

BUILDING THE FUTURE RADIATION PROTECTION WORKFORCE



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1. INTRODUCTION

The availability of qualified Radiation Protection (RP) personnel is becoming an important workforce challenge across several mature nuclear markets. However, the scale and characteristics of this challenge vary significantly between countries and should not be treated as a single global problem.

The United States provides one of the clearest documented examples. Data presented by the U.S. NRC at the 2024 ISOE North American Symposium highlighted a significant imbalance between the recruitment and retention of Radiation Protection Technicians (RPTs) available and willing to support nuclear outages. Between Fall 2018 and Fall 2021, the available Junior RP Technician workforce experienced an attrition rate of approximately 42%, while the Senior RP Technician workforce suffered a net reduction of around 37%.

The implications go beyond simple workforce numbers. Nuclear organizations may successfully recruit and train new technicians, but if those individuals leave before gaining sufficient experience, the industry continuously replaces entry-level personnel without developing the intermediate and senior expertise ultimately required.

The challenge is therefore not simply **how to train more people**, but how to build a sustainable professional pipeline in which workers can enter the industry, gain practical experience, develop progressively more advanced competencies and ultimately become experienced RP professionals.

Achieving this requires a combination of structured career pathways, competency-based training, improved workforce mobility, advanced simulation technologies and greater recognition of specialist activities that can provide alternative routes to radiation protection.

2. THE "BROKEN PIPELINE"

High turnover at junior level creates what can be described as a **revolving door**. Training programmers may recruit enough new technicians to replace those leaving, keeping overall numbers apparently stable, while the level of the workforce fails to increase.

The greater concern occurs in the middle of the career pathway. Junior technicians approaching the level of experience required for senior responsibilities are precisely the individuals that the industry needs to retain. When they leave, the natural progression from junior to senior competence is interrupted.

At the same time, the loss of experienced senior personnel creates a permanent drain of institutional knowledge. Senior technicians do much more than carry out surveys or supervise radiological work. They understand plant conditions, anticipate radiological risks, recognize abnormal situations and transfer operational knowledge to less experienced personnel.

This expertise is accumulated through years of practical experience and cannot be replaced simply by recruiting larger numbers of new technicians.

The workforce challenge should therefore be considered as a complete professional pipeline:

Recruitment → Training → Field experience → Progressive responsibility → Senior competence → Knowledge transfer

If one stage fails, increasing recruitment at the beginning of the process will not solve the shortage of experienced personnel at the end.

3. A DIFFERENT CONTEXT IN SPAIN

The Spanish situation should not automatically be assumed to mirror that of the United States.

Spain already has an established regulatory and professional framework for the training and qualification of personnel involved in nuclear safety and radiation protection. Training requirements, radiation protection instruction and continued competence are integrated into the operation of nuclear and radioactive facilities.

Consequently, the immediate Spanish challenge is not simply the absence of training mechanisms. A more relevant question is whether the sector can continue to **develop, retain and efficiently deploy sufficient experienced professionals as nuclear activities evolve**.

This distinction becomes increasingly important when considering the future workload of the sector.

Radiation protection requirements do not disappear when a nuclear facility moves from operation towards decommissioning. Instead, the nature of the work changes. Greater emphasis is progressively placed on radiological characterization, contamination control, decontamination, dismantling of radiologically significant components, radioactive material management, waste segregation and clearance activities.

These activities require experienced personnel and specific practical competencies.

The Spanish context should therefore be viewed differently from the US example. The American figures should not be interpreted as evidence that Spain currently faces the same level of attrition.

They should instead consider a warning of what can happen when recruitment, development and retention cease to operate as parts of the same workforce strategy.

For Spain, the key question may therefore be:

Are we developing today the radiation protection competencies that the sector will need tomorrow?

4. AN INCREASINGLY INTERNATIONAL WORKFORCE

Radiation protection workforce planning can no longer be considered exclusively at national level.



