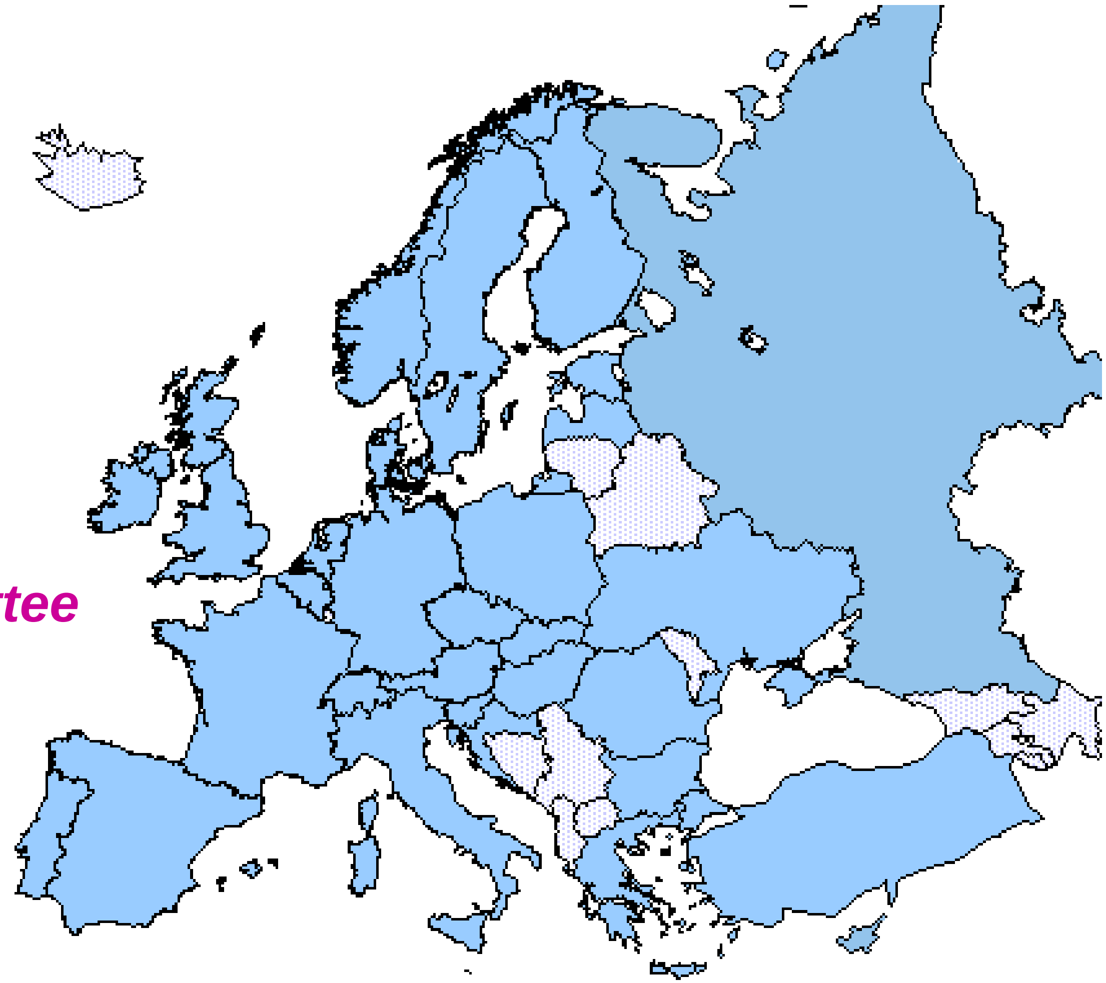
The Medical Physics Expert in Europe



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The Medical Physics Expert in Europe

OUTLOOK

- Definition and Recognition
- Roles and Responsibilities
- Knowledge, Skills and Competence
- Staffing Levels
- Next Steps
- Conclusions

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- **Definition and Recognition**

  Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 6/29/Euratom, 97/43/Euratom and 2003/122/Euratom (EU BSS).

