European Commission

JRC TECHNICAL REPORT

Job Classification and Taxonomy in the Nuclear Sector

Literature review

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2023

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JRC132572

Petten: European Commission, 2023

How to cite this report: ERIKSSON, A. and ERIKSEN, B. *Job Classification and Taxonomy in the Nuclear Sector, European Commission, Petten,* JRC132572.

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Acknowledgements

This report is the result of a joint effort of the following members of an EHRO-N ad-hoc group with the following membership: Emilia Janisz (ENS), Gabriel Pavel (ENEN), Michèle Coeck (EUTERP), Sophie Dayraut (Nucleareurope/ former FORATOM), Guido Lange (Euro-Fusion), Antonella Di Trapani (OECD-NEA). Any mistakes in this report is the sole responsibility of the authors.

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Abstract

The European Human Resources Observatory for the Nuclear Sector (EHRO-N) has decided to develop an EU framework for performing nuclear workforce assessments at national levels. Within this context it has been considered essential to develop a harmonised job classification that is suitable for a majority of member states.

A job classification/taxonomy is the basis for an assessment of the workforce in relation to identifying current and future needs. The work proposed here looks to cover the full nuclear sector.

The objective of this report is to present a proposal to establish a harmonised and workable job classification, based on findings of a literature review and on ensuing discussions within the network EHRO-N.

1 Introduction

1.1 Purpose and objective

The purpose of this report is to perform a review of the literature on job classification and /or job taxonomy in the nuclear field.

The European Human Resources Observatory for the Nuclear Sector (EHRO-N) has decided to develop an EU framework for performing nuclear workforce assessments at national levels and within this context it has been considered essential to develop a harmonised job classification and /or job taxonomy that is suitable for a majority of member states.

A job classification/taxonomy is the basis for an assessment of the workforce in relation to identifying current and future needs. It is possible to make assessments for specific job profiles and skills, but the work proposed here looks to cover the full nuclear sector.

The objective of this report is to, based on findings of the literature review and on ensuing discussions within the network EHRO-N, present an option for going forward with the work of establishing a harmonised and workable job classification and /or job taxonomy.

1.2 Background

In its latest version of Terms of Reference, EHRO-N has included the following objective:

> Develop methodologies and best practices at the EU level for performing workforce assessments and other aspects relevant to the knowledge management of human resources in the nuclear area. Work should consider aspects such as common terminologies, job taxonomies and modelling tools.

As mentioned above it has been considered essential to develop a harmonised job classification and /or job taxonomy that is suitable for a majority of member states. In order to perform this task, EHRO-N established an ad-hoc group to carry out the literature review and its analysis. The ad-hoc group held several meetings in 2021 and collectively identified relevant literature from Finland, France, UK, OECD-NEA, IAEA, EHRO-N and some supplementary sources of information of potential use in this and future work. Findings were presented to and discussed by the EHRO-N Advisory Board, and a way forward was agreed. In this report, the Joint Research Centre of the European Commission (JRC) have summarised the literature review, its findings and conclusions and have proposed a way forward.

1.3 Context – Basic elements of a national Nuclear Workforce Assessment

The general goal of workforce assessment is to provide a basis for long-term competence development, i.e. ensure a supply that will meet the future demand.

It should be noted that the most suitable approach to developing a job classification/taxonomy is obviously depending on the context in which it is to be used. In our case this is the assessment of the European nuclear workforce at national level. In order to develop a common understanding of this process, a basic conceptual framework and some of its basic element are shortly proposed and outlined below. This concept is open for discussion.

A national Nuclear Workforce Assessments (NWA) is an important tool for ensuring that sufficient and competent workforce is available for both nuclear power programmes and non-power nuclear applications. The national NWA should be reviewed at regular interval (e.g. every 10 years) or when changes or adaptations are made to the national nuclear strategy. It is important to define the full scope of the assessment from the beginning, which could for instance include:

- Power generation including contractors;
- Full fuel cycle (front-end, reprocessing and back-end);
- None-power application including contractors (e.g. medical);
- Regulation including technical support organisations;
- Research and Development including training facilities;
- Education and Training;
- Defence nuclear applications.

An NWA might be based on different scenarios from the nuclear strategy related to decisions on new reactors, long term operation and decommissioning. The main facilitator for ensuring the NWA is performed is often the ministry responsible for implementing the nuclear (power) programme. The ministry can manage the process themselves or delegate it to a third party, but it is important that all relevant stakeholders are part of the process.

When performing any workforce assessment, it is fundamental to have a job classification/taxonomy at hand, agreed by the key stakeholders. Further, the job classification/taxonomy must be suitable for the whole process for which it is being developed, e.g. it must be simple enough to be practical and workable, but it must be detailed enough as to deliver meaningful and workable end-results. A well-designed job classification/taxonomy is critical to allow it to be stable over time and to allow comparisons to be done over time and between different countries across the EU.

The graph below shows the full "Workforce capability and planning cycle". At least steps 1, 2 and 3 form part of a workforce assessment, and steps 4, 5 and 6, which follows logically, may or may not be considered part of it. Strictly speaking the assessment is concluded with step 3 and what follows thereafter are remedial actions (if necessary). These steps are described in detail below.

Figure 1. The "Workforce capability and planning cycle"

Step 1 - Detailed mapping of current nuclear workforce. This step consists of collecting detailed information on job function and context (i.e. industry and sector, see Table 1, Annex 1), as well as education level and skill. It may also include years of experience and age. The latter data is meant to provide information on age distribution/demographics for subsequent analysis of expected retirements. This "current status" analysis may also include collecting data regarding available educational programmes, as well as research funding, programmes and infrastructure used in the education and training of specialists and for innovation.