Refueling outages create significant peaks in demand for qualified personnel, while specialized contractors increasingly support activities across different facilities and countries. International resource sharing provides flexibility, but it also means that shortages in one major nuclear market can influence availability elsewhere.

A significant shortage of experienced technicians in the United States, for example, could increase competition for qualified RP personnel. European markets could consequently experience greater pressure during periods of peak demand.

Workforce mobility, however, is influenced by more than supply and demand.

Different regulatory systems, qualification requirements and site-specific training programmers can create substantial barriers. Even highly experienced technicians may be required to repeat significant amounts of basic training when moving between facilities.

Some site-specific training will always be essential. Every plant has different systems, radiological conditions, procedures and emergency arrangements. However, repeatedly demonstrating the same fundamental competencies generates an unnecessary training burden and reduces workforce flexibility.

The objective should therefore be to distinguish clearly between **portable fundamental competencies** and **genuinely site-specific knowledge**.

5. STANDARDISING COMPETENCE: LESSONS FROM THE EPRI MODEL

The US nuclear industry has already developed an interesting approach to this challenge.

Historically, supplementary contract RP technicians could spend considerable time retraining on fundamental tasks every time they moved to a new site. The Electric

Power Research Institute (EPRI), together with industry organizations, developed a framework to establish a recognized baseline for common RP activities.

The model described in the original article is based on three main components.

- First, **standardized operating procedures**, or NISPs, provide common methods for recurring RP activities such as instrument operation and access to high-radiation areas.
- Second, **Standardized Task Evaluations (STEs)** allow technicians to demonstrate competence against these procedures.
- Third, approved workforce providers can complete relevant assessments before technicians arrive at a new site, reducing unnecessary repetition.

The important concept is not necessarily the specific US system, but the principle behind it: **portable competence**.

A technician should not need to repeatedly demonstrate fundamental skills that have already been objectively assessed. Instead, additional training should focus on national regulations, local procedures and specific plant conditions.

Complete international harmonization would be unrealistic, but greater recognition of common fundamental RP competencies could significantly improve mobility.

A practical future model could therefore combine a recognized technical baseline with targeted **bridging training** for each country or facility.

6. SIMULATION: PRACTICAL TRAINING WITHOUT DOSE

Improving training quality is just as important as increasing training capacity.

Modern simulation technologies offer opportunities to reproduce complex radiological situations without exposing trainees to ionizing radiation.

Simulated radiation sources can create variable radiation fields, while simulated survey instruments and electronic personal dosimeters allow technicians to practice realistic operational situations.



The original article highlights the VIZRAD Frisk system as one example. Instructors can create virtual contamination patterns on a training mannequin and configure background count rates while trainees perform a realistic contamination survey using a simulated detector.

The main benefit is not simply realism.

Simulation allows practical performance to become **measurable and repeatable**.

Survey speed, detector distance, surface coverage and missed areas can be assessed objectively. Different trainees can also perform identical scenarios under equivalent conditions.

This makes simulation valuable not only for training, but also for competency assessment.

It is particularly useful for situations that should not deliberately be recreated using real radioactive material, such as significant contamination events or abnormal radiation fields.

7. CREATING A GENUINE JUNIOR CAREER PATHWAY

Training alone will not solve the workforce problem if newly trained personnel are not given opportunities to gain meaningful field experience.

A common inefficiency is the use of highly experienced senior personnel for relatively routine activities that appropriately trained junior technicians could perform safely.

This creates two problems simultaneously.

Senior expertise is consumed in activities that do not require its full value, while junior personnel lose opportunities to develop the experience necessary for progression.

The industry should therefore define junior roles more clearly.

A newly recruited technician and a junior technician who has already completed several outages clearly do not have equivalent skills. Recognizing intermediate levels of competence would allow responsibilities to increase progressively.

A possible pathway could be:

Trainee → Junior RP Technician → Experienced Junior → Senior RP Technician → Specialist or Supervisory Role

Progression should depend on demonstrated competence and practical experience rather than simply time in the role.