  "medical physics expert" means an individual or, if provided for in national legislation, a group of individuals, having the knowledge, training and experience to act or give advice on matters relating to radiation physics applied to medical exposure, whose competence in this respect is recognised by the competent authority;

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- **Definition and Recognition**

Article 14, paragraph 2 of Directive 2013/2013/EURATOM states:

"Member States shall ensure that arrangements are made for the establishment of education, training and retraining to allow the recognition of radiation protection experts and medical physics experts, as well as occupational health services and dosimetry services, in relation to the type of practice".

There are also clauses in the above directive that emphasise the requirements for recognition.

All Medical Physicists should read carefully this directive in order to identify the clauses that effect the Medical Physics Profession.

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- **Roles and Responsibilities**

Article 83 - Medical physics expert, states:

1. **Member States shall require the medical physics expert to act or give specialist advice, as appropriate, on matters relating to radiation physics for implementing the requirements set out in Chapter VII and in point (c) of Article 22(4) of this Directive.**
2. **Member States shall ensure that depending on the medical radiological practice, the medical physics expert takes responsibility for dosimetry, including physical measurements for evaluation of the dose delivered to the patient and other individuals subject to medical exposure, give advice on medical radiological equipment, and contribute in particular to the following:**

   (a) optimisation of the radiation protection of patients and other individuals subject to medical exposure, including the application and use of diagnostic reference levels;

   (b) the definition and performance of quality assurance of the medical radiological equipment;

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- **Roles and Responsibilities**

  (c) acceptance testing of medical radiological equipment;

  (d) the preparation of technical specifications for medical radiological equipment and installation design;

  (e) the surveillance of the medical radiological installations;

  (f) the analysis of events involving, or potentially involving, accidental or unintended medical exposures;

  (g) the selection of equipment required to perform radiation protection measurements;

  (h) the training of practitioners and other staff in relevant aspects of radiation protection;

3. The medical physics expert shall, where appropriate, liaise with the radiation protection expert.

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- **Knowledge, Skill and Competence**

The European Commission Radiation Protection Report 174 "Guidelines on Medical Physics Expert", specifies the requirements that a Medical Physicist should fulfil in order to be recognised as a Medical Physics Expert by the relevant Competent Authorities as specified by Directive 2013/59/EURATOM.

In these guidelines the Qualification Framework for Medical Physics Experts in Europe is defined and presented diagrammatically.

Qualification Framework for the Medical Physics Expert (MPE) in Europe

MPE: "An individual having the knowledge, training and experience to act or give advice on matters relating to radiation physics applied to medical exposure, whose competence to act is recognized by the Competent Authorities" (Revised BSS)

The Qualifications Framework is based on the European Qualifications Framework (EQF). In the EQF learning outcomes are defined in terms of Knowledge, Skills, Competences (KSC) (European Parliament and Council 2008/C 111/01)

EDUCATION

EQF Level 6
(e.g., Bachelor with 180 - 240 ECTS)
(i)

Physics or equivalent
(ii)

EQF Level 7
(e.g., Master with 90 - 120 ECTS)
(iii)

Medical Physics* or equivalent
(iv)

CLINICAL TRAINING

Clinical Certification in Medical Physics Specialty
(v)

Structured accredited clinical training residency in the specialty of Medical Physics in which the candidate seeks clinical certification. The duration should be typically two full-time year equivalents**
(vi)

ADVANCED EXPERIENCE and CPD

EQF Level 8 in Medical Physics Specialty
(vii)

Structured accredited advanced experience and CPD in the specialty of Medical Physics in which the candidate seeks certification as MPE. The duration would be an additional *minimum* of two full-time year equivalents***
(viii)

RECOGNITION

By Competent Authorities as MPE in Medical Physics specialty
(ix)

RE-CERTIFICATION

5 year CPD cycle
(x)

* Should include, as a minimum, the educational components of the Core KSC of Medical Physics and the educational components of the KSC of the specialty of Medical Physics (i.e., Diagnostic & Interventional Radiology or Nuclear Medicine or Radiation Oncology) for which the candidate seeks clinical certification. When this element of specialization is not included it must be included in the residency.

