is run by competent staff, whose continued training is laid down in the annual QA plan as part of the QA system. The IOS participated in the 12th EML/IAEA intercomparison for environmental dosemeters.

IV.4.8. Conclusions

The appraisal team concludes that the following provisions are worthy of special merit:

— The IOS is an institute that apparently takes its responsibility very seriously.

— There is an adequate QA programme in place.

— The staff appear to be motivated and competent.

— A good example of quality awareness is the graphical representation of the TL reader performance in the TL laboratory.

Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

IV.4.9. Recommendations

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. OS should require, from the SSDL (IJS), that the appropriate international standards for calibration be used. Irradiation should be requested to conform to ISO 4037-1, -2 and -3 (see Section A4.1.2) ***[Essential]***.

2. Type testing of the system by an independent laboratory might be considered ***[Advised].***

3. Modifying the dosemeter such that weakly penetrating radiation can be monitored for relevant users might be considered ***[Advised].***

FIG. 6. Panasonic TLD reader and dosemeters used atInstitute of Occupational Safety for personnel monitoring.

APPENDIX V

DETAILED FINDINGS : ASSESSMENT OF OCCUPATIONAL EXPOSURE DUE TO INTAKES OF RADIONUCLIDES

[Based on questionnaire No. 3]

V.1. SERVICE PROVIDED BY KRSKO NUCLEAR POWER PLANT

V.1.1. Monitoring Programme at NPPK

The organizational aspects of the monitoring programme are described in the NPPK *Radiation Protection Manual* (Procedure number ADP-1.7.002 dated 08.05.2001) and in the documentation on Personnel monitoring (Procedure ADP-1.7.006 dated 08.05.2001).

The dosimetric quantities used by the service are those recommended by the BSS:

— Intake I (Bq);

— Air concentration (Bq/m^3);

— Dose coefficient e(g) for ingestion and inhalation (Sv/Bq);

— Committed effective dose E_{50} (Sv).

In the manual there is an established annual limit for internal dose of 0.02 mSv of committed effective dose, which was selected as being 1% of the dose limit of 20 mSv /year.

In the manual, there are no site-based rules in the monitoring programme for fixing the frequency for routine monitoring. The current Slovenian legislation requires measurements at least twice per year (Art. 34, regulation Z6).

NPPK workers are routinely monitored on an annual basis, but additional monitoring is undertaken in response to workplace conditions such as:

— indications that air contamination has exceeded prescribed levels;

— skin contamination monitors at the control points have exceeded prescribed levels.

For plant personnel and contractors, the measurements are scheduled before and after work every day during outages and maintenance.

The investigation levels are defined in terms of measured activity in the body. The values of those levels are defined in Table I (page 18) of the *Radiation Protection Manual* (Procedure number ADP-1.7.002 dated 08.05.2001) for a group of radionuclides. The recording level is 0.02 mSv (page 18), and special investigation is required if the level exceeds 0.2. mSV. Derived levels are also defined.

For cases of accidents or incidents, the manual establishes an action plan for the assessment of serious intakes that potentially could occur. This plan includes actions for response to possible complications such as conventional health effects and external contamination. Local arrangements and formal agreements are in place with the Clinical Centre Zagreb, Croatia and Marie Curie Hospital in France for medical treatment of exposed workers.

The methodology for assessing intakes and dose for accidents and incidents situations does not include the collection of additional information (material specific and individual specific data), that may be needed for the assessment.

V.1.2. Direct measurement methods

Fission and activation products are being measured by direct methods with the use of a Whole Body Counter "Stand Fast II" from ORTEC in standing geometry. The system contains two 4x4x16 NaI(Tl) detectors . The counting chamber is accessible from both sides, the shielding is provided by a combination of carbon steel and solid cast lead. There is a system available for thyroid monitoring (Fig. 7, 8).

The electronics and data processing systems are also from ORTEC. For calibration a phantom with five different source-positioning cavities is available. A mixed gamma source, certified by the US company Analytics (confirmed by the US National Institute of Standards and Technology as per R6.4.15), is used for calibration and quality control of the systems. The calibration is performed once per year.

The minimum detectable amounts (MDAs) are in the order of 400 Bq for Co-60 and 1 kBq for Cs-137 for a preset counting time of 70 seconds.

The subjects to be measured change clothes for the measurement. No verification of possible external contamination is performed, reliance being based on the fact that workers come from the access control points at the working areas where external contamination should have been checked. Showering facilities are available before measurement, if needed.

V.1.3. Indirect measurement methods

No procedures are available and therefore no radionuclides are measured by indirect methods. There is a report available on H-3 measurements performed at the beginning of the 1990's with a few workers, all with negative results. A liquid scintillation counter is available but does not appear to be operational. It has been explained there are no reasons to use indirect methods.

V.1.4. Biokinetic models for internal dosimetry

The biokinetic models used for different routes of entry, systemic activity and excretion are not clearly stated in the documentation presented to the appraisal team. It was explained that LUDEP computer software is standing-by for more detailed analysis if needed. No models are used for entry of radioactive substances through wounds. It is assumed that inhalation pathway and activated oxides or corrosion products or fission products are relevant for those assessments.

The dose coefficients from the BSS are used in the process of dose estimation. Derived air concentrations and annual limits on intake (ALI) are also used to assist this process. The values are presented in Table 1 (page 18) of the *Radiation Protection Manual* and are available, but not regularly used, for the establishment of monitoring frequency and reference levels.

For the workplace specific assessment, the main information is related to the current air monitoring system installed at the facility. The appraisal team was presented with a study of aerosol size distribution carried out at the beginning of the 1990s. The study was based on few air measurements in different locations at the plant and a literature reference from 1952. On the basis of this information an AMAD of 1 μm was selected.

V.1.5. Interpretation of measurements

No information was provided on the biokinetic models used to obtain the retention or excretion function apart of the models already included on LUDEP. The time of intake is assumed to be the same day as the monitoring. Therefore the committed effective dose is calculated by assuming the measurement activity value as the intake and this intake is multiplied by the relevant dose coefficient from the BSS. For workers who are measured only annually, significant doses could be missed.

A computer code LUDEP is available for the intake and dose assessment but is not frequently used. No uncertainty estimation is carried out with the measured or estimated values.

FIG. 7. Whole-Body Counter at NPP Krško.

FIG. 8. Facility for thyroid monitoring with NAI(TL) detector at NPP Krško.

V.1.6. Dose record keeping and reporting

The current legislation in Slovenia does not include any specific requirements for record keeping in respect of internal dosimetry although Regulation Z10 does include a general requirement.

All data are recorded locally in terms of the measured activity and the committed effective dose E(50). This information is sent to the respective worker's employer (for contractors and other outside workers) and to the two central dose records managed by SNSA and HIRS.

For accidental situations, the NPPK accident plan includes provisions to inform management.

V.1.7. Quality assurance

The dosimetry laboratory is a part of the overall quality assurance programme of the NPPK. The Quality Manager was not available for interview and the staff in the laboratory do not have a clear picture on the ISO standard which they follow. An audit report was presented to the appraisal team covering not only the internal dosimetry service but the whole range of activities performed by the group.

The functional organization of the laboratory is consistent with the current organizational chart. In general the laboratory facilities are adequate, the equipment is appropriate and the access to the facilities is controlled. General safety conditions are considered.

The procedures for the internal monitoring programme are explained in the *Radiation Protection Manual*. No other formal procedure or working instructions are available for the analytical methods, the measurement procedures, the interpretation methods or the reporting.

There is a quality control procedure for verifying the proper operation of the whole body counter. This makes use of the available phantom and standard reference sources. The results of the control measurements are stored in the electronic media, but this procedure is not well documented.

The laboratory has not yet participated in any intercomparison exercises related to internal dosimetry.

The qualification of the individual who has technical responsibility for the laboratory is consistent with the job description. The staff have been trained in internal dosimetry and gamma measurement techniques with the whole-body counter, no other specific training in internal dosimetry has been given. There is no programme for education and training in internal dosimetry.