Step 2 - Predict future demands. This step is rather more complicated. It will require an analysis of national policy on energy and specifically nuclear energy taking into account new build programs, long-term operation and scheduled decommissioning in order to develop meaningful scenarios. Input may be obtained, as in the case of Finland, via questionnaires to the industry. An additional driver may be a country's industrial policy and the wish to capitalise on domestic or international opportunities (be it new-build, maintenance or decommissioning). This step should describe future demand at suitable intervals (e.g. in 5 and 10 years' time) based on industry, sectors, job function, basic educational need and experience.

Step 3 - Mapping of HR supply. This step is requiring a full inventory of existing ways of supplying sufficiently educated and experienced people to join the workforce. Such mapping would include e.g. education at academic level, VET-programmes, including for re-skilling and up-skilling, and Research programmes and its infrastructures used for Education & Training.

Step 4 - Analyse gaps between demands and supply. This step take into consideration currently available education and training programmes, retirement rates, mobility etc. and analyses to which degree it meets the future demand. It may also include an analysis of the adequacy of research activities, funding and infrastructure, as far as it is used for education and training, as well as for innovation and R&D needs.

Step 5 - Develop a nuclear skills strategy. Based on the findings in the gap analysis (Step 3) develop a strategy with actions needed to adjust the education and training system and resources, so as to provide the required future demand.

Step 6 - Implement nuclear skill strategy

Step 7 - Monitor and review the process

2 Literature review

The objective of this literature review is to identify and characterise references that contain a job classification or taxonomy suitable and useful for the ENRO-N work in relation to NWA.

2.1 Overview

In total 16 references were identified by the ad-hoc group on taxonomy. From these we identified six reference sets containing job classification/taxonomies, namely references from:

1) The OECD Nuclear Energy Agency (NEA) [1, 2];
2) EHRON [3];
3) Finland (FIN) [4, 5, 6];
4) France (FR) [7];
5) United Kingdom (UK) [8a-e, 9]; and
6) the International Atomic Energy Agency (IAEA) [10 - 13].

These are summarised in Table 1 below, and further described in the following sub-sections. Most of the sources are either contain illustrative examples or are non-exhaustive. The exceptions are the two from Finland (FIN) and the UK, which have actually been used in real national NWA.

The Table below identifies the source of information in the first column. The second and third columns report which industries and sectors are concerned. The industry covered is typically power generation, but also research, research reactors and defence are listed. Sectors include: new build, operation and decommissioning for power, but also research (reactors) and authority. Some references even consider nuclear fusion and Gen IV.

All examples use some form of hierarchical structure, reported in the fourth column, before reaching the level of specific jobs, but they all differ somehow even if some overlapping and some similarities can be found. In the table we have labelled them “Functions/specialist duties/competence areas”, though the vocabulary used in the original source may be different. They differ also in the level of detail. For instance, NEA refers only to 19 generic “functions” and subsequently identifies 111 more specific “job roles”. 30 of those job roles are each detailed on a sheet, typically a full A4 page that includes information such as job title, entry level education, job description, competencies and training needs.

If NEA have 19 function, we find at the other end of the spectrum France (FR) with 7 “Families” sub-divided into 41 “domains”, before listing 109 jobs (in this case no further job specifications are given).

Table 1. Summary from references that include job classification/taxonomy.

1	2	3	4	5	6
Source	**Industry**	**Sectors**	**Functions/ Specialist duties comp. area**	**Jobs**	**Job specifications**
NEA	Power gen. Research reactors	New build Operation Decommissioning RR	19	111	30
EHRO-N	Power gen.	New build Operation Decommissioning	25	135	135
FIN	Power gen. Research	New build Operation Decommissioning Authority R&D (incl. Gen IV, Fusion)	31	–	Short description (1/4 page)
FR	Power	New build Operation Decommissioning	- Concevoir, rechercher - Préparer organiser - Construire, fabriquer - QA - Exploiter, maintenir, démanteler - Acheter, commercialiser - Admin. + 41 sub-domains	109	–
UK	Power Defence R&D (incl. Fusion)	New build (incl. Gen IV, SMR) Operation Decommissioning R&D (incl. Fusion)	-Business -Engineering -Operations -Proj mgt. -Sci Tech Health safety and env. -Trades +29 sub-functions	161	–
IAEA	Power (industrial, medical, research, waste, security)	Op. and prod. Plant/site support (and admin.) Plant/site maint. Radiation Protection Design, Engineering and R&D Oversight	40	(40)	–

Two examples of specific interest in this review are those from the United Kingdom and Finland, since, as mentioned before, they have both been used repeatedly for the purpose of national NWAs.

Finland has used a set of

- 23 specialist duties/area of competence for staff with a Master level degree;
- 23 specialist duties/area of competence for staff with a Bachelor level degree;
- 8 specialist duties/area of competence for staff with a 2nd Level Vocational training.

In terms of duties/areas, there are 23 identical entries for EQF levels 6 to 8 (Bachelor, Master and PhD) and another 8 entries for EQF level 5 – EQF being the European Qualifications Framework. This case is more of one of job classification than a detailed taxonomy for each individual job position.

In the case of the United Kingdom, the situation is quite different, with a very detailed job specific approach used that describes no less than 161 individual job titles.

Beyond the six sets of most relevant references reported in Table 1, additional sources were identified, with relevant information on related professions such as radiation protection officer (RPO), radiation protection expert (RPE), and medical protection medical physics expert (MPE) [14, 15]. The ESCO classification was also considered. ESCO is the European multilingual classification of Skills, Competences and Occupations. It identifies and categorises 3008 occupations relevant for the EU labour market [16], but at a level too detailed for the purpose of this report.