** The EQF level of the residency is intermediate between EQF levels 7 and 8.

*** In countries where the MPE is required to be certified in more than one specialty of Medical Physics the number of years would need to be extended such that the MPE will achieve level 8 in each Specialty.

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- **Knowledge, Skill and Competence**

	Note	Rationale
(i)	The background educational level for the Medical Physicist is a Level 6 in Physics and Mathematics (The European Federation of Organisations for Medical Physics. Policy Statement No. 12: The present status of Medical Physics Education and Training in Europe. New perspectives and EFOMP recommendations[15])	Medical Physicists need to have good foundations in Physics and Mathematics as Medical Physics is a physical, numeric and exact science.

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➢ Knowledge, Skill and Competence

(vii)	The MPE in a given specialty of medical physics is a professional with clinical certification in a specialty of medical physics who has achieved the highest level of expertise in that particular specialty. The medical physics professional through *structured advanced* experience, ongoing extensive CPD and commitment places the KSC at the highest possible level i.e., EQF level 8.	The qualification level for the MPE has been set at EQF Level 8 because the MPE requires knowledge at the most advanced frontier of a field of work and at the interface between fields, the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research/innovation and to extend/redefine existing professional practice, demonstrate substantial authority, innovation, autonomy, professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work contexts including research (European Parliament and Council of the European Union, 2008). To carry out activities requiring expert action, involvement or advice with authority and autonomy and which are based on current best evidence (or own scientific research when the available evidence is not sufficient), the MPE requires frontier knowledge in own specialty of medical physics and at the interface between physics and medicine. The MPE requires specialised skills and techniques in radiation protection and comprehensive experience regarding the effective and safe use of the medical devices in own specialty, and the synthesis and evaluation skills required to solve critical problems in service development, research, innovation and the extension and redefinition of existing professional practice.

Qualification Framework for the Medical Physics Expert (MPE) in Europe

MPE: "An individual having the … atters relating to radiation physics applied to medical expo… nt Authorities" (Revised BSS)

Stages of Recognition

The Qualifications Framework is based on the European Qualifications Framework (EQF). In the EQF learning outcomes are defined in terms of Knowledge, Skills, Competences (KSC) (European Parliament and Council 2008/C 111/01)

EDUCATION

EQF Level 6 (e.g., Bachelor with 180 - 240 ECTS)

EQF Level 7 (e.g., Master with 90 - 120 ECTS)

EDUCATIONAL

… Physics or equivalent (ii)

… Medical Physics* or equivalent (iv)

CLINICAL TRAINING

Clinical Certification in Medical Physics Specialty (v)

PROFESSIONAL

… clinical training residency in the specialty of Medical Physics in which the candidate seeks clinical certification. The duration should be typically two full-time year equivalents** (vi)

ADVANCED EXPERIENCE and CPD

EQF Lev… Physi…

RADIATION SAFETY

Structu… advanced experience and CPD in the specialty of Medical Physics in which the candidate seeks certification as MPE. The duration would be an additional *minimum* of two full-time year equivalents*** (viii)

RECOGNITION

By Competent …ities as MPE in …ical Physics …pecialty (ix)

RE-CERTIFICATION

5 year CPD cycle (x)

* Should include, as a minimum, the educational components of the Core KSC of Medical Physics and the educational components of the KSC of the specialty of Medical Physics (i.e., Diagnostic & Interventional Radiology or Nuclear Medicine or Radiation Oncology) for which the candidate seeks clinical certification. When this element of specialization is not included it must be included in the residency.

** The EQF level of the residency is intermediate between EQF levels 7 and 8.

*** In countries where the MPE is required to be certified in more than one specialty of Medical Physics the number of years would need to be extended such that the MPE will achieve level 8 in each Specialty.