This model would allow senior personnel to focus on complex tasks requiring greater judgement while developing a stronger role in mentoring.

Visible career progression can also improve retention. Workers are more likely to remain within an industry when they can see a realistic route from their current position towards more advanced professional responsibilities.

8. DECONTAMINATION AS A PATHWAY INTO RADIATION PROTECTION

This same concept can be applied to decontamination.

Too often, decontamination is treated as a basic cleaning activity and grouped within general facility management or



conventional maintenance. This underestimates both its technical complexity and its potential value as a professional pathway into radiation protection.

Effective nuclear decontamination requires a practical understanding of contamination behavior.

Workers must understand how radioactive material can spread, how different surfaces retain contamination, how working techniques can create secondary contamination and how waste generation can be minimized.

Poor technique can transform a small contamination issue into a much larger radiological problem.

For example, uncontrolled wiping may simply spread contamination over a greater surface. Effective decontamination requires controlled working patterns, segregation of clean and contaminated materials, correct use and folding of wipes, suitable products and continuous verification of results.

Selection of consumables also matters. Materials designed for capturing dry contamination may become ineffective if incorrectly combined with liquid chemical products, producing additional radioactive waste without improving the result.

These are not simply cleaning skills. They are **contamination-control competencies**.

This creates an important connection with workforce development.

A properly trained decontamination operative gains practical experience in contamination behavior, personal protective equipment, zoning, cross-contamination prevention, waste segregation and ALARA principles. These skills can provide a strong foundation for additional RP training.

Rather than treating decontamination as an isolated low-level activity, organizations could establish a structured pathway such as:

Decontamination Operative → Advanced Decontamination Technician → Junior RP Technician → Senior RP Technician

This approach would achieve three objectives simultaneously: professionalize decontamination, create an additional entry route into radiation protection and develop personnel who already possess practical contamination-control experience before progressing into broader RP functions.

This may become particularly relevant in markets where decommissioning activities increase, because contamination management, characterization, decontamination and material clearance become increasingly important.

9. RESOURCE SHARING AND KNOWLEDGE TRANSFER

International resource sharing already provides part of the solution.

The original article describes how NUVIA has reduced pressure during periods of high demand by sharing personnel between different entities and countries. It also identifies the integration of Marsein as an opportunity to extend this model.

This approach offers benefits beyond simply filling temporary workforce gaps.

International assignments expose technicians to different facilities, work cultures, procedures and radiological situations. Junior personnel gain broader experience, while senior technicians can transfer knowledge and mentor less experienced colleagues.

Resource sharing therefore supports both **short-term capacity and long-term competence development**.

However, it cannot be the complete solution.

Moving the same limited number of experienced professionals between sites helps manage demand peaks but does not increase the total pool of senior expertise.

Resource sharing must therefore complement, rather than replace, recruitment, professional development and retention.

10. CONCLUSION

There is no single solution to the radiation protection workforce challenge.

Recruitment without retention creates a revolving door. Training without field experience does not produce senior competence. International mobility without recognition of transferable skills creates unnecessary barriers. And using

experienced personnel for tasks that could develop junior workers weakens the professional pipeline.

The industry therefore needs to think in terms of **career ecosystems rather than isolated training programs.**

Common competency standards can improve workforce mobility. Simulation can provide realistic practical training without unnecessary radiation exposure. Structured junior roles can accelerate professional development. Decontamination can become both a recognized technical profession and an alternative pathway into RP. International resource sharing can broaden experience and strengthen knowledge transfer.

For Spain, the lesson from the US experience is not that both countries necessarily face the same workforce problem today.

The lesson is that **experienced radiation protection capability takes years to develop but can be lost much more quickly.**

As the Spanish nuclear sector combines continued operation with increasing long-term requirements associated with decommissioning, radioactive material management and radiological characterization, maintaining expertise and developing the next generation of RP professionals will become increasingly important.

The question is therefore no longer simply whether the nuclear industry has enough radiation protection personnel today.

The real question is whether it is building the workforce it will need tomorrow. ■