2.2 OECD-NEA

The Nuclear Energy Agency of the OECD (NEA) published in 2012 a report of high relevance for this study [1, 2]. They offer the following definition of a job taxonomy:

Definition: A job taxonomy is an in-depth skills classification system which allows the mapping and characterisation of discrete job profiles according to the specific tasks, the responsibilities and activities the role entails, the competencies needed to fulfil them, as well as the associated entry level qualification, training and experience requirements.

In order to characterise the level of competence, NEA is using a so called **pyramid of competence**, that is to say a threefold categorisation of the necessary competencies:

- **Nuclear**: people with a specialised formal education in nuclear subjects (e.g. nuclear engineering, radiochemistry, radiological protection, etc.);
- **Nuclearized**: people with formal education and training in a relevant (non-nuclear) area (e.g. mechanical, electrical, civil engineering, systems) but who need to acquire knowledge of the nuclear environment in which they have to apply their competencies;
- **Nuclear aware**: people requiring nuclear awareness to work in the industry (e.g. electricians, mechanics, and other crafts and support personnel).

Industry coverage: Nuclear power, research reactors

Sectors (NPP): New build, Operation and Decommissioning (for NPPs), Research reactors and Regulation. It excludes part of the fuel cycle (mining, enrichment, etc.)

Hierarchical Structure of job classification:

- 5 Sectors
- 19 Functions
- 111 Job roles

Job roles: A total of 111 job roles are specified with key competencies at various occupational levels. Further, a subset of 30 job roles has been selected for in-depth characterisation (ca 1 page each), see Table below for further details. In Annex 1 we reproduce, for illustration, a typical sample of a one page job role specification.

Table 2. NEA three level taxonomy

<table>
<tr><td colspan="2">Objectives for employment</td><td></td></tr>
<tr><td>Sectors</td><td>Functions (no of job roles)</td><td>Job role specifications</td></tr>
<tr><td>NPP
- New build</td><td>- Design (16)
- Supply (5)
- Construction (12)
- Commission (6)</td><td rowspan="5">Multiple job roles for each function

Job title, description, context

Occupational level: professional, technical, craft

Competencies:
technical, regulatory personal, business

Entry level qualification,
experience
CPD and training</td></tr>
<tr><td>NPP
- Operation</td><td>- Operation (12)
- Maintenance (11)
- Waste management (3)
- Safety and environment (6)</td></tr>
<tr><td>NPP
- Decommissioning</td><td>- Decommissioning operation (6)
- Maintenance (5)
- Waste management (4)
- Safety and environment (10)</td></tr>
<tr><td>Research Reactors</td><td>- Design and engineering (3)
- Utilisation (5)
- Operation and control (7)</td></tr>
<tr><td>Regulation</td><td>- Assessment and review
- Authorisation
- Inspection and enforcement
- Regulation and guidance</td></tr>
</table>

2.3 EHRO-N

EHRO-N have developed a Nuclear Job Taxonomy (NJT), a classification of jobs in NPPs [3]. The focus is the requirements for each position defined in terms of knowledge, skills and competence (attitudes).

Industry coverage: Nuclear power

S**ectors (NPP)**: New build, operation and decommissioning.

Hierarchical Structure of job classification:

- 3 Sectors
- 25 Functions
- 135 Job titles

Job titles: In total 135 job titles with detailed descriptions are provided, see Table 3 below for further details. In Annex 1 we reproduce, for illustration, a typical example of a two-page job specification.

Table 3. EHRO-N Taxonomy

Sectors	Functions (no of job titles)	Job title/ specifications
New build	- Safety assessment (3) - Site location (4) - Design (12) - Construction (24) - Commissioning (7)	135 job titles w/ detailed descriptions. Occupational category: professional, technician, craft Functional category: management, specialist, executive Job requirements (EQF levels): Knowledge, skills, competence
Operation	- Plant manager (1) - Nuclear operations and waste management (6) - Operators in control room (3) - Operators in the field (2) - Waste management and RP (3) - Chemistry (3) - Safety and Security (4) - Maintenance (13) - Engineering (5) - CANDU (2)	
Decommissioning	- Management (8) - Decontamination (3) - Preparatory work for decommissioning (7) - Dismantling/equipment (3) - Demolition (building and structures) (3) - Site clean-up (2) - Radioactive waste (6) - Maintenance (3) - Health, safety and environment (7) - Site release (1)	

2.4 Finland

Finland has performed a full NWA for the power generation sector in 2010 [4], and the survey was later repeated in 2017-2018 [6]. The approach in both surveys was essentially the same, with only minor semantic changes.

The workforce assessment for Finland, with a view on long-term competence development, included ongoing and planned new-build at Olkiluoto and Fennovoima. The assessment resulted in present and future number of staff requirement for the years 2020, 2025 and 2030. The 2017 assessment was based on a survey/questionnaire sent to 127 organisations, with replies received from 41 organisations.

The latest data from 2018 show that 3807 staff are working in the field of nuclear energy with special competence in the field.

Industry coverage: Nuclear power

Sectors: Power companies, including new build and R&D and planning in nuclear waste management (subcontractors only partially), Authorities, University and Research Institutes (incl. fusion and Generation IV), other industrial companies

Hierarchical structure of job classification:

- 4 Sectors
- Area of competence, 23+23+8

The **areas of competence** were analysed in terms of basic education level:

- higher university/Masters: 23
- lower university/Bachelor: 23 (same labelling as above)
- 2nd level vocational (blue-collar): 8

The analysis was further carried out for number of personnel: current and future needs, for 'specialist duties/area of competence', education level, distribution of years of experience and age distribution.