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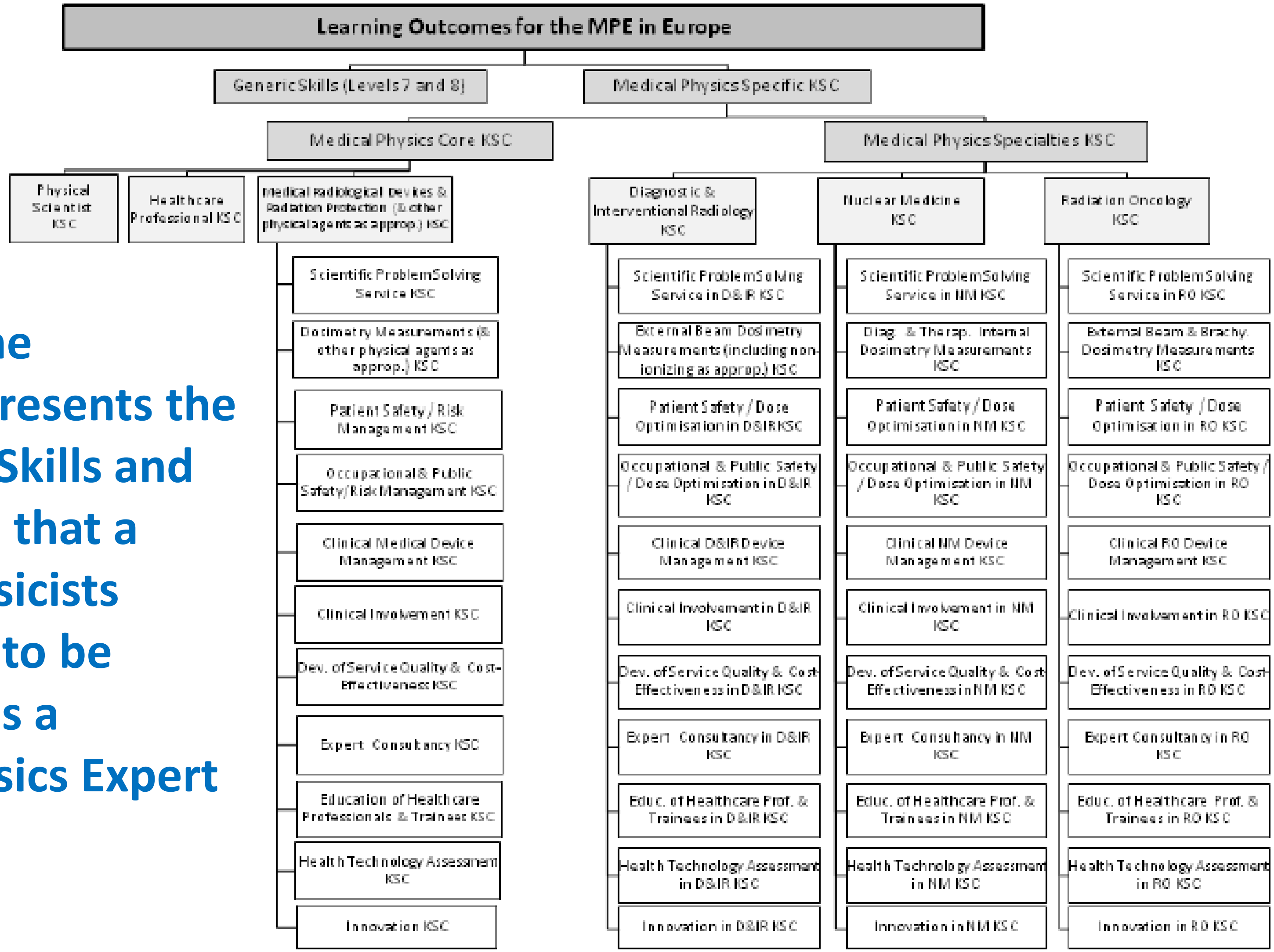
➢ Knowledge, Skill and Competence

Annex I of the Guidelines presents the Knowledge, Skills and Competence that a Medical Physicists should have to be recognised as a Medical Physics Expert



