National survey of personal protective equipment used to protect staff against occupational exposure to medical ionising radiation

Background

Personal protective equipment (PPE) in the workplace is defined under statutory instrument (SI) 299 (2007) as

> '..*equipment designed to be worn or held by an employee for protection against one or more hazards likely to endanger the employee's safety and health at work, and includes any additions and accessories to the equipment.'*

In healthcare, PPE is required to protect staff against the damaging effects of occupational exposure to ionising radiation. This type of PPE is used for radiological imaging procedures and consists mainly of lead aprons and thyroid shields[1].

The undertaking is obliged to provide the PPE to staff who work in areas where ionising radiation is used and it is also worn by individuals who act as carers to accompany patients during a radiological procedure. The aprons and thyroid shields come in various colours which denote different sizes to accommodate different sized staff; and they can be custom made, using different quantities of lead or equivalent barrier material, depending on the exposure risk associated with the radiological procedure. The PPE must always fit the individual correctly and be taken on and off in a recommended sequence to maximise protection.

In December 2024, a hospital radiology service raised an issue with the NRPC in relation to the procurement and quality assurance of lead aprons and thyroid shields. This matter highlighted that practices varied across different locations in relation to the purchase, maintenance and replacement of PPE.

Legislation for the provision of PPE in the workplace

SI 30 (2019) – Radiological Protection Act 1991 (Ionising Radiation) Regulations (2019) requires the undertaking to provide staff who work with ionising radiation appropriate PPE and where necessary, personal radiation dosimeters. The Environmental Protection Agency (EPA) is the regulator for the radiation protection of staff and members of the public, under SI 30 (2019). The EPA inspects radiological services to seek assurance that the relevant PPE is available to staff; that it is stored appropriately; and that staff are using it correctly.

The EPA has published helpful guidance to promote compliance with SI 30 (2019) which can be accessed here: https://www.epa.ie/publications/licensing--permitting/radiation/EPA_IRR19_Guidance_2022.pdf

[1] Radiation PPE also includes dosimetry monitors, glasses and facial shields, ceiling suspended shields and table mounted or mobile shields, depending on the level of risk associated with the occupational exposure.

The **European Union (Personal Protective Equipment) Regulations (2018)** provide that PPE may not be sold or used unless it complies with basic health and safety requirements. And it must bear the CE mark[2] to verify that it conforms to the European regulations.

SI 299 (2007) - The Safety, Health and Welfare at Work (SHWW) (General Application) Regulations legislates for the provision of PPE in the workplace and with the SHWW Act (2005), grants the Health and Safety Authority (HSA) extensive inspection and enforcement powers. The HSA provides detailed information on the PPE required for the protection of staff against physical, biological and chemical hazards however, it does not provide the equivalent guidance for radiological hazards.

The HSA is the market surveillance authority for all PPE and must be informed of any workplace incident involving PPE. However, the EPA must also be notified if an incident concerning PPE involved staff exposure to ionising radiation.

General guidance on PPE in the workplace published by the HSA can be found here: https://www.hsa.ie/eng/Topics/Personal_Protective_Equipment_-_PPE/PPE_-FAQs/

National Survey

The NRPC commissioned a national survey to establish local practices for the maintenance and replacement of PPE used for the protection against occupational exposure to medical ionising radiation. The NRPC was also interested in discovering what training, if any, was provided locally to staff in relation to PPE.

The survey was issued to all hospital and community diagnostic radiology services via the Regional Executive Offices in March 2025. The questionnaire focussed on aprons and thyroid shields because this type of PPE was common to all radiological services.

The findings from the survey will inform the development of national guidance aimed at standardising quality assurance processes for aprons and thyroid shields.

Findings

40 locations returned completed surveys to the NRPO within the required timeframe.
This number included two completed surveys returned by private hospital services, both of which had received the template from colleagues in the public sector.

The findings were collated and are presented herein.

1. Inventory of PPE

The legislation requires that the employer shall maintain strict record keeping in relation to the purchase, care and wear of PPE, and provide this information to the regulator, upon request.

[2] CE mark is the certificate to identify that the product has met EU safety, health and environmental protection requirements.