V.1.8. Conclusions

The appraisal team concludes that the following provisions are worthy of special merit:

— The overall standard of housekeeping gave the impression of good management control of quality systems, with motivated staff and well organized facilities;

— The database for record keeping, which was developed within the service, is user-friendly and contains all the relevant information for the workers and the employers, including the lifetime doses and the doses during the work at NPPK;

— Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

V.1.9. Recommendations

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. the monitoring programme should be revised and based on the recommendations of the IAEA Safety Guide RS-G-1.2 focusing on:

a. direct and indirect methods of measurement, frequency of monitoring based on the physical and chemical characteristics of the radionuclides, the MDA of the measurement technique, etc.;

b. introduction of newly developed biokinetic models of the radionuclides in the monitoring programme. ***[Essential].***

2. staff should enhance the training in intake and dose assessment. ***[Important].***

3. quality management systems should be established, based on the ISO 17025 standard. ***[Important].***

4. consideration might be given to an agreement with Nuclear Medicine Department at UCCL with regard to intake and dose assessment. This might include intercomparison exercises and backup support in the event of operational difficulties. ***[Advised].***

V.2. SERVICE PROVIDED BY THE NUCLEAR MEDICINE DEPARTMENT AT UCCL

V.2.1. Monitoring Programme

The organizational aspects of the monitoring programme are not described in a formal document. The occupationally exposed workers at the facility are monitored once per year, as required by the current legislation. Workers that attend the health surveillance examination performed by the Institute of Occupational Safety are sent to the whole body counter facility for measurement, also once per year.

The dosimetric quantities used by the service are those recommended by the BSS:

— Intake I (Bq);

— Air concentration (Bq/m^3);

— Dose coefficient e(g) for ingestion and inhalation (Sv/Bq);

— Committed effective dose E_{50} (Sv).

Neither reference levels nor derived levels are defined or in use.

In case of accidents or incidents, there are provisions for an action plan for the assessment of serious intakes that could occur. This plan includes actions for response to possible complications such as conventional health effects and external contamination.

The methodology for assessing intakes and dose in case of accident and incident situations does not include the collection of additional information (material specific and individual specific data), that will eventually be needed for the assessment.

V.2.2. Direct measurement methods

Fission and activation products are measured by direct methods with the use of a whole body counter from Canberra, in a scanning bed shadow shield geometry. The system contains two HpGe detectors with 25% relative efficiency and one NaI(Tl). The counting bed is accessible from both sides. (Fig. 9, 10).

FIG. 9. Facility for whole-body monitoring at Department of Nuclear Medicine UCCL.

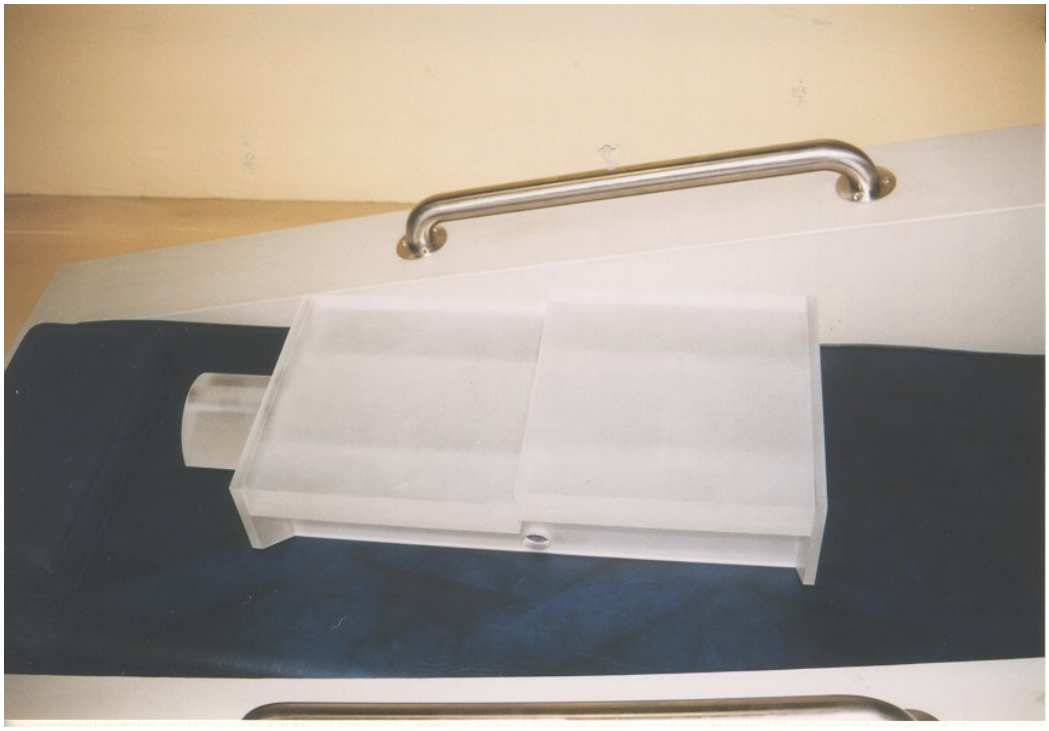

Fig. 10. Phantom for calibration of whole-body counter at Department of Nuclear Medicine UCCL.

The electronics and data processing systems are also from Canberra and comprise the ABACOS- Genie for PC software. For calibration, a phantom with four different source-positioning cavities is available. These positions allow for calibration related to a measurement of thyroid, lungs, whole body and the gastrointestinal tract. A

mixed gamma source, certified by the US company Analytics, is used for calibration and quality control of the systems. The calibration is performed once per year. There is no evidence of traceability to national standards.

The MDAs are in the order of 460 Bq for Co-60 and 360 Bq for Cs-137, measured with the HPGe detectors. For the NaI(Tl) detector the MDAs are 142 Bq for Co-60 and 145 Bq for Cs-137 for a 10 minutes measurement.

The subjects to be measured do not change clothes for the measurement. No verification of the external contamination is performed, reliance being placed on the fact that most of the workers come from the Institute of Occupational Safety, where it is assumed that surface contamination will have been checked. Showering facilities are not immediately available before measurement.

V.2.3. Indirect measurement methods

No procedures are available and therefore no radionuclides are measured by indirect methods.

V.2.4. Biokinetic models for internal dosimetry

The models used for different routes of entry, systemic activity and excretion were not clearly stated in the documentation presented to the appraisal team. The team was informed of the use of all models and methodologies from both ICRP Publication 30 and ICRP Publication 54. No model is used for entry of radioactive substances through wounds or through intact skin.

For the workplace specific assessment, the team was presented with a study of I-131 concentration at workplaces carried out in April 1998. The study was based on a few air measurements in different locations and hypothetical cases designed with a conservative approach. From this information, it was recognized that there is a clear need for regular monitoring of medical staff working in specific areas. However, this information is not being used for the design and optimization of the monitoring programme for the workers at the facility.

V.2.5. Interpretation of measurements

The biokinetic models used to obtain the retention or excretion function are those from the ICRP Publications mentioned above. The time of intake is assumed to be the middle of the monitoring interval; therefore, the committed effective dose is calculated by assuming the measurement activity value, calculating the intake multiplying this by the dose coefficient from the ICRP publication 54.

A computer code CINDY is available for the intake and dose assessment. No uncertainty estimation is carried out with the measured or estimated values.

V.2.6. Dose record keeping and reporting

The current legislation in Slovenia does not include any specific requirements for record keeping in respect of internal dosimetry, although Regulation Z10 does include a general requirement.

All data are recorded locally in terms of the measured activity and the committed effective dose E(50). This information is not sent to the respective worker’s employer (for contractors and other outside workers) but all dose assessments are sent to the central dose record data base managed by HIRS.

V.2.7. Quality assurance

The functional organization of the laboratory is consistent with the current organizational chart. In general the laboratory facilities are adequate, although they are situated in the basement of the hospital. The equipment is appropriate and the access to the facilities is controlled. General safety conditions are considered

There is no quality management system in place. There is a quality control procedure for verifying the proper operation of the whole body counter. This makes use of the available phantom and standard reference sources. The results of the control measurements are stored electronically, but this procedure is not well documented.