Areas of competence: In total, 31 different areas of competence were identified in the Finish case, see Table 4 below. In Annex 3 we reproduce, for illustration, a typical sample of a short description (1/4 page) of contents of each 'specialist duties/area of competence'.

Table 4. Specialist duties/area of competence, Finland

Masters and Bachelors	2nd level vocational
Construction engineering R&D nuclear waste management Automation and control room Mechanics/mechanical engineering Electrical engineering Operators Radiation protection Project management Process engineering Materials engineering Quality management and inspections Nuclear and particle physics Thermal hydraulics Reactor physics and dynamics Water chemistry Radiochemistry Probabilistic risk analysis (PRA) Nuclear fuel Severe accidents Security Human factors Safeguards Others[1]	Chemistry/process engineering Construction engineering Mechanics/mechanical engineering Electrical engineering Automation engineering Security Radiation protection Others[2]
NOTES: 1: 'Others' for Masters/Bachelors in the table above include: support functions such as procurement, personnel admin., training duties, document management, technical sales support; procurement; management system; information security; fusion and plasma physics research; official duties; technical business expert duties; management duties; duties related to financial profitability; strategic planning; extensive licensing-related functions; legal duties; environmental control. 2: 'Others' for 2nd level vocational in the table above include: Nuclear fuel treatment; maintenance duties; support functions; installation duties; operator duties; and technical documentation.	

2.5 France

The French nuclear industry association GIFEN (Groupement des Industriels Français de l'Energie Nucléaire) have produced a document with job classification [7]. The document is basically a table, without further explanation and analysis. It is nevertheless a useful illustration of the chosen approach.

Industry coverage: Nuclear Power: existing generation/operation, decommissioning, new build.

Hierarchical Structure of job classification:

- 7 *Famille* (families)
- 41 *Domaines* (domanins)
- 109 *Métiers* (jobs)

The list of jobs (*métiers*) is labelled 'non exhaustive'. Some job title appear in several different families, e.g. électricien, mécanicien, contrôleur non destructive. Some details of the document are summarised in the table below.

Table 5. 'Famille','Domaine' and number of jobs, France

7 Famille	41 Domaines	No of job
CONCEVOIR RECHERCHER	Veille - R&D - Innovation Conception - Études Exploration minière	2 8 2
PRÉPARER ORGANISER	Gestion de projet Planification - Ordonnancement Méthodes Estimation – Contrôle des couts Management de contrat	3 1 3 2 2
CONSTRUIRE FABRIQUER	Construction Essais et mise en service Fabrication Contrôles Non Destructifs Logistique - Transport Manutention - Levage Hygiène Santé Sécurité Environnement	8 2 4 1 2 1 2
S'ASSURER DE LA QUALITE	Assurance qualité Surveillance et inspection	4 3
EXPLOITER MAINTENIR DEMANTELER	Exploitation d'une installation nucléaire Exploitation d'un laboratoire Exploitation d'une mine Maintenance Essais et mise en service suite à une maintenance Contrôles Non Destructifs Sûreté nucléaire Radioprotection, Prévention des risques Hygiène Santé Sécurité Environnement Gestion des déchets Démantèlement / Assainissement	4 6 - 7 3 1 1 2 3 2
ACHETER COMMERCIALISER	Achats Approvisionnement Commercial - vente Marketing	2 - 3 1
GERER ADMINISTRER	Finances Ressources humaines Communication Systèmes d'information Performance - excellence opérationnelle Juridique Risques - assurances - audit Management des ressources - Direction d'entité Immobilier	4 - - 6 5 - - 2 -

2.6 United Kingdom - Nuclear Skill Strategy Group

The UK Nuclear workforce assessment [8] is forecasting skills demand (to 2025) and supply. As part of the UK Governments 'Nuclear sector deal' [9] it is addressing, inter alia, growth of a highly skilled workforce.

Industry coverage: Existing generation/operation, Decommissioning, Defence and Civil new build (incl. Gen IV), Research and development (incl. fusion) [8].

Sectors: –

Functions (resource code types): In total 6 functions areas:

Business, Engineering, Operations, Project and Programme Management, Science Technical Health Safety and Environment, Trades.

The 6 functions are further divided into 29 (1+7+5+4+6+6) **sub-functions** (high level resource code) further divided into 161 (37+48+20+14+13+29) **jobs/specialist areas** (low level resource code), see details in Table 6 below.

Hierarchical Structure of job classification:

- 6 Functions
- 29 Sub-Functions
- 161 Job/Specialist areas

The analysis is further based on the required level a job holder should have in terms of qualification/experience, knowledge and skills, called **Role Levels**, see [8] pp. 38-41.

Role Levels: 1 to 8 (based on Qualification/experience, Knowledge, Skills).

These role levels correspond closely to the 8 levels of the **European Qualifications Framework, EQF**. See details under Discussion/ way forward in next chapter.

Over the entire UK industry around 90% of the workforce are employed for their generic (non-nuclear) skills, and around 10% for nuclear specific skills. A small percentage of the latter may be further defined as Subject Matter Experts; those holding niche skills and experience built up over ten to fifteen years. They introduce the skills pyramid [8e], with some similarities to the one used by NEA:

- **Subject matter experts** (a relatively small number of experts with specialist skills which take a long time to acquire);
- **Nuclear skills** (specialist skills which are only required in the nuclear industry, such as nuclear safety case engineers); and
- **Generic skills** (ready market skills, principally for the construction activities).