All respondents confirmed that they held a local inventory of radiation PPE which included information on when the garment was last checked for efficacy and cleanliness however, additional details recorded in the database varied. For example, some respondents confirmed that their local inventory listed the manufacturing information and date of purchase of each item of PPE, the type and serial number of the garment and the level of radiation protection it provided. Whereas many other respondents advised that they did not keep a record of when the item was manufactured or purchased, with some noting that for older PPE, this information was not available.

One respondent confirmed that, in addition to the information provided above, the PPE in use at their location had also been individually embroidered with the date of purchase.

2. Responsibility for reviewing the PPE

All locations confirmed that the Radiation Safety Officer took responsibility for the maintenance and review of PPE. Six respondents advised that this task was also delegated to Clinical Specialist Radiographers working within the service.

Several respondents noted that the Radiation Safety Officer often sought input and advice from the Radiation Protection Adviser and Medical Physics Expert in relation to PPE.

21 respondents advised that the local Radiation Safety Committee was provided with a report on the status of PPE. For some Radiation Safety Committees, PPE was listed as a standing item on the meeting agenda and for others, the PPE was discussed on an ad hoc basis when the need arose, for example, in relation to procurement or decommissioning of apparel.

It is noteworthy however that 19 respondents confirmed that the local Radiation Safety Committee did not receive an update on the status or quality assurance of PPE.

The local Radiation Safety Committee is responsible for overseeing radiation protection, including the promotion of safe practice in relation to occupational exposure to medical ionising radiation. Therefore it should maintain oversight of the procurement, use and quality assurance of radiation PPE in the radiological services operating under its remit.

3. Assuring the quality of PPE

The employer has a legal obligation to ensure that any PPE provided to staff is hygienic, in good working order and fit for purpose. The employer shall ensure that the PPE is appropriately stored, maintained, repaired and replaced, as required.

To comply with these obligations, there must be a robust audit programme established locally to facilitate a regular, structured and proactive review of radiation PPE; with clear processes in place for identifying and removing defective PPE from circulation. This is especially important where PPE is not allocated to an individual but shared communally between staff within the department.

- ***Guidance and audit schedule***

35 respondents confirmed that guidance on the maintenance and review of PPE informed local policies and procedures for radiation protection. One respondent observed that their local guidance did not give an indication of the degree of damage to PPE that would necessitate removal from

circulation. Five respondents advised that such guidance did not feature in their radiation protection policies and procedures.

All respondents advised that PPE was routinely checked, either annually or more frequently and as required. Many noted that this schedule was dependent on the presence of trained staff who had the time available to perform the checks; access to the PPE which was often being used by staff at the time of the review; and the availability of a fluoroscopy suite to perform the screening. One respondent noted that in their service, these checks were often performed outside of the normal working hours within the department. Another suggested that contracting an external company to undertake this work would be beneficial.

All respondents confirmed that the PPE is checked upon arrival to the hospital and prior to commissioning. One respondent noted that on one occasion, the Radiation Safety Officer had not been notified of the purchase of new PPE. The garments were issued to staff without having undergone a review and the new PPE was later identified in the annual audit process.

Two respondents commented that the identification label attached to the PPE can detach over time, making it difficult to keep track of the garment. They suggested that applying an electronic tag or barcode at the time of manufacture would greatly improve the checking process.

- ***Quality assurance***

Checking processes included visual inspection of the outer fabric, belts and buckles; tactile review to feel for any irregular lumps or tears internally; and fluoroscopy imaging to check for any hidden, internal cracks in the garment. One respondent noted that fluoroscopy imaging was performed more frequently in high risk areas such as cardiology and interventional radiology suites.

It is important to note however, that these checking procedures do not quantify the amount of ionising radiation that may penetrate to the user, especially if there is some damage to the PPE or discrepancy in the specification ordered. Garments are typically expected to block up to 98% of the radiation a user may be exposed to. To give assurance that the quality of the PPE aligns with the particular specifications ordered and that there are no hidden defects, the amount of x-rays that pass through the material must be measured using a radiation detector. It was evident from the survey that this type of examination, namely transmission testing, was not routinely performed on PPE in all locations.