The laboratory has participated in several intercomparison exercises related to measurement of activity in simulated organs and phantoms (e.g. In 1996, organized by Human Monitoring Laboratory in Canada, and currently participating in a similar exercise organized by the IAEA). The staff have also participated in two international intercomparisons for intake and dose calculation organized by the IAEA and the EU (1997, 1998). The results in all cases were satisfactory.

The qualification of the individual who has technical responsibility for the laboratory is consistent with the job description. The staff have been trained in measurement techniques with the whole body counter, but no other specific training on internal dosimetry has been given. There is no programme for education and training in internal dosimetry

V.2.8. Conclusions

— The appraisal team found that the staff in charge of the measurement and dose assessment are very knowledgeable.

— Notwithstanding the above, the appraisal team makes the recommendations that follow as an aid to further strengthening the occupational radiation protection arrangements.

V.2.9. Recommendations

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. The monitoring programme should be revised according to the recommendations of the IAEA Safety Guide RS-G-1.2 focusing on:

    a. direct and indirect methods of measurement, frequency of monitoring based on the physical and chemical characteristics of the radionuclides, the MDA of the measurement technique, etc.;

    b. workplace characterization ***[Essential].***

2. Quality management systems should be established, based on the ISO 17025 standard ***[Important].***

3. Staff should be trained in intake and dose assessment ***[Advised].***

4. Consideration might be given to an agreement with the NPPK with regard to intake and dose assessment. This might include intercomparison exercises and backup support in the event of operational difficulties ***[Advised].***

Appendix VI

DETAILED FINDINGS : OCCUPATIONAL RADIATION PROTECTION IN FACILITIES – KRŠKO NUCLEAR POWER PLANT

[Based on Questionnaire No.4]

VI.1. INTRODUCTION

The Nuclear Power Plant at Krško has been in operation since 1983. The plant is equipped with a Westinghouse pressurized water reactor, PWR-664 model, with electrical power of 705 MWe. It provides 40% of energy production in Slovenia.

VI.2. FRAMEWORK OF RADIATION PROTECTION

There is a clear allocation and documentation of the respective responsibilities of the management for the occupational protection of itinerant workers (contractors) and appropriate information is provided to their employer, demonstrating that itinerant workers are provided with protection in accordance with the regulations. Procedure *Personal Dosimetry ADP - 1.7.006, Appendix 6.2* specifies the requirements for the personal data of radiation workers that has to be provided by contractors to Krško NPP.

VI.3. DOSE LIMITATION

The dose limits follow the requirements of both BSS and Euratom 96/29. The plant regulation dealing with the legal limits is *Radiation Protection Manual ADP* - 1.7.002, Chapter 5.1.1.1.

It is forbidden for persons under 18 years of age to work with radiation sources or to be occupationally exposed.

Special provisions are made for pregnant workers and women of reproductive age. It is forbidden for pregnant women to work with radioactive sources or to be otherwise occupationally exposed and breast feeding women are not allowed to work with unsealed sources. Women of reproductive age should not work on tasks related to exceptional exposure or to be involved in interventions.

VI.4. OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

An ALARA policy is implemented at NPPK and the management commitment is clearly demonstrated. The ALARA procedures (ADP - 1.7.003, ADP - 1.7.004, ADP - 1.7.010, ADP - 1.7.011) have been issued and are followed. An ALARA committee and ALARA groups have been created and responsibilities have been assigned. The dose constraints (5 mSv individual dose and 10 man mSv collective dose) were set by management. Training on optimization is one part of the program of radiation protection.

In the year 2000, the collective radiation dose at NPPK was 2598 man mSv, but 1540 man mSv of this was due to work during the replacement of the steam generator. For the year 2001, the target for collective radiation dose was 1100 man mSv.

Occupational radiation protection at the plant has been reviewed during several independent missions. Internal audits are also performed. An appropriate system for reporting and investigation has been established for those occasions when deficiencies are identified by audit, or if radiological incidents occur (ADP - 1.1.201 *Deviation Report Procedure*).

VI.5. RADIATION PROTECTION PROGRAMMES

(a) Prior radiological evaluation

Prior radiological evaluation of the NPPK was undertaken during the commissioning and licensing process. At present, the prior radiological evaluation is a part of optimization procedure.

(b) Radiation Protection Measures

Assignment of responsibilities

The assignment of responsibilities is described in internal regulation on NPPK Organization. Although the terms 'radiation protection officer' and 'qualified expert' are not recognized by present legislation, the SNSA assigned the radiation protection manager as the person responsible for radiation protection at the plant. It is understood that the above mentioned terms will be introduced into the new legislation.

The accountability system for radioactive sources is in place and is well maintained. The actual data for the radioactive sources are available in a LAN.

Classification of Areas

Controlled and supervised areas, as defined in the *Radiation Protection Manual* ADP - 1.7.002, Chapter 4.0, are established at the NPPK. The areas are appropriately delineated and warning symbols are posted. Access is controlled and local rules and procedures are in place.

All the required occupational radiation safety measures have been met:

- Access to controlled areas is restricted. Access points to high radiation areas (ie where the dose rate is greater than 10 mSv/h) are locked and access is controlled according to the procedure ADP - 13.013;

- Protective clothing and equipment, monitoring equipment and suitable storage for personal clothing are provided at the entrances to controlled areas;

- Equipment for monitoring contamination, washing and shower facilities and suitable storage for contaminated protective clothing and equipment is provided at exits from controlled areas;

- Periodical reviews are conducted of the conditions in controlled areas.

Local rules, supervision and personal protection equipment

The workers are provided with suitable personal protective equipment. Personnel entering contaminated areas are required to wear protective clothing. The basic requirements are described in *Radiation Protection Manual* ADP - 1.7.002. Usage of protective clothing is defined in the procedure PRZ - 7.601. A different procedure, PRZ - 7.307, covers radiation protection in areas with a high potential for hot particles.

The type of respiratory protection device is determined by the airborne activity concentration and conditions are laid down in Table II, *Radiation Protection Manual* ADP - 1.7.002. Respirators are issued only to personnel who are trained, fitted and medically qualified to wear such respiratory protection. [The proper use as well as the condition of protective equipment (protective clothing and electronic operational dosimeters) was observed during a visit to a radiation controlled area].

General information on the protective equipment is given to the workers during the initial and periodical RP training courses - Radiation Protection (RZ - 3) at Krško NPP, HP - F09.03.Y1.

Work planning and radiation work permits

Adequate preparation time is allowed at NPPK when planning radiation work. Planning is performed in compliance with the ALARA procedure ADP - 1.7.003. Provided that the planned doses do not exceed the optimization criteria, the ALARA instructions are described in radiation work permits.

There are two kinds of radiation work permit (RWP) at the plant (*Radiation Protection Manual* ADP - 1.7.002, chapter 5.5.3). The general RWP is to govern routine work for which the radiation and contamination conditions do not exceed specified levels (1 mSv/h, 400 Bq/100cm^2, 1 DAC of airborne activity). The special RWP is issued to control work not covered by the general RWP.

RWPs contains all the necessary data to ensure adequate radiation protection, including:

— a short description of the work to be undertaken;

— where and when the work will be undertaken;

— the radiation and contamination conditions in the working area(s);

— list of workers;

— planned doses (dose constraints);

— time allowed;

— radiation protection support required;

— necessary protective equipment;

— ALARA reference.

Briefing is provided before the work commences and the RWP is also signed by the workers. Finally, the responsible radiation protection technician authorizes the RWP.

(c) Radiation monitoring and dose assessment

General

The *Radiation Protection Manual* ADP - 1.7.002 states clearly the requirements for radiation monitoring in order to ensure radiation protection of the workers from the point of view of both external and internal exposure. Individual monitoring of external and internal exposure is provided for all workers working in controlled and supervised areas.