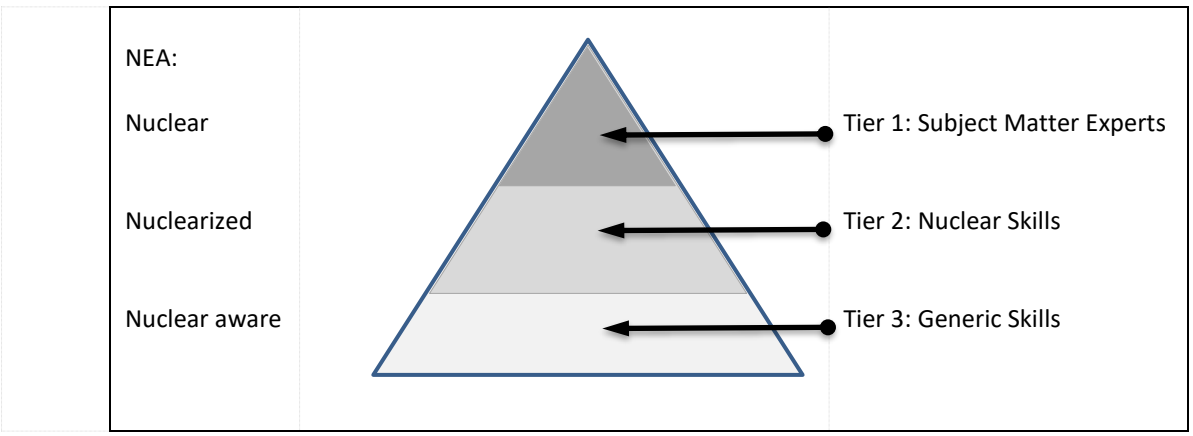

Figure 2. Graphical representation of skills levels, NEA vs UK.

The UK assessment analyses the number of staff currently and demand up to the year 2037. It further looks e.g. at the distribution of age, functions and level.

Table 6. Functions, sub-function and number of jobs, UK

6 Functions (resource code type)	**29 Sub-functions** (high level resource code)	**No of jobs/ specialist areas** (low level resource code).
Business	Business function (37)	37
Engineering	Civils Commissioning and other Engineers Control & Instrumentation Design Electrical Mechanical Safety Case Management	8 10 7 2 7 9 5
Operations	Facilities Management Infrastructure Fuel and Plant Processing Transport Waste Management	5 4 4 5 2
Project management	Construction Management Project & Programme Management (Construction) Project Controls Project Management	1 1 8 4
Science Technical Health safety and environment	Chemistry/Chemical Environment/Geology Environment/Geology Quality Assurance Radiological Safety/Health Physics Research	3 1 4 3 1 1
Trades	Building Trades Construction/Decommissioning Trades ME&I Rigging Scaffolding Welding	8 1 16 2 1 1
		161 job types in total

2.7 International Atomic Energy Agency – IAEA

The International Atomic Energy Agency (IAEA), in its 'Methodology for Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety' [11], provides some examples of "**functions**" in non-power applications (industrial, medical, research, waste, security) that might prove to be useful in later development of the work proposed in Section 3.2.

In a guide for 'Managing Human Resources [12], IAEA is providing 18 examples of functions and activities suitable for centralization and 20 examples for functions typically suitable for Technical and Scientific Support Organisations (TSOs) or contractors (pp. 28 and 70 respectively), summarised in Table 7 below.

Table 7. Examples of functions suitable for centralisation, and for TSOs/contractors

Typically centralized functions	**Functions suitable for TSOs or contractors**
Budget/finance; Chemistry control; Communications/public affairs; Emergency preparedness; Engineering, design modifications; Human resources; Training (curriculum development, testing); Personnel performance management; Information technology; Licensing; Nuclear fuels; Outage planning/scheduling (for all units/sites); Project management; Quality management; Radiation protection; Industrial safety/health; Security/physical protection; Procurement (contracting, purchasing, materials management and storing).	Design of nuclear facilities; Nuclear engineering, including fuel, shielding and core physics; Information technology services; Mechanical engineering; Electrical engineering; Chemistry; Maintenance; Outages; Non-destructive testing; Modernization of instrumentation and control systems; Participation in design change engineering packages; Commissioning of nuclear facilities; Decommissioning of nuclear facilities; Human factors considerations; Training; Development of nuclear facility managers; Performance inspection; Independent nuclear oversight; Physical protection; Support in establishing management systems (including support in establishing quality assurance programmes).

Further information, very useful in this context, has been received as private communication [13], based on a project that is currently under consideration. This approach covers the nuclear power industry and has jobs divided into 6 categories, which are further divided into 40 illustrative positions. These are summarised in Table 8.

Table 8. Private communication (HR Data Global Survey): Operating NPP

Category	Illustrative positions	No of positions
Operation and production	Operations Operations Support Environmental Chemistry	4
Plant/site support (and administration)	Dedicated Fire Responders Materials Management/Warehousing Contracts & Purchasing Procurement Engineering Information Technology Business Services Records Management & Procedures Human Resources Housekeeping & Facilities Management Communications & Community Relations Management Assistance / Industry Associations Training Management Admin/Clerical	14
Plant/site Maintenance	Maintenance Planning Maintenance & Construction Support Scheduling Outage Management Project Management Electrical Maintenance Instrumentation & Controls (I&C) Maintenance Mechanical Maintenance Other Craft/Tool room/Calibration Technicians	9
Radiation Protection	Radiation Protection Radwaste	2
Design, Engineering and R&D	Design/Modification/Technical Engineering Plant Computer Engineering Plant/Systems/Maintenance Engineering Non-destructive Examination (NDE) Nuclear Fuels/Reactor Engineering	5
Oversight	Security Quality Assurance Quality Control Corrective Action Program & Operating Experience Industrial Safety/Health Licensing Emergency Preparedness	6
Other		

3 Discussion and way forward

3.1 Discussion

EHRO-N has set itself the objective of developing methodologies and best practices at EU level for performing workforce assessments and other aspects relevant to knowledge management of human resources in the nuclear area. A first step in this endeavour is this literature review, which was undertaken with the purpose of identifying useful job classifications and taxonomies in the nuclear field.

