INSTITUTE OF RADIOPROTECTION AND DOSIMETRY - IRD

Lato Sensu Postgraduate Degree in Radiological Protection and Safety of Radioactive Sources

MODULE: 1 - FUNDAMENTALS REVIEW

COORDINATING TEACHER: JOSÉ UBIRATAN DELGADO

TOTAL MODULE HOURS: 52 hours

NUMBER OF DAYS: 13 DAYS

TEACHING STAFF:

• JOSÉ UBIRATAN DELGADO

• JOSE FRANCISCO

CLASS PERIOD: March 25th to April 12th

PROGRAM:

Mass, Charge, Energy, Phys. Basic Atomic and Nuclear, Introduction L. S., Radioactivity, Nuclear Radiations, Basic Mathematics, Review of mathematics and Physics, Alpha, beta decay, positrons, Electronic capture, gamma rays, X and Internal conversion, Activity and decay equation, Half-lives , Radioactive series and Radioactive equilibrium, Interaction of charged particles with material medium, Interaction, Braking, Penetrating power, Range and LET, Penetrating power, Range and LET, Photon interaction, Photoelectric effect, Compton scattering, Pair production, Coefficient linear attenuation, Neutron interaction, Properties, Elastic, inelastic scattering, Absorption reactions, Fission and activation, Quantities and units, Exposure, Absorbed dose and dose rate, Kerma, Radiation weight factors, ICRP60, Dose equivalent, Effective, Committed dose, Relationship between quantities, Weight factors for tissues, Incorporation of radioactive material, Radioprotection parameters, The inverse square law of distance, Radiation detectors, Nuclear instrumentation and characteristics of gas detectors and Region of operation: CI, proportional and G-M, Portable alpha detectors and scintillation detectors, Gamma detectors, x-rays, neutron detectors, Sources of natural / artificial radiation, Cosmic radiation, Healthcare exhibitions, Fallout, Nuclear explosions. Exercises. Final evaluation.

BIBLIOGRAPHY:

TAUHATA, L. et al. Radioprotection and Dosimetry – Fundamentals. IRD/CNEN. Rio de Janeiro, 2014.

TAUHATA, L., RAMOS, M. M. O. Quantities and Units. LNMRI - IRD/CNEN. Rio de Janeiro, 2011.

Handouts, various transparencies and translations.

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MODULE 2 - QUARTERIES AND MEASUREMENTS

COORDINATING TEACHER: JOSÉ UBIRATAN DELGADO

TOTAL MODULE HOURS: 32 hours

NUMBER OF DAYS: 8 DAYS

TEACHING STAFF:

• JOSÉ UBIRATAN DELGADO

• JOSE FRANCISCO

• RICARDO AMORIM

• RONALDO LINS DA SILVA

• ALFREDO LOPES FERREIRA

• WALSAN WAGNER PEREIRNA

• PEDRO PACHECO

CLASS PERIOD: April 15th to April 24th

PROGRAM:

Quantities and Measurements; Activity; Decay constant; Partial decay constant; Half life; Transition probability; Air kerma rate constant; Radiation fields; Fluency (rate); Energy flow (rate), Cross section, Mass attenuation coefficient and mass braking power; Visit to LN; Linear energy transfer; Tissue-equivalent detectors, Phantoms; Dosimetry, Chemical yield of irradiation; Metrology, Traceability and Interlaboratory Comparison Programs; Source preparation, Visit Radionuclides Lab. Principles of Radiation Detection and Measurements; Gas Detectors; Ionization chamber with current measurement; condensing chamber, Pressurized ionization chamber; extrapolation chamber. Extra class 4, Exercises; Proportional detector; G-M; Extra class 5, Exercises; Semiconductors and Scintillators. Exercises; Dosimetric Quantities and Dosimetric Calculations: calculating kerma and absorbed dose; Point, linear, planar and volumetric fonts; Calculating the absorption and scattering of photons in air and tissue; Microdosimetry; Radiological monitoring in emergency situations - Scenarios, Use of PPE and measurements with Detectors; Equivalent dose and dose rate; Radiation weight factors; Effective dose; Fabric weight factors; Weakly and strongly penetrating radiation; Ambient dose equivalent; Committed equivalent dose; Compromised effective dose. Extra class; Visit to the calibration laboratory; Final evaluation.