To ensure the correct assessment of doses to personnel, periodic measurements are made of spectra near to the primary loop in the containment during the outage. The type and energy of the radiation is known and proper instrumentation for radiation protection monitoring is made available. Radiation equipment is checked and calibrated according to the technical specifications and *Radiation Protection Manual*. There are daily, monthly and six-monthly functional checks, supported by annual calibrations by external laboratories. Appropriate records are also kept in LAN.

Individual monitoring for external radiation

Dosimeters are provided to all persons entering radiation controlled and supervised areas. TLD is the legal dosimetry system and the usual evaluating period is one month. Each worker entering a neutron radiation area is provided with a TLD albedo dosimeter. Electronic personal dosimeters, type DMC 2000, are also used as appropriate and NPPK has ordered a special calibrator for this dosimeter. The number of dosimeters is sufficient and adequate software exists for keeping records. Additional dosimeters are provided for measuring extremity doses and additional dosimeters would be used in situations where there is a particularly non-uniform radiation field.

Current legislation requires that dosimetry services be approved by the appropriate regulatory authority. This is a requirement of the *Act on Radiation Protection and Safe Use of Nuclear Energy* (Off. Gaz. SFRY 62/84). NPPK has not yet been approved, but is currently seeking such approval.

Visitors are restricted by an effective dose constraint of 0.5 mSv during any single visit, on the basis of an annual dose limit to the public of 1 mSv.

Workplace monitoring

The workplace monitoring programme is established as a part of the *Radiation Protection Manual* ADP - 1.7.002:

— Chapter 5.1.4.1, Radiation surveys;

— Chapter 5.2.3.1, Airborne radioactivity surveys (joint procedures are PRZ - 7.304 & PRZ - 3.05);

— Chapter 5.3.3.2 , Contamination surveys;

Supervised areas are surveyed monthly, according to the relevant procedure PRZ - 7.306.

The frequency and extent of surveys are commensurate with the potential for the radiation and contamination conditions to change. Survey results are logged and reviewed weekly by the radiation supervisors. Where measured levels exceed reference levels, the areas are adequately posted to signify the presence of a higher radiation/contamination field. Monitoring results are maintained in special software that is accessible to the authorized persons. Consequently, the monitored data is available as radiation maps and also trends can be evaluated.

Individual monitoring for intakes of radionuclides

All workers in contamination controlled areas are monitored for internal contamination. A whole body counter is used for activity monitoring and the standard measurement interval is one year. Selected members of staff from the maintenance, operations, radiation protection and chemistry departments, who are routinely involved in work in highly contaminated areas, are monitored quarterly. Contractors, who work in contamination controlled areas, are measured before commencing and after completing such work, and daily whilst the work is in progress.

When there are reasonable grounds for believing that a radioactive intake has occurred, the radiation protection technician can request that the worker(s) be subjected to a measurement of internal contamination. This can occur after facial contamination, a positive nasal smear, or any failure of respiratory protection.

Bioassay techniques are not used for the assessment of internal exposure of radionuclides that cannot be measured by the whole body counter. The capability for biological dosimetry exists off site (at the IOS), and would be performed if a potential intake were suspected.

Investigation and intervention levels

Investigation levels are set for external and internal exposure in *Radiation Protection Manual* ADP - 1.7.002, Chapter 5.5.4 - Radiation Protection Deviations and Incidents. Records of radiation protection incidents have to be prepared by responsible radiation protection personnel and submitted to the radiation protection superintendent. An additional report is required when any investigation level is exceeded. The events are then investigated by a special committee at the plant level, the details are analyzed and suggestions are made for corrective action.

Dose record keeping

The record keeping policy is well established at NPPK. It is prescribed in general (ADP - 1.7.002, chapter 5.1.5., 5.2.4 and 5.3.4) for radiation survey records, instrument tests and calibrations, external radiation exposure, results of area monitoring dosimeters, records of dosimetry device calibration, testing and quality control checks, dose assessments, time keeping records, radiation work permits, investigation records, internal radioactivity measurements, records of skin, clothing and area contamination. All doses below 0.01mSv, measured monthly by TLDs, are recorded as zero.

The exposure records are preserved at least until the worker attains or would have attained the age of 75 years and not less than 30 years after the termination of the work involving occupational exposure (Personal Dosimetry, ADP - 1.7.006, Chapter 5.8). Dose records are regularly sent to the Central Dose Register at HIRS and at the SNSA.

VI.6. INFORMATION AND TRAINING

Staff and contractors receive regular radiation protection training and the level of knowledge of radiation protection personnel was found to meet high standards (Fig. 11). There are three levels of training, depending on the assignment of the workers:

Level 1 is devoted to radiation protection officers and radiation protection technicians. Initial training takes 200 hours. Retraining takes 80 hours and is repeated every two years.

Level 2 is for radiation workers and the initial training takes 40 hours. Retraining takes 20 hours and is required at 5 yearly intervals. Level 3 is for occasional workers and initial training take 6 to10 hours.

Mock-ups are used in the training, including the steam generator, and several mechanical parts of primary circuit and valves. A multiscope simulator is also available to assist with the training of staff.

The textbook *Radiation Protection (RZ - 3) at Krško NPP (HP - F09.03.Y1)* contains radiation protection lessons and sets of questions as an aid for self-assessment. Small information handbooks are issued for the outages. These assist in achieving better efficiency during the outage and provide personnel with a better understanding of the plant goals.

Initial training of Level 2 and 3 has been provided at the plant under the supervision of an approved organization (IJS). Level 1 is performed at specialized training facilities abroad. Retraining courses are performed at the plant under audits or direct control of ITS or HIRS. However, the most recent retraining at Level 1 (in the year 2000) was performed by NPPK staff, who are, strictly speaking, not approved for this role but have done the job under supervision of inspectors from HIRS. The NPPK radiation protection experts and personnel were directly involved this retraining according to the recommendations, management and compliance with good practices.

FIG. 11. Training facility at the NPP Krško.

VI.7. QUALITY ASSURANCE, AUDITS AND REVIEWS

The management at NPPK took responsibility for setting up and maintaining a QA programme at the plant and adequate responsibilities were delegated. The system of QA audits and reviews was described during interview and was considered to be appropriate.

VI.8. INTERVENTION IN EMERGENCIES

An emergency response plan is in place at NPPK and was prepared in accordance with specific regulations. All workers involved in an emergency at NPPK would come under Category 1 of the BSS categorization, since they would be directly involved in the countermeasures. However, this system of categorization has not been formally introduced.

The roles and responsibilities of all workers are defined. Workers involved in specific emergency actions, which might lead to a dose above the annual dose limit, are required to be volunteers. These workers should be comprehensively informed in advance of the associated health risk and should be trained. Dose limits are set for specific emergency situations (Procedure EIP - 17.062).

Adequate provisions are made with external hospitals for the reception and treatment of persons involved in an accident.

VI.9. HEALTH SURVEILLANCE

The routine period between medical examinations is one year for radiation workers. If a higher dose is reported, a special examination can be required. All examinations include the taking of a blood sample for chromosome aberration analysis. Medical fitness is one of the conditions required for permission to work with radiation sources and it is confirmed by the responsible radiation technicians before allowing a worker to commence work on the plant.

The health surveillance records are kept confidential. The occupational physician in charge of the health surveillance of workers has access to all information concerning working conditions that may influence workers' health and to formal dose records for each individual worker. The occupational physician is adequately trained in radiation protection (e.g. the present doctor received training from the IAEA). Specific counseling by the occupational physician is available to workers, especially at the time of the medical examinations.

VI.10. CONCLUSIONS

The appraisal team concludes that the following provisions are worthy of special merit:

— In general the occupational radiation protection at the plant is managed in compliance with the requirements stated in BSS 115. In effect, this is to a considerably more modern standard than is required by the current legislation in Slovenia and is particularly noteworthy;

— The well organized training programme has produced radiation protection personnel who are especially knowledgeable in up-to-date radiation protection principles;

— The overall impression from the plant was very positive and the indicators submitted during the appraisal demonstrated the high quality of the operational and workplace aspects of radiation protection;

— The plant is kept clean with a very good standard of housekeeping.

Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

VI.11. RECOMMENDATIONS

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that*:*

1. NPPK should progress the application for approval of its external and internal dosimetry services without delay ***[Important].***

2. NPPK should seek approval to operate its own training courses, where this would be most appropriate ***[Important].***

Appendix VII

DETAILED FINDINGS : OCCUPATIONAL RADIATION PROTECTION IN FACILITIES – SLOVENIAN NATIONAL BUILDING AND CIVIL ENGINEERING INSTITUTE (SNBCEI)

[Based on Questionnaire No.4]

VII.1. INTRODUCTION

As the national building and civil engineering institute, SNBCEI plays an important role in Slovenia's system of quality attestation and certification in the construction industry.

Two staff in the Stone and Aggregates Laboratory use a Philips X-ray diffraction analyzer for qualitative mineral analysis. In the Department of Geotechnics and Traffic Infrastructure, about 11 staff use Troxler gauges (various models) for measuring the moisture content, density and compaction of soils, soil-stone aggregates, asphalt treated bases and asphalt surfacing.

VII.2. FRAMEWORK OF RADIATION PROTECTION

No contractors are allowed to work with the X-ray diffraction equipment or with the Troxler gauges.

VII.3. DOSE LIMITATION

All workers have received statutory training in radiation protection. The current legislation specifies what would happen in the event of an overexposure or of a woman declaring herself pregnant. SNBCEI are aware of the requirements but reported that recorded personal doses have always been very low.

VII.4. OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

Optimization has a very low profile in a company that is confident that all workers will record doses that are less than 2 mSv per 2 months, but the subject is mentioned during the 'statutory' training courses.

VII.5. RADIATION PROTECTION PROGRAMMES

The radiation protection programme does not feature in current legislation. As a consequence, it is not a concept about which the company has any real knowledge or understanding.

(a) Prior radiological evaluation

No questions asked.

(b) Radiation Protection Measures

Assignment of responsibilities

Mr. S. Ziberna was appointed as the Radiation Protection Officer only some two months previously; he has no deputy.

The IOS are contracted to provide radiation protection services and associated advice. There is an accountability system for radioactive sources but this is based simply on the fact that a specific person uses each source. If both the source and the person are out of the building, it is assumed that the source is legitimately in use and therefore under control. Control of sources is significantly hampered by the fact that some 13 old, unused sources are still in store because there is no national disposal route available to the SNBCEI. These sources are up to 30 years old. There appears to be an efficient system in place to ensure that only authorized staff can gain entry to the source store.

Classification of areas

The source store and the room in which the X-ray diffraction equipment is used are effectively controlled areas in that access is restricted. However, a controlled area is not defined when the Troxler gauges are in use on a site. The only periodic reviews are the annual radiation surveys conducted by the IOS. Supervised areas are not designated.

Local rules, supervision and personal protection equipment

There are no local rules and personal protective clothing is not required.

(c) Radiation monitoring and dose assessment

Individual monitoring for external radiation

All staff working with radiation are monitored for external exposure for photon radiation. It was not known whether neutron doses have ever been assessed. The dosemeters are changed at two monthly intervals. This strictly contravenes the current legislation (which requires monthly changes), but is considered appropriate to the level of risk. Additional extremity doses are not considered to be necessary.

Workplace monitoring

Workplace monitoring cannot be undertaken by the SNBCEI because they have no monitor. Annual monitoring is undertaken by the IOS, but it was noted that this has never included leakage testing of the sealed radiation sources. This means that sources up to 30 years old have never been tested.

The results provided by the IOS are evaluated and action would be taken if unusual measurements were reported.

Investigation and intervention levels

No investigation or intervention levels have been set. Any unusual results would be investigated by the appointed RPO.

Dose record keeping

Dosemeters are provided by the IOS, who also maintain the dose records.

VII.6. INFORMATION AND TRAINING

Training in radiation protection is in accordance with current legislation. Retraining is at two yearly intervals for the RPO and five yearly for other staff.

VII.7. QUALITY ASSURANCE, AUDITS AND REVIEWS

QA/QC does not really feature in present law and, in terms of radiation protection, is not addressed by the SNBCEI.

VII.8. INTERVENTION IN EMERGENCIES

The company has a ‘contingency plan’ specifying what to do in a transport or other type of emergency. This includes contact telephone numbers.

VII.9. HEALTH SURVEILLANCE

As required by current legislation, all workers are subject to appropriate health surveillance, which is provided by the IOS.

VII.10. CONCLUSIONS

The appraisal team concludes that the following provisions are worthy of special merit:

— Training of staff is regular and includes radiation protection, transport of radioactive sources and on-the-job training in the use of the gauges.

— Medical surveillance is maintained in accordance with legislation.

— The SNBCEI appears to have an efficient security system to safeguard use of the key to the source store.

Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

VII.11. RECOMMENDATIONS

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. An improved system should be introduced for source accountancy. A positive, written record should be maintained, on a daily basis, of all sources (gauges) removed from and returned to the source store. Only in this way can it be ensured that the whereabouts of each source is always unambiguously identifiable ***[Essential].***

2. The contents of the source store should be carefully investigated and all extraneous materials should be removed. Ideally, the store should contain nothing other than currently used gauges and old, inoperative gauges that are being stored in anticipation of a disposal route being made available. Potentially contaminated items should either be stored elsewhere, or should be more clearly demarcated from the currently used gauges ***[Advised].***

3. Concise local rules should be drawn up to cover the radiation protection aspects of the safe use of the gauges ***[Advised].***

4. At the earliest opportunity, the Republic of Slovenia should provide a viable waste disposal route and depository for radioactive materials ***[Essential].***

5. A suitable radiation dose rate monitor should be provided and kept in the source store. It should be used, on each occasion that a gauge is removed from and returned to the store, to indicate that the source shutter is correctly in the fully closed position ***[Important].***

6. Sources in the currently used gauges should be tested for leakage of radioactive material at intervals not exceeding two years (such a provision needs to be directed also to the service providers). The very old sources in the inoperative gauges should not be directly examined, but the external surfaces of the gauges should be checked for loose radioactive material ***[Important].***

Appendix VIII

DETAILED FINDINGS : OCCUPATIONAL RADIATION PROTECTION IN FACILITIES – DEPARTMENT OF NUCLEAR MEDICINE, UCCL

[Based on Questionnaire No.4]

VIII.1. INTRODUCTION

The department consists of four divisions:

- Nuclear medicine diagnostic division, where different radioisotope diagnostic tests are undertaken;
- Division for thyroidology, where different diagnostic tests and therapeutic treatments are performed;
- Division for radiopharmacy and clinical radiobiochemistry;
- Division for electronics, computers and physics in nuclear medicine.

As well as the department's responsibilities to patients, it has responsibilities for the education of physicians and other medical staff and is also involved in research work.

VIII.2. FRAMEWORK OF RADIATION PROTECTION

Provision is made to ensure the adequate protection of contractors working in the department, including an assessment of their occupational exposure. However, it was not clear that these provisions were being applied, for example, to service engineers working on equipment in the department.

VIII.3. DOSE LIMITATION

The department operates a dose limitation system that is probably closer to the requirements of the BSS than to the current legislation in Slovenia.

VIII.4. OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

Considerable efforts are made to achieve an optimized standard of radiation protection, including the setting of dose constraints, where appropriate. Management has a written commitment to optimization and workers are encouraged to take an active part in the process. Training programmes include the principles of optimization.

Weekly meetings of Division Heads and Department Heads can include radiation protection matters, when appropriate.

VIII.5. RADIATION PROTECTION PROGRAMMES

(a) Prior radiological evaluation

The department's licence is required to be renewed at six monthly intervals, principally because iodine waste disposal goes directly to drains and no limits have been specified by HIRS for these disposals. The licence renewal information includes the data that is appropriate to a prior radiological evaluation.