The literature review identified a wide variety of approaches towards national job classifications /taxonomies. There are differences both in terms of the hierarchical structure used (industry/sector/function etc.) as well as labelling of jobs.

The literature contains examples of job classifications ranging from 161 specific job titles (UK), down to 31 competence areas/ specialist duties (Finland).

Two of the sources (NEA and EHRO-N) also provide detailed job specifications (approximately 1-2 pages for each job) for 30 and 135 jobs respectively. For the Finnish case, there is approximately a one quarter page description of each competence area, see Annex 1 to 3 for such examples.

Several of the sources specify that the compiled lists of jobs are only illustrative and non-exhaustive. The two national cases of Finland and the UK however are of special interest as they have actually been used multiple times in assessments of the national nuclear workforce.

Taking into consideration the reasonable assumption that Member States will inevitably have some diversity when it comes to detailed job titles, it was agreed that a taxonomy/classification should be shorter (and generic) rather than longer (and too detailed). The more detailed such list, the more likely it will be in contradiction with practices in specific Member States.

One advantage offered by the UK example is that it provides not only a full list of 161 jobs but also a hierarchical structure for the entire activity, thus providing both a better overview of the scale and complexity of an NPP organisation and the place of specific jobs within it. The drawback is that Member States will likely have some diversity when it comes to classification and labelling detailed jobs as well as the hierarchical structure, and, thus, the more detailed the list is the more likely it will be in contradiction with practices in some other Member States and it will make comparisons at European level more difficult. The 29 UK sub-functions are more comparable with the FIN specialist duties.

The Finish NWA is based on a job classification with 31 "**specialist duties/areas of competence"**, covering three levels of basic education: master, bachelor and 2nd level vocational. It is a combination of rather generic areas of competence such as mechanical or electrical engineering with more specialised duties like radiation protection, probabilistic safety assessment and safeguards. Thus, it is actually not a job taxonomy but rather a job classification based on a mix of competence, tasks and expertise areas.

It can be argued that this higher level approach used in Finland may me more suitable than a very detailed one like the one of the United Kingdom.

One additional advantage of the Finnish approach is that it is at a higher level and thus more robust vis-à-vis national approaches. It might also be argued that it is more easily and directly linked to formal education programmes in many cases. On the down side it does not precisely reflect the full complexity of the combined workforce and organisational structure in the power sector.

3.2 A proposal for the way forward

The findings of the literature review have been discussed by EHRO-N members and a way forward has been agreed, as outlined in the following.

When deciding on a most suitable approach, EHRO-N has to take into consideration a number of factors. **The job taxonomy should satisfy the following criteria:**

- Be suitable for national workforce assessments covering (all) nuclear sectors;

- Be flexible enough for use in different organisations and different Member States;
- Be well-designed to make it be stable over time and to allow comparisons of workforce at different times and between different countries across the EU;
- Be simple to use for staff involved in management of human resources in the nuclear field;
- Agreed by key stakeholders.

As a starting point, the example from Finland should be used, with its 31 **areas of competence**, here linked to education levels:

- higher university/Masters: 23
- lower university/Bachelor: 23 (same labelling as above)
- 2nd level vocational (blue-collar): 8

The full list of specialist/areas of competence is given in Table 9 below.

This starting points for job classification should be modified and supplemented with additional entries (areas or jobs) as seen fit. This may e.g. include special cases like radiation protection officer (RPO), radiation protection expert (RPE), medical physics experts (MPE), fusion and plasma physics, etc.

Within EHRO-N it has been further agreed that the job classification should cover a wide range of nuclear sectors, not only nuclear power generation, which is the dominating sector in the studied literature. Initially, EHRO-N agreed on the scope reported in Table 10.

Table 10. Industrial scope to be addressed

Industrial sectors	**Sub-sectors**
Fuel cycle	mining, processing, storage, disposal
Power plants	new build, operation, decommissioning
Regulatory and licensing activities	
Research and development	research reactors, Uni, Gen IV, SMR
Medicine	treatment and diagnostics
Food and agriculture	
Fusion	
Other industrial applications	

Table 9. EHRON-N proposal for specialist duties/area of competence, based on the Finnish case.