The radiation safety issue raised with the NRPC in December 2024 which prompted this survey, was identified through transmission testing of newly acquired PPE. At the time of writing this report, the NRPO was informed by another location that transmission testing of PPE currently in use identified a failure and defect rate higher than would be anticipated through the normal wear and tear of daily practice. The hospital confirmed that they had notified the EPA and HSA of the matter and were in the process of engaging with the manufacturer to determine the cause of the increased failure rate. The hospital did not suspect that any occupational dose limit for staff had been exceeded.

One respondent suggested that national guidelines on the steps required for transmission testing would be beneficial.

- ***European CE certification***

Some respondents highlighted the importance of ensuring that the PPE had a visible CE mark attached to the garment to verify that it met European Union standards and requirements.

Aprons and thyroid shields are made up of separate layers of fabric and lead (or equivalent material) lining. Each layer of material is individually CE certified. However, these layers must be stitched together in the correct order and direction to ensure that the PPE provides the maximum protection. A failure to adhere to this strict protocol in the manufacturing process could render the garment less than satisfactory at repelling ionising radiation, thereby reducing the validity of the CE certification for the finished product.

Transmission testing or physically opening a seam in the garment to visualise the layers stitched together will provide some assurance that the garment meets the specifications required. One respondent commented that the manufacturer should confirm that they have tested the finished product, in addition to the individual layers of material, before they issue to hospital services.

4. Removing defective PPE from circulation

All respondents confirmed that defective PPE is removed from circulation and either disposed of locally or returned to the vendor. This is done in consultation with the Radiation Protection Adviser and the reason for disposal is recorded in the local database. The operational manager for the department is informed and replacement PPE is ordered.

Several respondents advised that the hospital maintenance department considered the lead component of the PPE in disposal. Two respondents stated that they take the defective PPE to a local recycling plant for safe disposal. One respondent requested that national guidance be developed on the safe disposal of PPE and another commented that development of a local policy with the hospital maintenance department was in progress.

When a defect was identified in a garment, the criteria for removal from circulation varied. For example, one respondent stated that they would decommission the PPE if a tear was greater than 1.5cm whereas another specified that a hole bigger than 10mm would warrant disposal. It is possible that perhaps this variation could be related to where the defect is located in relation to the vital organs and also to the dose of radiation the user is routinely exposed to.

5. Training staff on the use and maintenance of PPE

The employer has a legal duty to educate staff on the wear and care of the PPE provided and the employee, having regard to their training and instructions, shall make correct use of this PPE. The user should put the PPE on and take it off in a particular sequence and it is essential that the PPE is fitted correctly to the user to afford the maximum protection. It must also be stored appropriately on the hangers provided in the department to minimise the potential for damage to the material and prolong the lifespan of the garment.

One respondent commented that guidance on the lifespan of PPE would be helpful. There is no legal requirement to replace PPE after a certain period of use however, the employer must follow the manufacturer's guidelines and also replace a garment when it is deemed no longer fit for purpose.

All respondents confirmed that education was provided to staff on the correct way to wear PPE, how to clean it and the importance of storing it correctly after use. Training also included information on the types of PPE available; the importance of full overlap of the material at the front when wearing it; the necessity for it to fit comfortably; the importance of the lead equivalence weight of the PPE and the reason why this might vary depending on the level of occupational exposure.

Training was typically provided by the radiation protection team at the time of induction, at refresher training sessions throughout the year and in some cases, as part of an online radiation safety training module that was provided locally. Three respondents reported that their hospital departments had posters and QR codes on display to remind staff how to wear and care for PPE. One respondent noted that information on PPE was included in a staff newsletter.

The majority of respondents commented that medical staff were not always compliant with the guidance, particularly in relation to the appropriate cleaning and storage of PPE. One respondent observed that medical staff were also reluctant to attend PPE training sessions.