(b) Radiation Protection Measures

Assignment of responsibilities

It was reported that responsibilities are clearly assigned either within documents relating to the radiation protection programme or elsewhere. Mr. Grmek has responsibility for radiation protection within the Nuclear Medicine Department and on such matters he reports directly to the Director but in collaboration with the Division Heads (i.e. in principle, Mr. Grmek's radiation protection responsibilities bypass the Division Heads). UCCL has appointed a radiation protection officer, although he has a wider health and safety at work role and does not specialize in the use of unsealed radioactive materials.

The department seeks radiation protection advice from both the IJS and the IOS, both organizations effectively fulfilling the Qualified Expert role.

Records are maintained of all radioactive material entering the department and of all material that is dispensed. Radioactive waste is collected within each working area and records are maintained. Waste from the whole department is stored in segregated bins in a special area of the basement, where it is held for decay, as appropriate, and normally released at monthly intervals. Before release it is checked, with a release level equivalent to about a doubling of the background level on the monitor. There is currently no information regarding the identification of pipe-work carrying radioactive waste and, in particular, this is of potential concern in the case of the iodine therapy wards. Measurements have been made in the past to check the activity content of liquid waste from the hospital and it was concluded that the iodine-131 concentration was not excessive by comparison with the annual derived concentration for drinking water (regulations Z9).

Classification of areas

Areas where unsealed radioactive material is handled or used are designated as controlled areas; the remainder of the department is designated as supervised. Notices are displayed on the doors into controlled areas**.**

Berthold contamination monitors (generally the model LB122) were available in most of the laboratories, where unsealed radioactive material was in use, or certainly in an immediately adjacent area. The monitors are calibrated/checked by the IJS every two years, as required by the current legislation.

It was noteworthy that all working areas appeared to have readily available:

— protected receptacles for the collection of contaminated dangerous items (e.g. ‘sharps’);

— receptacles for other items of waste;

— copious supplies of disposable gloves;

— ready access to contamination dose-rate monitors.

Local rules, supervision and personal protection equipment

Local rules have been prepared, with sections specific to particular parts of the department, and include elements of a contingency plan for the case of accident or incident situations. All staff are required to sign a statement to the effect that they have seen the local rules. There was not time during the visit to evaluate the local rules.

Work planning and radiation work permits

There is no formal system in place relating to detailed work planning or the use of permits to work.

(c) Radiation monitoring and dose assessment

General

Occupational exposure control is provided by the IOS for external radiation and the Nuclear Medicine Department’s own whole body counter for intakes of radionuclides. All workers working with radioactive material are subject to routine exposure control.

Individual monitoring for external radiation

Monthly dose results are scrutinized but no formal trend analyses have been undertaken. Doses are perceived to have remained more or less constant over the past 7 years. The highest doses are recorded by staff in the ‘hot laboratory’ and those concerned with iodine therapy; such staff have recorded an accumulated dose of 10 to 15 mSv over the past 7 years. Most other staff have typically recorded less than 5 mSv over the past 7 years. Additional dosemeters would be made available, as necessary, for such as extremity monitoring.

There are rules governing the need to provide monitoring for visitors.

Workplace monitoring

Contamination monitors are used on a regular basis, especially following any suspected spill and at the end of periods of work. However, monitoring results are only recorded when they exceed what amount to relatively high intervention levels of:

— 8.10^3 Bqm^{-2} for the skin;

— 4.10^4 Bqm^{-2} for clothes;

— 4.10^5 Bqm^{-2} for other surfaces.

It was said that this involves only some five to ten monitoring records each year. Such a regime does not allow any detailed analysis of working trends.

Six monthly visits that include workplace monitoring are made by the IJS.

Individual monitoring for intakes of radionuclides

Staff working in controlled areas are checked annually on the Department's whole body counter. Other staff are checked at three yearly intervals. No bioassay assessments are undertaken.

Investigation and intervention levels

Legislative intervention levels are set (see above) but lower investigation levels have not been addressed.

Dose record keeping

Relevant information that was gained is reported elsewhere.

VIII.6. INFORMATION AND TRAINING

All staff working with radioactive material are subjected to appropriate training as required by current legislation. The training is provided by the IJS. Initial training takes place over three days at the IJS and it is examined. Retraining (at five yearly intervals) takes place within the Department.

Training records, including copies or training certificates, are maintained.

VIII.7. QUALITY ASSURANCE, AUDITS AND REVIEWS

The impression gained was that good QA procedures are in place in some areas (e.g. radiopharmacy) and that these include the essential elements of radiation protection.

Guidelines would appear to be required to determine the frequency and need for audits/reviews of the radiation protection programme.

VIII.8. INTERVENTION IN EMERGENCIES

Contingency plans are in place to deal with spills involving radioactive materials.

VIII.9. HEALTH SURVEILLANCE

As required by current legislation, all workers are subject to appropriate health surveillance, which is provided by the IOS.

VIII.10. CONCLUSIONS

The appraisal team concludes that the following provisions are worthy of special merit:

— The high overall standard of ‘housekeeping’ throughout the department, which presented a very good impression of general management quality control;

— The consistent and logical approach, whereby selected areas have been designated as controlled areas with the remainder of the department being supervised areas;

— Medical surveillance is maintained in accordance with legislation;

— An apparently consistent approach to surface contamination monitoring, albeit not supported by records.

A consistent approach whereby all working areas were provided with:

— protected receptacles for the collection of contaminated dangerous items (e.g. ‘sharps’);

— receptacles for other items of waste;

— copious supplies of rubber gloves;

— ready access to a contamination dose-rate monitors.

The routine use of syringe shields.

The provision of local rules and a requirement for workers to acknowledge, by signature, receipt of these rules.

Inclusion, as appropriate, of radiation safety as a part of weekly departmental meetings.

Staff involvement in international meetings and committees, resulting in an active interest in current safety topics such as patient protection.

Notwithstanding the above, the appraisal team makes the recommendations that follow as an aid to further strengthening the occupational radiation protection arrangements.

VIII.11. RECOMMENDATIONS

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. Although difficult, associated with this recommendation, it has to be recommended that some means must be found for tracing the routes of pipe-work carrying radioactive waste, particularly from the iodine-131 therapy ward. Once identified, the pipe-work should be clearly marked to indicate the potential presence of internal contamination and a permit to work scheme should apply to any associated maintenance work ***[Important].***

2. Following on the above recommendation, a means should be provided for the reliable estimation of the activities being disposed to the sewer. Alternatively, storage tanks should be installed to allow decay before final disposal, thereby obviating the need for estimation ***[Advised].***

3. Even though surface contamination monitoring is regular and reliable, appropriate investigation levels should be set for surface contamination levels above which the monitoring results should be permanently recorded. Such records should then be periodically reviewed to identify whether any systematic incidents are occurring and this would provide a valuable aid to the optimization of protection. Similar principles might be applied to the periodic measurement and recording of dose rates ***[Important].***

4. Investigation levels should be introduced for personal monthly doses, and results exceeding these values should be investigated to determine whether or not doses are optimized. Different levels would be appropriate for different groups of workers ***[Important].***

5. Consideration should be given to the appointment of responsible persons in each division to take local responsibility for radiation safety ***[Advised].***

6. Consideration should be given to the production of an annual departmental review of radiation safety as an aid to the optimization of protection. Such reports should identify trends in workers' annual radiation doses, and should prompt the identification of explanations for any identified trends that appear to be significant ***[Advised].***

7. A more formal system will need to be introduced to ensure the protection of visiting workers from another employer (e.g. service engineers working on radiation equipment) ***[Important].***

Appendix IX

DETAILED FINDINGS : OCCUPATIONAL RADIATION PROTECTION IN FACILITIES – DEPARTMENTS OF RADIOLOGY AND CARDIOLOGY, UCCL

[Based on Questionnaire No.4]

IX.1. INTRODUCTION

The extensive departments of radiology and cardiology are well provided with generally modern X-ray equipment to undertake essentially the full range of modern diagnostic radiology examinations. Their work also includes the use of ultrasound equipment.

IX.2. FRAMEWORK OF RADIATION PROTECTION

No provisions are made for contractors working in the departments.

IX.3. DOSE LIMITATION

The departments observe the current Slovenian legislation that lays down the actions to follow in the event of an overexposure and for the protection of pregnant women.