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➢ Knowledge, Skill and Competence

2 TABLE 1: GENERIC SKILLS

Generic Skills Required at Level 7	Generic Skills Required at Level 8 (MPE Level)
Instrumental 1. Retrieve information from different sources. 2. Analyze and synthesize. 3. Solve problems. 4. Use general productivity software. 5. Organize, plan and manage one's workload. 6. Communicate effectively (orally and in writing) in two European languages. 7. Take decisions in a timely manner. *Interpersonal* 1. Communicate orally and in writing with both experts in the field and non-experts. 2. Respect diversity and multiculturalism. 3. Exhibit aptitude to work in an international context. 4. Demonstrate ongoing ethical commitment. 5. Work productively in both mono-disciplinary and multi-disciplinary teams. 6. Criticise constructively and accept constructive criticism. *Systemic* 1. Generate new ideas (creativity). 2. Design and manage projects. 3. Adapt to new situations. 4. Learn autonomously and take responsibility for one's own learning. 5. Reflect and evaluate one's own practice and learning. 6. Apply research skills and use published evidence to develop and improve the quality of one's own practice. 7. Work within the scope of one's practice and abilities. 8. Seek advice when a task is outside one's ability. 9. Be entrepreneurial. 10. Display a will to succeed. 11. Display leadership and initiative. 12. Assume responsibility for one's own actions.	1. Demonstrate a systematic understanding of a field of study and mastery of the skills and methods of research associated with that field. 2. Find, select and define problems of interest. 3. Reflect upon the questions raised, the types of knowledge produced and the impact their knowledge might have on society 4. Organize a number of relevant facts in a coherent framework, which allows the development of an "economy of knowledge, based on experimental facts and overarching ideas". 5. Apply the acquired knowledge and understanding in different contexts and to innovate. 6. Conceive, design, implement and adapt a substantial process of research with integrity. 7. Make a contribution through original research that extends the frontier of knowledge some of which merits national or international refereed publication. 8. Demonstrate critical analysis, evaluation and synthesis of new and complex ideas. 9. Communicate with peers, the larger professional community and with society in general about their areas of expertise. 10. Promote within professional contexts, technological, social or cultural advancement in a knowledge based society.

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Knowledge, Skill and Competence