It is worth noting that in 2024, there were 43 incidents of inadvertent staff exposures to ionising radiation reported on the National Incident Management System.[3] Almost half of these incidents related to staff either forgetting or declining to wear the appropriate PPE. Harm from occupational exposure to ionising radiation can be acute or cumulative and PPE is essential for safe practice. Therefore, all staff should be encouraged to undertake the training facilitated by local radiation protection teams and to make proper use of the PPE provided.

6. Priorities for the quality assurance of PPE

The survey asked people what they considered were the priorities in relation to a quality assurance programme for PPE.

Almost all respondents confirmed the need for regular audits of PPE with some citing limited time and resources as a hindrance to this schedule. Suggestions included the need for an agreed framework for the acceptance testing of new PPE, a clearly defined process for transmission testing of PPE already in use and guidance on the safe disposal of defective PPE.

Educating staff on the importance of wearing the PPE correctly, the reasons why it must be stored appropriately and the need to ensure it is hygienically fit for use were prioritised. One respondent highlighted the need to track and label the PPE correctly for record purposes. Another commented that it was difficult to ensure that the PPE was hygienic and that it fitted all staff correctly, especially in departments where it was routinely shared between multiple users.

One respondent suggested that high dose areas of work should be prioritised for training and audit. Another suggested that staff who were found to misuse PPE should receive a fine.

[3] National Radiation Protection Committee End of Year Report 2024
https://www.hse.ie/eng/about/who/acute-hospitals-division/radiation-protection/reports/

7. Procurement of PPE

Currently, there is no national contract in place to facilitate the procurement of PPE and individual locations must initiate a tendering process to purchase PPE for their service.

Local practices pertaining to the procurement of PPE fell outside the scope of this survey however, some comments were submitted for consideration. Two respondents advised that an individual hospital based approach to procurement rather than a single national tender was preferred. One respondent suggested that any group established to manage the tendering process should consider the quality of the PPE and the aftersales service provided by the vendor, in addition to the price. Another noted that it was imperative that such a working group had, as members, relevant experts in radiation protection.

At the time of writing this report, the HSE National Finance and Procurement Division confirmed that a new national tender for radiation protection equipment and apparel was in development. In addition, a product evaluation group which included relevant experts in radiation protection, had been established to oversee the process.

Conclusion

PPE is essential for safe practice when working with medical ionising radiation. The employer is obliged to provide appropriate PPE that is fit for purpose, sized correctly and hygienically clean. The employee has an obligation to make proper use of this PPE and to maintain it in accordance with the manufacturer's instructions.

It was evident from the survey that all services provided onsite training on how to wear and care for PPE and in some locations, this was supplemented by an online education programme and demonstrations. Some hospitals also had posters and QR codes displayed in areas where PPE was in regular use to support and encourage staff to wear the apparel.

However, the survey highlighted gaps in the PPE quality assurance process which included, for example, poor oversight by some local Radiation Safety Committees; limited time and resources available to undertake a review of PPE; variations in local procedures for the safe disposal of PPE; and, perhaps most notably, the lack of transmission testing to ensure that the PPE was fit for purpose.

The findings from this survey will inform NRPC guidance on the maintenance and quality assurance of PPE used to protect staff against the detrimental effects of occupational exposure to ionising radiation.

Recommendations

The following recommendations are proposed to promote best practice in relation to the maintenance, quality assurance and disposal of PPE:

1. The local Radiation Safety Committee should retain oversight of the procurement, use and quality assurance of radiation PPE for all radiological services operating under their remit.

2. Radiological services must ensure that the appropriate facilities are available to store the PPE correctly and that staff are routinely reminded of the importance of hanging up the apparel after use to reduce the potential for damage

3. The NRPC should establish national guidelines to:
- Standardise the information that is recorded on the local inventory of PPE.
- Incorporate transmission testing into the PPE quality assurance process.
- Determine the degree of damage to PPE that would necessitate removal from circulation.
- Standardise PPE decommissioning and disposal practices.

4. The HSE National Finance and Procurement Division should include in the procurement contract for radiation apparel, a requirement for the manufacturer to attach a barcode to the garment to improve traceability; and also verification that transmission testing of the finished garment has been performed.

The NRPO would like to thank the management and staff working in all radiological services for their positive and proactive engagement which enabled the completion of this national survey.