IX.4. OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

Doses to both patients and staff are periodically evaluated from the viewpoint of optimization, although this only a recommendation and not a requirement of current legislation. Special attention is paid to interventional procedures. Training in optimization has included the involvement of visiting lecturers, thereby encouraging the active participation of staff.

The departments have requested IOS to include the optimization of patient dose in their training programmes. Dose constraints have not been set, but the UCCL's radiation protection officer would investigate unusual incidents and accidents.

A good example of the application of optimization is that, in appropriate situations, ultrasound is used as a precursor to radiography.

IX.5. RADIATION PROTECTION PROGRAMMES

(a) Prior radiological evaluation

A prior radiological evaluation has been a part of the licensing procedure and would be undertaken prior to the introduction of any new radiological procedure. Safety assessments are a regular procedure.

(b) Radiation Protection Measures

Assignment of responsibilities

The heads of departments have issued internal instructions to identify radiation protection responsibilities. UCCL has appointed a radiation protection officer, although he has a wider health and safety at work role and does not specialize in radiation protection. An ALARA committee has not yet been appointed, but Professor Jevtic has been appointed as the qualified expert, despite this not being a legal requirement in the current legislation.

Classification of areas

Current legislation requires that areas where personal doses may exceed 0.3 times the relevant dose limit should be designated as controlled areas. This has been interpreted to mean the whole of both departments, with staff access being controlled at all points of entry. Warning symbols are displayed. This policy means that supervised areas are not used. Periodical reviews of working conditions are undertaken annually by the IOS.

Local rules, supervision and personal protection equipment

In many cases, occupational protection and safety measures are included in local rules. Lead aprons for staff were readily available, it seemed, in all rooms, and were carefully stored on hangers. It was noted that some examination tables were lacking lead protective drapes.

Work planning and radiation work permits

Detailed working procedures are currently being drawn up to cover radiation protection aspects of interventional techniques.

Radiation work permits are not used.

(c) Radiation monitoring and dose assessment

General

Individual monitoring and workplace monitoring are performed by the IOS. All exposure is due to diagnostic quality X-rays.

Individual monitoring for external radiation

As required by current legislation, all workers in controlled areas are subject to individual monitoring. Dosemeters are changed monthly.

It was reported that visitors are not allowed entry to the departments since they are controlled areas. However, this failed to recognize the needs of visiting workers such as service engineers. Additional dosemeters are provided, as appropriate, particularly for extremities during interventional techniques.

Workplace monitoring

Workplace monitoring is undertaken annually by the IOS but there appeared to be no evidence of a structured monitoring programme, including reviews or trend analyses; certainly there appeared to be little or no input from staff in the departments. The staff in the departments do not possess their own equipment to undertake workplace monitoring.

Investigation and intervention levels

Any actions in response to high or unusual dose or dose rate measurements would be related to the current dose limit of 50 $mSvy^{-1}$, or possibly to 20 $mSvy^{-1}$, since the department voluntarily prefers to work to this lower value. No other investigation or intervention levels have been set.

Dose record keeping

The departments have not addressed any aspects of dose record keeping, leaving all such considerations and consequent actions to the IOS.

IX.6. INFORMATION AND TRAINING

All staff working in the departments are subjected to appropriate training as required by current legislation. The training is provided by IOS. The departments are able to influence the content of training programmes and have, for example, asked for the inclusion of topics related to relevant EU directives. Training by the IOS is supplemented by lectures from visiting experts.

IX.7. QUALITY ASSURANCE, AUDITS AND REVIEWS

Some QA procedures are in place, but a formal system of QA/QC, audits and reviews does not yet exist.

IX.8. INTERVENTION IN EMERGENCIES

Not really practically applicable within diagnostic radiology work.

IX.9. HEALTH SURVEILLANCE

As required by current legislation, all workers are subject to appropriate health surveillance, which is provided by IOS.

IX.10. CONCLUSIONS

The appraisal team concludes that the following provisions are worthy of special merit:

— The high overall standard of 'housekeeping' throughout the department presented a very good impression of general management quality control;

— Medical surveillance of workers is maintained in accordance with legislation;

— New diagnostic methods are required to be approved by the Ethics Commission of the Ministry of Health;

— Staff involvement in international meetings and committees results in an active interest in current safety topics such as patient protection;

— Ultrasound techniques are used as a precursor to radiography, where appropriate (a practical example of optimization of protection);

— The occasional use of visiting experts boosts the training programme by presenting specialist lectures.

Notwithstanding the above, the appraisal team makes the recommendations that follow as an aid to further strengthening the occupational radiation protection arrangements.

IX.11. RECOMMENDATIONS

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. Investigation levels should be introduced for personal monthly doses, and results exceeding these values should be investigated to determine whether or not doses are optimized. Different levels would be appropriate for different groups of workers ***[Important].***

2. The departments should be equipped with dose and dose rate measuring instruments to enable their own staff to undertake periodic workplace monitoring. Investigation levels should be set above which results should be permanently recorded. Such records should then be periodically reviewed to identify whether any systematic variations are occurring and this would provide a valuable aid to the optimization of protection ***[Advised].***

3. The training course provider should be encouraged to provide training directed specifically towards the optimization of protection [in relation to both staff and patient doses] ***[Advised].***

4. It was noted that some X-ray examination tables would benefit from the addition of lead protective drapes, between the table top and the floor, to provide improved protection for the cardiologist/radiologist/operator ***[Advised].***

5. Consideration should be given to the current practice of designating the whole of both departments as controlled areas. It may be that this devalues the concept of such designation, and that a suitable combination of controlled and supervised areas could be more appropriate ***[Advised].***

6. Consideration should be given to the appointment of responsible persons in each section of each department to take local responsibility for radiation safety ***[Advised].***

7. A more formal system will need to be introduced to ensure the protection of visiting workers from another employer (e.g. service engineers working on radiation equipment) ***[Important].***

Appendix X

DETAILED FINDINGS: OCCUPATIONAL RADIATION PROTECTION IN FACILITIES – INSTITUTE OF ONCOLOGY

[Based on Questionnaire No.4]

X.1. INTRODUCTION

The Institute of Oncology is the only cancer treatment hospital in Slovenia and treats some 4,500 patients per year. There are 140 staff working with ionizing radiation. The work involves:

- two linear accelerators;
- two cobalt-60 therapy machines;
- one therapy X-ray set operating at up to 150 kVp;
- brachytherapy with caesium-137 and iridium-192, using after-loading techniques;
- treatment with iodine-131, up to 150 mCi per patient;
- diagnostic nuclear medicine, using Tc-99;
- seven diagnostic X-ray machines for treatment planning;
- two X-ray devices for radiobiology studies.

X.2. FRAMEWORK OF RADIATION PROTECTION

No control is exercised over contractors, principally because their work (e.g. service engineers working with machines) was not appreciated as requiring specific control. Attention was drawn to the new requirements that would be introduced as a result of conforming to the BSS and the EU controls. Staff at the Institute were not aware of the potential content of impending new legislation in Slovenia but a representative has been involved in drafting a regulation on radiation protection of patients undergoing medical examinations.

X.3. DOSE LIMITATION

In accordance with current legislation in Slovenia, if a worker were to exceed a dose limit he/she would be moved away from work with radiation sources. Similar action would be taken if a woman were to declare herself pregnant. It was reported that no worker has exceeded 20 $mSv.y^{-1}$ during the past 10 years, the highest recorded annual dose during this period being 12 mSv.

X.4. OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

An internal order requires protection to be optimized and requires money to be spent on protection. Formal optimization requirements are not a part of current legislation and consequently there are few formal practices designed specifically to achieve optimization of protection. Dose constraints are not set. However, the radiation protection officer keeps annual dose records for all workers in a convenient format that allows annual trends to be readily identified.

X.5. RADIATION PROTECTION PROGRAMMES

(a) Prior radiological evaluation

(b) Radiation Protection Measures

Assignment of responsibilities

Internal regulations allocate responsibilities, largely in accordance with the current Slovenian legislation. A radiation protection officer is appointed, but it was noted that he retires in the near future.