EQF 7 & 8 (MSc + PhD)		EQF 6 (BSc)		EQF 5
Construction engineering	Materials science and engineering (nuclear facility materials, failures, component engineering, inspections and lifetime management)	Construction engineering	Materials science and engineering (nuclear facility materials, failures, component engineering, inspections and lifetime management)	Construction engineering
Electrical engineering	Nuclear and particle physics	Electrical engineering	Nuclear and particle physics	Electrical engineering
Instrumentation and control (automation)	Reactor physics and dynamics	Instrumentation and control (automation)	Reactor physics and dynamics	Instrumentation and control (automation)
Mechanics/mechanical engineering	Thermal hydraulics and coolants	Mechanics/mechanical engineering	Thermal hydraulics and coolants	Mechanics/mechanical engineering
Nuclear fuel cycle (R&D, front-end, reprocessing and back-end)	Risk analysis (incl. probabilistic risk assessments)	Nuclear fuel cycle (R&D, front-end, reprocessing and back-end)	Risk analysis (incl. probabilistic risk assessments)	Radiation protection
Process engineering	Safeguards	Process engineering	Safeguards	Safety and security (business security and fire safety)
Project management	Safety and security (business security and fire safety)	Project management	Safety and security (business security and fire safety)	Process engineering
Radiation protection	Severe accidents	Radiation protection	Severe accidents	Chemistry (water)
Reactor and "hot" lab operation	Nuclear waste management, decommissioning and dismantling (including R&D and planning)	Reactor and "hot" lab operation	Nuclear waste management, decommissioning and dismantling (including R&D and planning)	
Quality management and inspections	Radiochemistry	Quality management and inspections	Radiochemistry	
Organisational and human factors	Chemistry (water)	Organisational and human factors	Chemistry (water)	
Others: (support functions such as procurement, personnel admin., training duties, document management, technical sales support; procurement; management system; information security; fusion and plasma physics research; official duties; technical business expert duties; management duties; duties related to financial profitability; strategic planning; extensive licensing-related functions; legal duties; environmental control)		Others: (support functions such as procurement, personnel admin., training duties, document management, technical sales support; procurement; management system; information security; fusion and plasma physics research; official duties; technical business expert duties; management duties; duties related to financial profitability; strategic planning; extensive licensing-related functions; legal duties; environmental control)		Others: (support functions such as nuclear fuel treatment; maintenance duties; support functions; installation duties; operator duties; and technical documentation)

Finally, EHRO-N decided that a harmonised job classification should follow the principles of the European Qualification Framework (EQF)[1]. The EQF is similar and compatible with both the Finnish and British approaches, see table below.

Table 11. EQF – the European Qualification Framework vs Finland and UK

EQF	Finland	UK
8	(Doctorate)	8
7	Master	7
6	Bachelor	6
5	2nd Level Vocational	5
4		4
3		3
2		2
1		1

[1] https://europa.eu/europass/en/europass-tools/european-qualifications-framework

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Annex 1. Example of typical nuclear job role – Specification, according to OECD-NEA, ref. 1, p. 154.

Mechanical design technician

Sector: NPP – New build
Function: NPP-NB/Design
Occupational level: Technical
Nuclearisation: *

Job title	Entry level qualification
Mechanical design technician	Vocational qualification in engineering/mechanical technology, and/or suitable experience.

Job descriptor

The *mechanical design technician* undertakes work on mechanical components and systems to ensure compliance with project procedures, quality assurance requirements, schedules, budgets, industry standards and regulations.

Competencies — Technical (T), Regulatory (R), Business (B), Personal (P)

The *mechanical design technician* will be able to:

- Contribute as a member of a team that provides engineering design, analysis or hands-on work including preparation of design documentation in the area of the mechanical design of the reactor, plant systems and related components. (T)
- Provide technical or hands-on contribution for a variety of equipment including their selection and sizing, support to related development and verification testing, and maintenance, repair, and operation. (T)
- Contribute to documentation including, but not limited to assessment documents, performance analysis, design requirements, design manuals, installation and commissioning documents, registration and equipment technical specifications. (T)
- Assist with recommendations, taking into consideration the feedback from the existing plants as well as client and project requirements. (T)
- Perform general or specific hands-on activities including the operation, maintenance and repair plant equipment or specialised tooling or test equipment and systems. (T)
- Interface with other disciplines as required. (T, P)
- Assist supervision or management with the preparation of detailed planning and budgeting information as required. (T)
- Conduct work in accordance with quality assurance requirements both for safety-related systems, components and structures; and pressure-retaining systems, components and structures in accordance with the applicable codes including the execution of the necessary design verification activities. (T, R)
- Contribute to work plans and resource requirements for the production of deliverables. (T)

The *mechanical design technician* will have:

- Familiarity with the design of a range of mechanical components and their design elements relevant to the nuclear industry. (R, T)
- Specific knowledge of some national and international design standards (e.g. ASME) as they may pertain to aspects of the work being undertaken. (R)
- Detailed knowledge of one or more of the manufacture, performance or in-service inspections of nuclear components. (R, T)

The *mechanical design technician* will have:

- The ability to understand and consistently meet deadlines under pressure. (P)
- The ability to execute extensive and complex procedures in the performance of specific tasks or activities. (P)
- Effective problem solving skills with a results-oriented approach. (P)
- Skills associated with the performance of a variety of operation, repair or maintenance activities. (P)
- Planning and organisation skills. (P)
- The ability to collaborate effectively in a team environment. (P)
- Good oral and written communication skills and a demonstrated ability to effectively co-operate with staff, project management, and customers if and when required. (P)
- Ability to communicate information in a clear and concise manner and present a compelling case. (P)
- Ability to develop and maintain productive working relationships. (P)
- Open and receptive attitude to change and learning opportunities. (P)
- Ability to manage career development by setting targets and planning how they will be met. (P)

The *mechanical design technician* may be required to:

- Understand the theory, principles and practices associated with certain business improvement techniques. (B)
- Support improvements to process problems using business improvement techniques. (B)
- Contribute to and support innovation within the team. (B)
- Comply with quality assurance systems. (B)

Advised training/CPD — Technical (T), Regulatory (R), Business (B), Personal (P)

- Membership or certification in a trade organisation. (T, R)
- Trade "passport" schemes as appropriate. (T, R)
- NPP fundamentals. (T)
- Radiation principles. (T)
- Internal training in company procedures and practices with respect to business practices. (B)
- Basic nuclear industry induction, security, contexts, behaviours. (R, T)
- Safety, health and environmental. (R)
- Compliance (construction, engineering, nuclear). (R)
- Supervisor training. (P)
- Leadership and management. (P)

Annex 2. Example of typical nuclear job taxonomy, according to EHRO-N, ref. 3.