3 TABLE 2: KSC FOR THE MPE AS PHYSICAL SCIENTIST

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
K1. Explain the fundamental quantities and dimensions of physics, including use in checking consistency of equations. K2. Explain the common fundamental and derived constants of physics. K3. Explain the base and derived SI units. K4. Explain the properties of the common fundamental particles, including mass, charge and spin. Particle-antiparticle annihilation (in depth treatment of positron-electron annihilation). K5. Explain the various forms of energy and types of forces in nature and the properties of their carrier particles. K6. Explain the principles of quantum theory and relativistic mass-energy. K7. Explain the structure of the atom and nucleus and define the terms 'isotope' and 'isobar'. K8. Explain nuclear and electron energy levels, ionization, nuclear isomers and the auger effect. K9. Explain the structure of the periodic table and chart of the nuclides. K10. Explain the various forms of chemical bonding. K11. Explain the forms of spectroscopy / spectrometry (including MRS and EPR) K12. Explain the band theory of solids with particular emphasis on semiconductors. K13. Discuss nuclear stability, explain quantitatively the various common modes of radioactive decay (alpha, beta, positron decay, gamma, isomeric transition, electron capture, internal conversion), explain decay schemes, gamma and beta spectra, use of decay and secular / transient equilibrium equations. K14. Explain the main types of nuclear reactions including phototransmutation. K15. Explain processes for the production of medical radionuclides using cyclotrons, reactors and generators, including quantities of generated activities in thin and thick targets. K16. Explain the characteristics of common electronic components and integrated circuits. K17. Explain the general design of a measuring instrument K18. Utilize the ISO international vocabulary of metrology (VIM). K19. Explain the specifications of measuring instruments including accuracy, SNR, precision, range of measurement, resolution, reliability (repeatability, reproducibility, consistency, stability, ruggedness), sensitivity, specificity, linearity, response time. K20. Explain the meaning of calibration (relative, absolute, calibration coefficients…), traceability and primary / secondary standards. K21. Explain in detail and quantitatively the main types of sensors, their mode of action and response: mechanical (position, velocity, force, pressure, sound and ultrasound), temperature, electric and magnetic fields, voltage, ionizing electromagnetic radiation (include gas-filled (including cavity theory, Bragg-Gray principle, conversion of charge to absorbed dose), semiconductor, scintillation-optical systems (solids and liquids), storage TL phosphor systems, optically stimulated luminescence (OSL), films (including radiochromic), non-ionizing electromagnetic radiation, ionizing particles, chemical and biochemical. K22. Explain quantitatively the following characteristics of ionizing radiation sensors / detectors: pulse height spectrum and energy resolution, counting curves and plateau, detection efficiency and energy response, dead time, detection threshold and temporal resolution.	S1. Manage the acquisition, editing, analysis, interpretation, presentation, and reporting of measurement data. S2. Communicate clearly results to peers (in the form of notes, resumes, reports, poster, article, oral presentation) at local and international meetings and for research journals. S3. Use statistical techniques / tests and software to analyse measurement data and manage associated uncertainties. S4. Able to analyze critically the international literature within a given area of research S5. Design and evaluate systems for the rigorous and safe conduct of physical measurements and experiments.	C1. Manage the conduct of experimental work autonomously and in a safe manner. C2. Assume responsibility to autonomously: - Explain a set of research objectives worthy of attention and which are realizable given the available resources. - Write a literature review article concerning the area of interest. - Realize the research objectives by integrating and applying knowledge and skills. - Communicate clearly results to peers (in the form of notes, resumes, reports, poster, journal/conference article, oral presentation) at local and international meetings and for research journals. - Defend results in front of peers. C3. Organise networks for research and development within own scientific community. C4. Assume responsibility for ethical issues associated with research.

The first of three pages of KSCs for the MPE as a Physical Scientist

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Knowledge, Skill and Competence