Classification of Areas

Controlled areas are established and notices are displayed at points of entry. However, the notices generally draw attention to the presence of radiation, rather than specifically mentioning a controlled area. Electrical interlocks are fitted to the doors into the rooms housing the accelerators and cobalt units; however their mode of operation did not appear to 'fail to safety'. All treatment areas are consistently designated as 'controlled', as is the whole of the brachytherapy department.

It was noted that personal dosemeters are mounted at fixed locations in controlled areas, usually close to the operator's position, to provide an ongoing record of ambient doses in these areas. Conditions in the controlled areas and in adjacent areas are reviewed by the service providers at six monthly intervals where unsealed radioactive material is used and used annually where only external radiation is present.

Supervised areas are not required in current Slovenian legislation and have not been designated.

Local rules, supervision and personal protection equipment

Although primarily only recommended (as opposed to required) in current legislation, personal protective equipment is provided as necessary and workers are trained and required to use it as appropriate.

Work planning and radiation work permits

Some work planning is included in internal regulations, but not in any great detail. These regulations do include advice on when to consult the radiation protection officer. Work permits are not used.

(c) Radiation monitoring and dose assessment

General

Assessment of occupational exposure is performed by the IJS for external radiation and by the IOS for intakes of radionuclides. Information is provided to the dosimetry service regarding the types of radiation likely to be encountered, but this cannot be used effectively for workers who work in more than one area. All staff working with radiation sources are subject to occupational dose assessment, whether or not they enter controlled areas.

Individual monitoring for external radiation

Visitors are not normally allowed to enter controlled areas, meaning that monitoring is not required.

Monitoring for workers is generally at a set frequency, rather than determined by the potential for exposure. Where higher/variable dose rates are likely to be encountered, additional dosemeters are used especially for extremities. Supporting electronic dosemeters, with alarms, are available and used where appropriate.

Workplace monitoring

Regular monitoring for both dose rate and surface contamination takes place in the brachytherapy department and in the isotope department. Results are generally not recorded unless they exceed the equivalent of three tenths of appropriate limits. In these areas, there appeared to be sufficient numbers of functioning monitors available. An additional feature was an installed gamma alarm monitor at the door out of the brachytherapy department, to warn of any patients trying to leave whilst still undergoing treatment.

Otherwise, routine workplace monitoring is only undertaken at either six monthly or 12-monthly intervals by the service providers, as required by current legislation.

Individual monitoring for intakes of radionuclides

No information recorded.

Investigation and intervention levels

Levels equivalent to three tenths of appropriate dose limits are usually set as effective intervention levels, other investigation levels have not been considered. (For example, a dose exceeding 6 mSv on a single monthly dosemeter would result in the worker being taken off work with radiation and referred for medical examination). Formal responsibilities have not been identified.

Dose record keeping

This is left very much to the service providers. However, it was noted that the radiation protection officer did maintain his own dose records in such a way that annual trends could be identified.

X.6. INFORMATION AND TRAINING

Information, initial training and retraining is provided in accordance with current legislation.

X.7. QUALITY ASSURANCE, AUDITS AND REVIEWS

A QA/QC network has been established for teletherapy work. Calibration of radiotherapy sources and measuring instruments is undertaken by the IJS, and the Seibersdorf laboratory in Austria also provides assistance.

In general there are few, if any, formal QA procedures in place in relation to occupational exposure control.

X.8. INTERVENTION IN EMERGENCIES

The internal regulations specify actions to be taken in a number of identifiable accident and incident situations. These are principally designed for the benefit of the patient but include occupational protection measures for the staff involved. It was not clear how well staff are instructed concerning these procedures or whether exercises are conducted. Dose constraints are not specified. All accident and incident situations must be investigated and a written report produced.

X.9. HEALTH SURVEILLANCE

Health surveillance of workers is maintained in accordance with the current legislation. Medical examinations of workers is undertaken by the IOS.

X.10. CONCLUSIONS

The appraisal team concludes that the following provisions are worthy of special merit:

— The regular involvement of staff in international meetings and committees results in an active interest in current safety topics such as patient protection;

— Medical surveillance is maintained in accordance with legislation;

— The RPO’s dose records enable dose trends for individual workers to be identified;

— Treatment areas are consistently designated as controlled areas, including the whole of the brachytherapy department. The radiation alarm monitor at the door into this department;

— Contamination and dose-rate monitors are readily available in the brachytherapy department;

— Although not primarily an occupational exposure topic, it was noted that a good waste storage system was in place for effluent from the iodine therapy wards.

Notwithstanding the above, the appraisal team makes the recommendations below as an aid to further strengthening the occupational radiation protection arrangements.

X.11 RECOMMENDATIONS

[See Section 2.4 for the priority of recommendations, as given in square brackets following each recommendation]

The appraisal team recommends that:

1. The institute should seek an alternative supplier of personal dosemeters for external radiation. Dosemeters should have the facility to provide energy compensation/correction to permit the more accurate assessment of dose for staff who are working with different sources of radiation of widely differing energies ***[Essential].***

2. Investigation levels should be introduced for personal monthly doses, and results exceeding these values should be investigated to determine whether or not doses are optimized. Different levels would be appropriate for different groups of workers ***[Important].***

3. The use of installed radiation warning instruments would provide much greater defence in depth in the event of an equipment/safety feature failure. It is understood that the IAEA is currently funding the provision of a number of such instruments and it is recommended that they be installed without delay. Once installed, they should be subject to quality controlled performance checks ***[Essential].***

4. Since all staff are provided with personal dosimeters, the current practice of fixing environmental monitors in operator areas might be questioned ***[Advised].***

5. Staff should be encouraged to undertake more in-house dose and dose-rate measurements, particularly as a part of operational studies with a view to improving working practices and reducing staff doses (i.e. optimization of protection). This would be facilitated by the provision of more adequate staffing levels as recommended below. Investigation levels should be set above which results should be permanently recorded. Such records should then be periodically reviewed to identify whether any systematic variations are occurring and this would provide a valuable aid to the optimization of protection ***[Advised].***

6. The pipe-work to the waste storage tanks should be clearly marked to indicate the potential presence of internal contamination and a permit to work scheme should apply to any associated maintenance work on the pipe-work and on the tanks. Alternatively, if it is not now practicable to mark the pipe-work, clear procedures should remain in place to ensure that similar precautions are taken ***[Important].***

7. Whilst strictly outside the remit of this appraisal mission, it has to be noted that the number of trained physicists in the institute cannot possibly be sufficient to adequately support the very high workload. This was clearly apparent during the visit to the institute. It is suspected that dose planning for patients, equipment calibrations and other essential duties must be compromised under the present situation. A significant failure to adequately support or protect patients (and staff) must be a real risk ***[Important].***

FIG. 2. Mission meeting with the counterparts.

LIST OF ABBREVIATIONS

ALARA	As low as reasonably achievable
EURADOS	European Radiation Dosimetry Group
HIRS	Health Inspectorate of the Republic of Slovenia
HPS	Health Physics Society
IJS	Institute Jozef Stefan
ILO	International Labour Office
IOS	Institute of Occupational Safety;
IRPA	International Radiation Protection Association
IRRT	International Regulatory Review Team (IAEA)
ISSDO	International Solid State Dosimetry
NPPK	Nuclear Power Plant at Krško
NRPB	National Radiological Protection Board
ORPAS	Occupational Radiation Protection Appraisal Service
OSART	Operational Safety Advisory Review Team
PROCORAD	Society for the Promotion of Quality Control in Medical and Radiotoxicological Analysis
RAIS	Regulatory Authority Information System
SNBCEI	Slovenian National Building and Civil Engineering Institute
SNSA	Slovenian Nuclear Safety Administration
SRFJ	Socialist Federal Republic of Yugoslavia
SRP	Society for Radiological Protection
SSDL	Secondary Standard Dosimetry Laboratory
UCCL	Nuclear Medicine Department of the University Clinical Centre at Ljubliana
WANO	World Association of Nuclear Operators