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BIBLIOGRAPHY:

TAUHATA, L. et al. Radioprotection and Dosimetry – Fundamentals. IRD/CNEN. Rio de Janeiro, 2014.

TAUHATA, L., RAMOS, M. M. O. Quantities and Units. LNMRI - IRD/CNEN. Rio de Janeiro, 2011.

Handouts, various transparencies and translations.

GUM “Guide for Expressing Measurement Uncertainties” – Evaluation of Measurement Data. 1st. Brazilian Edition of BIPM – Rio de Janeiro – 2012.

VIM “International Metrology Vocabulary: Concepts and Fundamentals”. INMETRO, 2012.

ABNT/ISO/IEC 17025. “General Requirements for the Competence of Testing and Calibration Laboratories”.

ICRU. International Commission on Radiological Protection. Basis for Dosimetric Quantities used in Radiological Protection. Task Group of ICRP Committee, 2005.

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MODULE 3 - BIOLOGICAL EFFECTS OF IONIZING RADIATION

COORDINATING TEACHER: ANA CRISTINA DOVALES

TOTAL MODULE HOURS: 24 hours

NUMBER OF DAYS: 6 days

TEACHING STAFF:

1- Ana Cristina Murta Dovales

2- Carlos Eduardo Bonacossa de Almeida

CLASS PERIOD: April 29th to May 7th

PROGRAM:

Review of cell biology, effect of radiation on cells, carcinogenesis, dose-response relationship, hereditary effects, effects on the embryo and fetus, epidemiological studies and issues, interpretation of epidemiological data, assessment of risks associated with doses, effects of high doses, biological dosimetry analysis of chromosomal aberrations

BIBLIOGRAPHY:

1. Alberts, B et al. Molecular Biology of the Cell. 6th edition. Garland Science (2016).
2. Hall, E.J & Giaccia, A.J. Radiobiology for the Radiologist. 7th edition. J.B. Lippincott Williams & Wilkins (2012).
3. International Atomic Energy Agency (IAEA). Cytogenetic Analysis for Radiation Dose Assessment - A Manual. Technical Reports Series (2001).
4. International Atomic Energy Agency (IAEA). Cytogenetic Dosimetry: Applications in Preparedness for and Response to Radiation Emergencies, Emergency Preparedness and Response (2011).
5. International Atomic Energy Agency (IAEA). Cytogenetic Dosimetry: Applications in Preparedness for and Response to Radiation Emergencies – Training Materials, Emergency Preparedness and Response (2013)
6. International Atomic Energy Agency (IAEA). Diagnosis and Treatment of Radiation Injuries, Safety Reports Series No. 2 (1998).
7. International Atomic Energy Agency (IAEA). Radiation Biology: A handbook for teachers and students. IAEA TCS-42 (2010).
8. International Commission on Radiological Protection (ICRP). 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, Ann. ICRP 21 (1991).
9. International Commission on Radiological Protection (ICRP). The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103. Ann. ICRP 37 (2008).

10. National Research Council, Division on Earth and Life Studies, Board on Radiation Effects Research, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006).
11. United Nations Scientific Committee on The Effects of Atomic Radiation (UNSCEAR). Sources and Effects of Ionizing Radiation. 2000 Report to the General Assembly), United Nations, New York (2000).
12. United Nations Scientific Committee on The Effects of Atomic Radiation (UNSCEAR). Heritable Effects of Radiation. 2001 Report to the General Assembly with Scientific Annex, United Nations, New York (2001).
13. United Nations Scientific Committee on The Effects of Atomic Radiation (UNSCEAR). Summary of low-dose radiation effects on health, 2010 Report to the General Assembly with Scientific Annex, United Nations, New York (2010).

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MODULE 4 - INTERNATIONAL RADIATION PROTECTION SYSTEM AND THE REGULATORY FRAMEWORK

COORDINATING TEACHER: FRANCISCO SILVA

TOTAL MODULE HOURS: 48 hours

NUMBER OF DAYS: 12 days

TEACHING STAFF:

• Francisco Cesar Augusto da Silva

• João Carlos Leocadio

CLASS PERIOD: May 13th to May 28th

PROGRAM:

3.1. Principles of Radiological Protection 3.1.1. Review of radiological protection concepts. Fundamental Security Principles. Categorization of radioactive sources. International standards and organizations UNSCEAR, ICRP and IAEA. International Recommendation GSR Part 3: Basic international safety standards for protection against ionizing radiation and for the safety of radiation sources. CNEN Standard 3.01: Basic Radiological Protection Guidelines. 3.2. Organization and Implementation of a National Regulatory Program for the Control of Radiation Sources 3.2.1. Need for a Regulatory Program: Objectives and scope. Structure of a Legal Framework. 3.2.2. Framework for a Regulatory Infrastructure in Radiological Safety: Legislation. Regulatory authority. Primary responsibility for radiological safety. 3.2.3. Basic Elements of a Regulatory Program for Radiological Safety: Financing. Regulation. Physical security of radioactive sources. Brazilian standards for the control of radiation sources. Notification of possession and use of radiation sources. Authorization for import and export of radioactive sources. Authorization for use and possession of radiation sources. Regulatory inspection. Coercion. Emergency response. Investigation and follow-up. Staffing and training. Dissemination of information. Coordination and cooperation. Technical support services. 3.2.4. Management and Assessment of the Effectiveness of the National Regulatory Program for the Control of Radioactive Sources: Management systems. Collection and analysis of program data. Program performance criteria. Program evaluation level. Need for resources.

BIBLIOGRAPHY:

3.5.1. IAEA Code of Conduct on the Safety and Security of Radioactive Sources. 3.5.2. IAEA General Safety Requirements - GSR Part 3 - Radiation Protection and safety of Radiation sources. 3.5.3. IAEA Guidance on the Import and Export of Radioactive Sources. 3.5.4. IAEA Nuclear Security Series 11 – Technical Guidance – Security of

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Radioactive Sources. 3.5.5. IAEA Safety Fundamentals – SF-1 – Fundamental Safety Principles. 3.5.6. IAEA Safety Guide – RS-G-1.9 – Categorization of Radiation Sources. 3.5.7. CNEN NN 3.01 – Basic Radiological Protection Guidelines.

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MODULE 5 - ASSESSMENT OF EXTERNAL AND INTERNAL EXPOSURES (NON-MEDICAL) (OCCCUPATIONAL)

COORDINATING TEACHER: MARISTELA SOUZA SANTOS

TOTAL MODULE HOURS: 60 hours

NUMBER OF DAYS: 15 days

TEACHING STAFF:

• Ana Letícia Almeida Dantas

• Bernardo Maranhão Dantas

• Eder Augusto de Lucena

• Maristela Souza Santos

• Sueli Alexandra de Mesquita

• Wanderson de Oliveira Souza

• Denison de Souza Santos

• Everton Rodrigues da Silva

• Marcus Alexandre Vallim de Alencar

• Ricardo Alberto Giannoni

CLASS PERIOD: June 3rd to June 21st

PROGRAM:

Assessment and Control of Occupational Exposure; Development of Monitoring Programs; Individual; Reference Levels; Quantities and Dosimetric Units; Individual Monitoring; External: Fundamentals; External Individual Monitoring Programs; Database

Personal dosimeters and Calibration of dosimeters and monitors; External Dose Assessment and Interpretation; Computational modeling; estimation of the External Dose by Cytogenetics; Internal Individual Monitoring: Fundamentals; Dosimetric Quantities and Units / Direct Monitoring Methods for In Vivo Bioanalysis; Indirect In Vitro Bioanalysis Monitoring Methods; Air Monitoring: Aerosol; Practice at LABMIV - Monitoring in the Whole Body Counter / Practice in the In Vitro Bioanalysis Lab; Practice at LABMIV - Monitoring in the Whole Body Counter / Practice in the In Vitro Bioanalysis Lab; Biokinetic Models and Dosimetric Models; Interpretation of bioanalysis data; AIDE Program

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BIBLIOGRAPHY:

- BELL S., A Beginner's Guide to Uncertainty of Measurement, NPL Measurement Good Practice Guide No. 11 (Issue 2), National Physical Laboratory, Teddington (2001).
- CASTELLANI C.M., MARSH J.W., HURTGEN C., BLANCHARDON E., BERARD P.,
- GUISSANI A., LOPEZ M.A., IDEAS Guidelines (Version 2) for the Estimation of Committed Doses from Incorporation Monitoring Data, EURADOS Report 2013-01, ISSN 2226-8057, Braunschweig (2013).
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- EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation
- Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Direct Methods for Measuring Radionuclides in the Human Body, Safety Series No. 114, IAEA, Vienna (1996).
- Calibration of Radiation Protection Monitoring Instruments, Safety Series No. 16, IAEA, Vienna (2000).
- Indirect Methods for Assessing Intakes of Radionuclides Causing Occupational Exposure, Safety Reports Series No. 18, IAEA, Vienna, (2002).
- Methods for Assessing Occupational Radiation Doses due to Intakes of Radionuclides, Safety Reports Series No. 37, IAEA, Vienna, (2004).
- Environmental and Source Monitoring for Purposes of Radiation Protection, IAEA Safety Standards Series No. RS-G-1.8, IAEA, Vienna (2005).
- Intercomparison of Personal Dose Equivalent Measurements by Active Personal Dosimeters, IAEA TECDOC Series No. 1564, IAEA, Vienna, (2007).
- Measurement Uncertainty, IAEA TECDOC Series No. 1585, IAEA, Vienna (2008).
- Determination and Interpretation of Characteristic Limits for Radioactivity Measurements - Decision Threshold, Detection Limit and Limits of the Confidence Interval, IAEA Analytical Quality in Nuclear Applications Series No. 48, IAEA, Vienna (2018).
- Radiation Protection of the Public and the Environment, IAEA Safety Standards Series No. GSG-8, IAEA, Vienna (2018).
- Prospective Radiological Environmental Impact Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSG-10, IAEA, Vienna (2018).

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- INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE,
- Occupational Radiation Protection, IAEA Safety Standards Series No. GSG-7, IAEA, Vienna (2018).
- INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH
- ORGANIZATION, Radiation Protection and Safety in Medical Uses of Ionizing Radiation, IAEA Safety Standards Series No. SSG-46, IAEA, Vienna (2018).
- INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Human
- Respiratory Tract Model for Radiological Protection, ICRP Publication 66. Ann. ICRP 24 (1- 3) (1994).
- General Principles for the Radiation Protection of Workers, ICRP Publication 75. Ann. ICRP 27 (1) (1997).
- Human Alimentary Tract Model for Radiological Protection, ICRP Publication 100. Ann. ICRP 36 (1-2) (2006).
- Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures, ICRP Publication 116, Ann. ICRP 40(2-5) (2010).
- Occupational Intakes of Radionuclides: Part 1, ICRP Publication 130. Ann. ICRP 44(2) (2015).
- Occupational Intakes of Radionuclides: Part 2, ICRP Publication 134. Ann. ICRP 45(3/4), (2016).
- Occupational Intakes of Radionuclides: Part 3, ICRP Publication 137. Ann. ICRP 46(3/4) (2017).
- INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, Determination of the
- characteristic limits (decision threshold, detection limit and limits of the confidence interval) for measurements of ionizing radiation -- Fundamentals and application, ISO 11929:2010, ISO, Geneva (2010).
- NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS,
- Development of a Biokinetic Model for Radionuclide-Contaminated Wounds and Procedures for Their Assessment, Dosimetry and Treatment, NCRP report 156, NCRP, Bethesda (2006).
- -Uncertainties in Internal Radiation Dose Assessment, Report No. 164, NCRP, Bethesda (2009).

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MODULE 6 - ASSESSMENT OF EXTERNAL AND INTERNAL EXPOSURES (NON-MEDICAL) (OCCCUPATIONAL)

COORDINATING TEACHER: FRANCISCO SILVA

TOTAL MODULE HOURS: 16 hours

NUMBER OF DAYS: 4 days

TEACHING STAFF:

• Francisco Silva

CLASS PERIOD: June 24th to June 27th

PROGRAM:

3.1. Structure of occupational radiological protection 3.2. Exposure of workers in planned exposure situations 3.3. Exposure of workers in emergency exposure situations 3.4. Exposure of workers in existing exposure situations

BIBLIOGRAPHY:

6.1. IAEA Fundamental Safety Principles. Safety Fundamentals SF-1. 2006 6.2. IAEA Categorization of Radioactive Sources. Safety Guide RS-G-1.9. 2005 6.3. IAEA Occupational Radiation Protection. General Safety Guide GSG-7. 2018 6.4. IAEA Radiation Protection and Safety of Radiation sources: International Basic Safety Standards. General Safety Requirements GSR Part 3. 2014 6.5. IAEA Radiation Safety of Gamma, Electron and X-Ray Irradiation Facilities. Safety Standards Series SSG-8. 2010 6.6. IAEA Safety of Radiation Generators and Sealed Radioactive Sources. Safety Guide RS-G-1.10. 2006 6.7. CNEN Basic Radiological Protection Guidelines. CNEN NN 3.0 standard. 2014 6.8. CNEN Exclusion criteria, exemption and exemption from radiological protection requirements. CNEN NN 3.01/001 standard. 2011 6.9. CNEN Dose restriction, occupational reference levels and classification of areas. CNEN NN 3.01/004 standard. 2011 6.10.CNEN Glossary of the Brazilian nuclear and radiological sector. 2020 6.11.IAEA Safety glossary. 2019.

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MODULE 7 - PLANNED EXPOSURE SITUATIONS IN NON-MEDICAL APPLICATIONS

COORDINATING TEACHER: FRANCISCO SILVA AND PAULO FERREIRA

TOTAL MODULE HOURS: 64 hours

NUMBER OF DAYS: 16 days

TEACHING STAFF:

- Francisco Cesar Augusto Da Silva
- João Carlos Leocadio
- Paulo Roberto Rocha Ferreira
- Alfredo Lopes Ferreira Filho

CLASS PERIOD: July 1st to July 22nd

PROGRAM:

Occupational radiological protection in industrial radiography; Occupational radiological protection oil well logging; Occupational radiological protection industrial meters; Occupational radiological protection industrial accelerators; Organization and Management – APPLICATION OF IAEA BASIC STANDARDS - Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards among others; Radiological Protection Program; Installation project characteristic; monitoring of workplaces; area classification, personal protection; optimization of radiological protection; quality assuranceNORM in industry, radiological protection in facilities process flow diagram; main international bodies related to the transport of radioactive material, main documents related to safety in the transport of radioactive materials, sealed sources, classes of radioactive materials, excepted materials, low specific activity materials, contaminated objects on the surface, fissile materials, selection packaging, Q system, packaging characteristics, general requirements for packaged objects, industrial, type A, B, BU, BM, E, low dispersivity and packaged materials containing fissile materials, operational controls, transport index, criticality, marking, labeling and placards, permissible radiation levels.

BIBLIOGRAPHY:

6.1. Lessons Learned from Accidents in Industrial Radiography, Safety Reports Series No. 7, IAEA, Vienna (1998). 6.2. Radiation Safety in Industrial Radiography, IAEA Safety Standards Series No. SSG-11, IAEA, Vienna (2011). 6.3. Radiation Safety of Gamma, Electron and X Ray Irradiation Facilities, IAEA Safety Standards Series No. SSG-8, IAEA, Vienna (2010). 6.4. Radiological Safety Aspects of the Operation of Electron Linear Accelerators, Technical Reports Series No. 188, IAEA, Vienna (1979). 6.5. Safety of radiation generators and sealed radioactive sources, IAEA Safety Standards Series

No. RS-G-1.10, IAEA, Vienna (2006). 6.6. The Radiological Accident at the Irradiation Facility in Nesvizh, IAEA, Vienna (1996); 6.7. The Radiological Accident in Chile, IAEA, Vienna (2009). 6.8. The Radiological Accident in Cochabamba, IAEA, Vienna (2004). 6.9. The Radiological Accident in Gilan, IAEA, Vienna (2002). 6.10.The Radiological Accident in San Salvador, IAEA, Vienna (1990). 6.11.The Radiological Accident in Soreq, IAEA, Vienna (1993). 6.12.The Radiological Accident in Yanango, IAEA, Vienna (2000).

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MODULE 8 - PLANNED EXPOSURE SITUATIONS IN MEDICAL APPLICATIONS

COORDINATING TEACHER: ALEXANDRE DA FONSECA VELASCO

TOTAL MODULE HOURS: 60 hours

NUMBER OF DAYS: 15 days

TEACHING STAFF:

• ALEXANDRE DA FONSECA VELASCO

• CLAUDIO DOMINGUES

• DELANO BATISTA

CLASS PERIOD: July 29th to August 16th

PROGRAM:

General Principles: Medical exposure for diagnostic and treatment purposes; registration of professionals; graduates; role and responsibilities of the radiologic physician, medical physicist, and medical radiation technologist; Training: Workers to be trained; content of training programs; program updates; refresher training; Unintentional and Accidental Medical Exposures: Identification and investigation of unintentional and accidental medical exposures; report to the regulatory body, when appropriate; lessons learned and feedback in operation; Records: Identification of information to be recorded related to the type of medical exposure; Introduction: Principles of radiological protection applicable to diagnostic radiology and image-guided interventional procedures; Justification: Levels of justification; special cases – pregnancy, pediatric patients; alternative techniques; damage assessment; reference guidelines; Design considerations for equipment - International requirements or standards (IEC, ISO) for radiation generators; basic technical characteristics; regular inspection and maintenance; Operational Considerations: Choice of appropriate equipment; factors affecting patient dose and the choice of technique and parameters to provide the minimum patient exposure to meet the clinical objective; Calibration: Calibration of radiation generators, including quantities, protocols and traceability; calibration of dosimeters; Patient Dosimetry: Evaluation of typical doses for common radiological procedures and image-guided interventional procedures; Control of Occupational and Public Exposure: Safety assessment, particularities: Control of occupational exposure: particularities related to the project, source of occupational exposure, definition of areas, examples of local rules, personnel to be considered occupationally exposed and related dose assessment methods , personal protective equipment, definition of investigation levels, dose restriction. Control of public exposure: sources of public exposure, measures to ensure control of public

exposure (design, visitor control, signage). Safety assessment: identification of aspects that must be considered in the assessment of safety, risks and possible accidents.

BIBLIOGRAPHY:

EUROPEAN COMMISSION, Criteria for Acceptability of Medical Radiological Equipment used in Diagnostic Radiology, Nuclear Medicine and Radiotherapy, Radiation Protection No. 162, EC, Luxembourg (2012).

INTERNATIONAL ATOMIC ENERGY AGENCY, Accidental Overexposure of Radiotherapy Patients in San José, Costa Rica, IAEA, Vienna (1998).

- Lessons Learned from Accidental Exposures in Radiotherapy, Safety Reports Series No. 17, IAEA, Vienna (2000).

- Investigation of an Accidental Exposure of Radiotherapy Patients in Panama, IAEA, Vienna (2001).

- Radiological Protection of Patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy, Proceedings Series, IAEA, Vienna (2001).

- Optimization of Radiation Protection in the Control of Occupational Exposure, Safety Reports Series No 21, IAEA (2002).

- Accidental Overexposure of Radiotherapy Patients in Bialystok, IAEA, Vienna (2004).

- Applying Radiation Safety Standards in Nuclear Medicine, Safety Reports Series No 40, IAEA, Vienna, (2005).

- Applying Radiation Safety Standards in Diagnostic Radiology and Interventional Procedures Using X Rays, Safety Reports Series No 39, IAEA, Vienna, (2006).

- Applying Radiation Safety Standards in Radiotherapy, Safety Reports Series No 38, IAEA, Vienna, (2006).

- Nuclear Medicine Resources Manual, IAEA, Vienna, (2006).

- Radiation Protection in the Design of Radiotherapy Facilities, Safety Reports Series No 47, IAEA, Vienna, (2006).

-Dosimetry in Diagnostic Radiology: An International Code of Practice, Technical Reports Series No. 457, IAEA, Vienna (2007).

- Release of Patients After Radionuclide Therapy Safety Reports Series No. 63, IAEA, Vienna, (2009).

- Radiation Protection in Paediatric Radiology, Safety Reports Series No. 71, IAEA, Vienna, (2012).

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- Diagnostic Radiology Physics - A Handbook for Teachers and Students, IAEA, Vienna (2014).

- Nuclear Medicine Physics - A Handbook for Teachers and Students, IAEA, Vienna (2015).

- Radiation Protection of Patients Website, IAEA, Vienna. Accessible at: https://rpop.iaea.org.

INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Occupational Radiation Protection, IAEA Safety Standards Series No. GSG-7, IAEA, Vienna (2018).

INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety in Medical Uses of Ionizing Radiation, IAEA Safety Standards Series No. SSG-46, IAEA, Vienna (2018).

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Avoidance of Radiation Injuries from Medical Interventional Procedure, Publication No. 85, Ann ICRP 30(2), Elsevier Science Ltd, Oxford (2000).

- Prevention of Accidents to Patients Undergoing Radiation Therapy, Publication No. 86, Ann ICRP 30(3), Elsevier Science Ltd, Oxford (2000).