4 TABLE 3: KSC FOR THE MPE AS A HEALTHCARE PROFESSIONAL

Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
K1. Explain the functions of healthcare organizations, the way healthcare is organized (internationally, nationally and locally), principles of clinical governance and developments in healthcare policy.	S1. Communicate effectively clinical information, advice, instruction and professional opinion to patients, colleagues, other healthcare professionals, support staff, service users, relatives, carers, comforters and volunteers in medical research within own area of medical physics practice using appropriate terminology.	C1. Practise responsibly within the legal, regulatory and ethical boundaries of the profession.
K2. Explain the function of the various healthcare entities (including own institution) within the local healthcare organization and their role within the national framework for healthcare provision.	S2. Establish the necessary communication links and relations with other healthcare professionals and organizational units related to own area of medical physics practice.	C2. Maintain fitness to practise in an autonomous manner.
K3. Explain the role of Medical Physics Services in healthcare.	S3. Recognize and respond appropriately to own, patients' and relatives' emotional responses.	C3. Collaborate with other healthcare professionals, support staff and service users, relatives, carers and comforters within own area of medical physics practice.
K4. Utilise accurate medical terminology in communication with other healthcare professionals.	S4. Survey EU Directives, national regulations and guidelines and recommendations from national and international organizations related to own area of medical physics.	C4. Take responsibility for the management of own workload to ensure effective and efficient input to the work of the healthcare team in own area of medical physics practice.
K5. Explain those sections of the human biological sciences (anatomy, physiology, pathology, cellular and biomolecular science, radiological anatomy) relevant to own area of medical physics practice.	S5. Make best use of available resources in the interest of patients and society.	C5. Organise the various aspects of the routine service within own area of medical physics practice.
K6. Explain and discuss the concepts of quality, safety / risk and cost-effectiveness as applied to healthcare.		C6. Work responsibly within national / local professional codes of practice and own competence limitations.
K7. Explain and discuss ethical and legal issues in healthcare relevant to the scope of the profession (e.g., research ethics, data protection, privacy, dignity, ethical governance).		C7. Take responsibility for appropriate behaviour towards colleagues, patients and relatives as stipulated by organizational policies and national legislation.
K8. Discuss those aspects of healthcare psychology and sociology relevant to the profession.		C8. Take responsibility for own input within mono-disciplinary and multi-disciplinary research teams.
K9. Explain the technological infrastructure required for quality service within own future area of medical physics.		C9. Take responsibility for making the best use of available resources to provide optimum healthcare to patients and members of society.
K10. Explain the European and national legal frameworks, regulations, guidelines and codes-of-practice impacting the role of the MPE.		C10. Assume responsibility for timely action (within own limitations) to prevent and respond to adverse events.
K11. Explain briefly European and national legal frameworks, regulations, guidelines and codes-of-practice impacting the practice of other professions with whom the MPE interacts.		C11. Assume responsibility to ensure that all activities are based on current best evidence or own scientific research when the available evidence is not sufficient.
K12. Discuss the development of the MPE profession in both the local and European context.		C12. Take responsibility to maintain one's knowledge and skills current through an appropriate continuous professional development programme.
K13. Discuss the principles of healthcare management.		C13. Facilitate learning of peers, other healthcare professionals, students (including Medical Physics trainees).
K14. Discuss the principles of epidemiology.		C14. Take responsibility for the development of effective, safe and efficient teams (including multi-professional teams) in own area of medical physics practice.
K15. Discuss the principles and processes of quantitative and qualitative research involving human subjects.		C15. Show respect towards the ethical, religious and cultural perspectives of patients.
		C16. Adhere to the Code of Ethics of the profession.
		C17. Assume responsibility for ethical issues associated with research involving human subjects.

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➢ Knowledge, Skill and Competence

8 TABLE 6: KSC SPECIFIC FOR THE MPE IN NUCLEAR MEDICINE

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Scientific Problem Solving Service	K1. Explain statutory and institutional requirements for Medical Physics Services in Nuclear Medicine with respect to Scientific Problem Solving Service. K2. Explain the application of beta decay, electron capture, positron decay, positron annihilation, isomeric transitions in Nuclear Medicine. K3. Explain the functioning of the radiation detectors specific to Nuclear Medicine. K4. Illustrate the characteristics of a Nuclear Medicine counting system including the effect of background counts and minimum detectable counts. K5. Discuss the characteristics of electronics related to Nuclear Medicine devices K6. Explain the concepts of fundamental detector properties like energy resolution, sensitivity, spatial resolution and temporal resolution and how they affect the performance of Nuclear Medicine devices. K7. Explain how statistical techniques are used for radiation measurement in Nuclear Medicine K8. Explain the physical and technological working principles of the imaging devices used in Nuclear Medicine including gamma camera systems, single photon and positron emission tomography systems, combined modality systems and dedicated scanner design. K9. Explain the application of Information and Communication Technology (ICT) to Nuclear Medicine including image storage, image acquisition and processing and file format and secure file transfer K10. Explain the concepts of image reconstruction in Nuclear Medicine including analytical and iterative reconstruction techniques. K11. Illustrate the mathematical concepts used in Nuclear Medicine including linear systems, Fourier analysis and FFT, convolution/deconvolution, curve fitting and function optimization. K12. Explain the procedures for correction and quantitation, and fundamental limits in Nuclear Medicine. K13. Explain the concepts of compartmental analysis and its use in Nuclear Medicine. K14. Explain the main types of computer codes used for dose calculation. K15. Explain up to date Nuclear Medicine literature, scientific reports and national and international recommendations.	S1. Identify measurable physical quantities relevant to Nuclear Medicine and realize experiments for their measurement. S2. Operate radiation measurement devices/detectors and interpret the results in the context of Nuclear Medicine. S3. Design and test physical and technical aids for physical measurements relevant to Nuclear Medicine. S4. Realize experiments for the measurement of properties relevant for instrument specific performance assessment, especially with reference to established national and international standards (NEMA, IEC). S5. Develop, assess and implement new methods and technologies in Nuclear Medicine. S6. Analyze and handle images from a Nuclear Medicine imaging device. S7. Extract parametrical information/image from Nuclear Medicine data. S8. Calculate biological parameters from Nuclear Medicine images using compartmental modelling.	C1. Take responsibility for statutory and institutional requirements for Medical Physics Services in Nuclear Medicine with respect to Scientific Problem Solving Service. C2. Take responsibility for good practice in the use of sealed/unsealed sources of ionizing radiation. C3. Take responsibility for inventory of sealed radiation sources present in the laboratory and in the hospital environment. C4. Support the measurement of physical quantities relevant to Nuclear Medicine. C5. Take responsibility for the handling, management and maintenance of radiation measurement devices.