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Ref	Job Title	Occupational Category
2.2.01	**Shift Engineer**	Professional
Phase / Area	**Alternate job title(s) – specialisations**	**Functional Category**
NPP O Operations in Control Room	Shift Supervisor Shift manager	Specialist
Role / Functions		
Responsible for the safe and error-free operation of the nuclear unit, including access to the power grid, and coordination of the activities of the shift personnel.		
• Supervises control and monitoring of the nuclear unit according to the technical specifications: (radiation situation, chemical regime, limits and conditions). • Provides team and technical supervision. • Supervise the continuous update of operation records. • Interfacing with other departments of the organization. • Assisting in the preparation of continuous training programmes for control room crew (SM). • Assesses incidents, determining the degree of the event, manages operations in accordance with the emergency plan and comply with the reporting obligations. • Coordinates/approves maintenance interventions. • Directs shift personnel in emergency situations, in accordance with emergency operating procedures		

JOB REQUIREMENTS	
KNOWLEDGE (Cognitive competence)	EQF level (1-8)
Nuclear engineering: reactor physics, thermal limits in nuclear fuels, nuclear power plant systems, reactor heat transfer and fluid flow	6
National and international regulations, codes and procedures related to safe operation	6
Physics and Chemistry theory: thermodynamics, fluid mechanics	5
Applied Techniques and engineering: electric power generation, energy conversion, mechanical, electrical engineering, electric power system operation, electrical, energy conversion, sensors, measurements, signal processing, instrumentation and control, pipe systems, pumps and turbine, hydraulic and pneumatic installations	5
Plant Chemistry	5
Radiation Protection	5
Nuclear Safety Culture	5
Human error prevention techniques	5
Emergency preparedness	5
Sensors, Measurements, and Signal Processing including their design, use, M&R; Instrumentation and control	5
Mechanical Vibrations	4
Engineering drawings and diagrams	3
Occupational safety and personal protective equipment	3
Operating experience	3
Application and sharing of emergency situation experience	3
Transient and accident reports understanding	3
SKILLS (Technical and functional competence)	EQF level (1-8)
Recognise abnormal situations of plant status and inform about it.	7

Predict the results of actions over systems and components and conduct possible corrective actions required.	7
Transmit instructions by using safe and effective communication techniques.	7
Maintain power equipment in conditions of safe and economical operation in accordance with the technical specifications and procedures.	6
Monitor the condition of the equipment and technical systems.	6
Maintain and update repair logs, tracking and reporting systems.	6
Identify measures or indicators of system performance and predict how changes in conditions or operation will affect outcomes.	6
Assess and communicate the nature and level of emergency.	6
Provide first response to events and coordinate application of the emergency plan.	6
Monitor and maintain a safe working environment.	5
Read and interpret engineering drawings and diagrams.	4
Provide input for preparing nuclear safety documentation.	4
Prepare technical reports and operation records.	4
Check the progress of the works on refuelling.	4
Issues admission of M&R personnel to work on equipment and systems.	4
Check the progress of M&R activities.	4
Acceptance of equipment after M&R.	4
Conduct tests and inspections of services and processes to evaluate their quality or performance.	4
Assess system performance and how changes in conditions or operation will affect outcomes.	3
Prepare technical reports and operation records.	3
COMPETENCE (Attitude; behavioural and personal competence)	**EQF level (1-8)**
Situational awareness	6
Team working	5
Stress resistance	5
Analytical thinking	5
Decisiveness	5
Conservative approach	5
Communication – Ability to understand and be understood	4
Problem solving	4

NOTES

DRAFTED BY:	1ST REVIEW:	2ND REVIEW:
1ST ECVET WORKSHOP	N. SHULEPOVA	5TH ECVET WORKSHOP
14.10.2011	10.11.2013	13.11.2013

Annex 3. Examples of potential contents of two specialist duties, according to FIN, ref. 4, p. 23-24.

Automation and control room: The purpose of automation is to keep the power plant process under control by means of automatic functions or measures taken by operators. The automation system designer is assigned by process designers to develop the functions by which the power plant is to be controlled, and designs the implementation of these in the automation systems. The automation system designer must have comprehensive knowledge of the power plant operations to ensure that the systems function in a correct manner.

Control room designers plan the interface between humans and machines such that the power plant operators remain sufficiently informed of how the power plant process functions under any circumstances, and of whether the various systems of the plant are in a proper state to perform the functions required by the operator. In the opposite direction, control room designers ensure that the control commands are transmitted to the machines as quickly as the situation requires. Control room designers must be familiar both with the automation systems and with human behaviour under different circumstances.

Operators refers to the shift team in the nuclear power plant main control room that normally consists of at least three operators qualified in accordance with the YVL Guide, one of whom is an approved shift supervisor and two who are approved other operators. Before initial fuel loading into the reactor can begin, a new nuclear power plant must have a sufficient number of operators with approval from the authorities.

In accordance with the YVL 1.6 Guide operators must be given in-depth training in the structure, functions and operation of the plant and its systems. The obligation to operate the plant in accordance with the Operational Limits and Conditions and the plant procedures must be emphasised in the training. In preparation for the various plant operational conditions, as well as for disturbance and accident situations, the operators must assimilate sufficiently extensive knowledge and skills pertaining to plant behaviour, observation of plant conditions and performance of control operations. Operator training must give good teamwork readiness as required by the duties, and similar readiness for the administrative control and supervision of work performed at the plant. Shift supervisors must be given training in managerial and communicative skills, and their training must be more wide-ranging than that of other operators.

The training of operators at nuclear power plants takes several years, and their competence and skills are monitored by regular assessments (a written examination, an oral examination, and demonstration of professional skill).

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