- Prevention of High-dose- rate Brachytherapy Accidents, Publication No. 97, Ann ICRP 35(2), Elsevier Science Ltd, Oxford (2005).

- Radiological Protection in Medicine, ICRP Publication 105. Ann. ICRP 37 (6), Elsevier Science Ltd, Oxford (2007).

- Preventing Accidental Exposures from New External Beam Radiation Therapy Technologies, Publication No. 112, Ann ICRP 39(4), Elsevier Science Ltd, Oxford (2009). - Radiological Protection in Cardiology, Publication No. 120, Ann ICRP 42(1), Elsevier Science Ltd, Oxford (2013).

- Radiological Protection in Paediatric Diagnostic and Interventional Radiology, Publication No. 121, Ann ICRP 42(2), Elsevier Science Ltd, Oxford (2013).

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MODULE 9 - EXPOSURE SITUATIONS, PREPARATION AND EMERGENCY RESPONSE

COORDINATING TEACHER: RAUL SANTOS

TOTAL MODULE HOURS: 20 hours

NUMBER OF DAYS: 5 days

TEACHING STAFF:

• RAUL SANTOS

• CARLOS

• NILTON

• VANESSA

CLASS PERIOD: August 19th to August 23rd

PROGRAM:

Nuclear and Radiological Accidents in the World; Categorization of Ionizing Radiation Sources; Preparedness and Response, response management; RADEX, Goiania accident, PPE, PRD RID nuclear instrumentation, monitoring procedures, dirty war.

BIBLIOGRAPHY:

1. EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF

THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY,

INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY

AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS

ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation

Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).

2. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS,

INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL

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AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEARTEST-BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

3. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-2, IAEA, Vienna (2011).

4. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2007).

5. INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Early Notification of a Nuclear Accident, IAEA, Vienna (1986).

6. Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency, IAEA, Vienna (1986).

7. Arrangements for the Termination of a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-11, IAEA, Vienna (2018).

8. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations, ICRP Publication 109, Ann. ICRP 39 (1), Elsevier (2009).

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MODULE 10 - PUBLIC EXPOSURE TO IONIZING RADIATION (ENVIRONMENTAL)

COORDINATING TEACHER: LAÍS ALENCAR DE AGUIAR

TOTAL MODULE HOURS: 60 hours

NUMBER OF DAYS: 15 days

TEACHING STAFF:

• LAIS ALENCAR DE AGUIAR

• ELAINE

• MARIZA

• ANA CRISTINA

CLASS PERIOD: August 26th to September 13th

PROGRAM:

Environmental radioprotection, environmental radiological impact assessment, methodologies applied to environmental monitoring, planned exposure situation, existing exposure situation, emergency exposure situation.

BIBLIOGRAPHY:

EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014). INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Radiation Protection against Radon in Workplaces other than Mines, Safety Reports Series No. 33, IAEA, Vienna (2003). - Remediation Process for Areas Affected by Past Activities and Accidents, IAEA Safety Standards Series No. WS-G-3.1, IAEA, Vienna (2007). - Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSR Part 5, IAEA, Vienna (2009). - Disposal of Radioactive Waste, IAEA Safety Standards Series No. SSR-5, IAEA, Vienna (2011). - Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. SSR-6, Vienna (2012). INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 2007 Recommendations of the International Commission on Radiological Protection, Publication 103, Pergamon Press, Oxford and New York (2007). - Radiological Protection against Radon Exposure, ICRP Publication 126, Ann. ICRP 43(3). ICRP (2014). JOINT FAO/WHO FOOD STANDARDS PROGRAMME, CODEX

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ALIMENTARIUS COMMISSION, Codex General Standard for Contaminants and Toxins in Foods, Schedule 1 — Radionuclides, CODEX STAN 193–1995, CAC, Rome (2015). UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATION, UNSCEAR 2006 Report to the General Assembly, Vol. II, Annex E: Source-to effects Assessment for Radon in Homes and Workplaces, United Nations, New York (2008). - Sources and Effects of Ionizing Radiation, UNSCEAR 2008 Report to the General Assembly with Scientific Annexes, Vol. 1, Annex B: Exposures of the Public and Workers from Various Sources of Radiation, United Nations, New York (2010). WORLD HEALTH ORGANIZATION, WHO Handbook on Indoor Radon: A Public Health Perspective, WHO, Geneva (2009). - Guidelines for Drinking-water Quality — 4th Ed., WHO, Geneva (2011).