The first of nine pages of KSCs for the MPE in Nuclear Medicine

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➢ Staffing Levels

Annex II of the Guidelines gives recommendations as to the staffing levels required to fulfil the requirements of the Directive.

Table 1: MPE Staffing Factors for Radiotherapy

Equipment Dependent Factors		Item	MPE WTE	MPS WTE
	Linear Accelerator	Multi-mode	0.6	1.2
	Linear Accelerator	Single-mode	0.2	0.9
	IGRT	Unit	0.1	0.2
	HDR	Unit	0.2	0.4
	CT Simulator	Unit	0.2	0.4
	Planning	System	0.1	0.4
	IMRT	Unit	0.2	0.4
	RT Data/Imaging	Data Network	0.1	0.4
	Simulator	Unit	0.1	0.4
	MLC	Unit	0.05	0.2
	EPID	Unit	0.05	0.2
	Advanced/Brachy TPS	Unit	0.1	0.2
	300 kV	Unit	0.05	0.2
	150 kV	Unit	0.05	0.2
	Low Dose After-loading	Unit	0.1	0.4
	Block Cutter	Unit	0.05	0.2
	Automatic Outlining	Unit	0.05	0.2
	SBRT (new)	Unit	0.2	0.2
	SBRT (established)	Unit	0.1	0.2
Patient Dependent Factors		**No. of Courses**	**MPE WTE**	**MPS WTE**
New patients	External	1000	0.5	1.8
	3D Conformal	100	0.1	0.4
	TBI	100	0.4	0.8
	SBRT/SABR	100	0.4	0.8
	IMRT	100	0.4	0.8

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- **Next steps**

With respect to the Recognition of Medical Physics Experts, EFOMP is currently involved in a European Commission funded project to develop and implement the EC RP174 "Guidelines on Medical Physics Expert" in the field of Diagnostic and Interventional Radiology.

EUTEMPE•RX

http://www.eutempe-rx.eu/

3 year project

01/08/2013 – 1/07/2016

EU support: € 1,658,000

WP 1 Coordination of the project and Management

WP 2 Practical organisation of the EUTEMPE-RX teaching activities

WP 3 Development of an educational framework and strategy for dedicated teaching activities

WP 4 Organization of the first EUTEMPE-RX Course

WP 5 Sustainability of the EUTEMPE-RX course

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- **Next Steps**

With respect to the MPE EFOMP needs to:

- ✓ **Contribute actively to finalise EUTEMPE – RX and implement similar projects for Radiotherapy and Nuclear medicine in a sustainable way.**

With respect to the Clinically Qualified Medical Physicist EFOMP needs to:

- ✓ **Revise Policy Statement 6 and encourage all its NMOs to implement it and to notify the European Commission of the existence of their registration schemes.**

What are the next steps to be taken in Cyprus?

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- **Conclusions**

There is still a long way to go in order to achieve full recognition of the Medical Physics Profession in Europe and therefore guarantee freedom for mobility and establishment in all the European Union Member States.

http://www.eutempe-rx.eu/

http://www.efomp.org/