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MODULE 11 – SAFETY CULTURE

COORDINATING TEACHER: LAÍS ALENCAR DE AGUIAR

TOTAL MODULE HOURS: 8 hours

NUMBER OF DAYS: 2 days

TEACHING STAFF:

• LAIS ALENCAR DE AGUIAR

• CLAUDIA DA SILVA SILVEIRA

CLASS PERIOD: September 16th to 17th

PROGRAM:

Introduction. Theoretical foundations of culture: basic concepts and cultural change. Safety culture in organizations, facilities and activities with sources of ionizing radiation: conceptual particularities; and practical particularities. Basic elements of safety culture: the 10 basic elements of safety culture specific to organizations that carry out activities with radiation sources. Safety culture levels: benefit and complexity of establishing safety culture levels; and levels of safety culture in organizations that carry out activities with radiation sources. Safety culture indicators: importance and types of safety culture indicators; safety culture indicators; and threats to security culture and symptoms of its deterioration in an organization. Safety culture assessment: particularities, forms, stages, and assessment techniques. Promotion and development of safety culture. Safety culture and safety management systems. Safety culture in regulatory bodies. Analysis of the impact of safety culture on the occurrence of radiological events.

BIBLIOGRAPHY:

IAEA. Security culture in organizations, installations and activities linked to the use of ionizing radiation sources. IAEA-TECDOC-1995. Vienna, 2022

FORUM. Security Culture in organizations, installations and activities containing sources of ionizing radiation. Forum (Iberoamerican Radiological and Nuclear Regulatory Organisms). Julius, 2015.

IAEA. Performing safety culture self-assessments. Safety reports series, no. 83. Vienna, 2016.

IAEA. Safety glossary - terminology used in nuclear safety and radiation protection. International Atomic Energy Agency, 2018 revision.

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IAEA. Categorization of radioactive sources. International Atomic Energy Agency, 2005. no. RS-G-1.9

IAEA. Safety assessment for facilities and activities: general safety requirements. GSR part 4 (Rev. 1) Vienna, 2016.

IAEA. Leadership and management for safety. International Atomic Energy Agency, 2016. no. GSR part 2

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MODULE 12 – TRAINING COACHES

COORDINATING TEACHER: AUCYONE AGUSTO DA SILVA

TOTAL MODULE HOURS: 20 hours

NUMBER OF DAYS: 5 days

TEACHING STAFF:

• AUCUYONE AUGUSTP DA SILVA

• PAMELA PERROTTA

CLASS PERIOD: September 23rd to 27th

PROGRAM:

General considerations about how people learn: Factors that can affect the success of a training sequence: classroom environment, student state of mind; teacher/coach. Different ways of learning. Different personal styles. Need to adapt the style of the trainer/teacher to meet the needs of different learners. (students); Comparison between andragogy and pedagogy. Andragogy – Knowles' model. Honey and Mumford– Learning styles. Kolbe's learning cycle: the importance of experience and reflection. Motivation – why it is important and how to improve it. Application of training sequences in Radiation Protection (Radioprotection); Training needs analysis Systematic approach to learning. Knowledge, competence and qualification processes. Characteristics of the people to be trained: qualified specialists; Radioprotection Supervisor; qualified operators; Health professionals; practicing physician; workers, including operators of radiation applications and those marginally involved in radiation work activities; employees of regulatory authorities; and personnel involved in nuclear emergency responses. Being a speaker/teacher Factors that help and hinder the transmission of our message when speaking to a group. Creating the right atmosphere. Student motivation. Language adaptation. Body language. Improving group discussions. Asking and answering questions. Active listening. Using teaching materials Variety of teaching materials available: presentation, flipchart, videos, simulators, voting systems, teaching games, etc. Pros and cons of them. The effective use of teaching materials in a sequence of classes. Use of e-learning tools and methodologies. Simple rules for an impactful presentation using PowerPoint. Data presentation.

BIBLIOGRAPHY:

- INTERNATIONAL ATOMIC ENERGY AGENCY, Training in Radiation Protection and the Safe Use of Radiation Sources, Safety Reports Series No. 20, IAEA, Vienna (2001).

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- Establishing the Infrastructure for Radiation Safety, Specific Safety Guide No. SSG-44, IAEA, Vienna (2018).

- ENAP Teaching Material