The UK Nuclear Industry Guide To:

Respiratory Protective Equipment

Nuclear Industry Safety Directors' Forum

This Nuclear Industry Guide was produced by the Industry Radiological Protection Co-ordination Group (IRPCG) and published on behalf of the Nuclear Industry Safety Directors' Forum (SDF)

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Revision History

Issue No.	Revision Date	Changes
1	December 2016	New document
2	August 2023	• Foreword and introduction changes to incorporate discussions with HSE & ONR with regard context for use in the nuclear industry and recognition of the hierarchy of controls that exists in addition to RPE that is specific to the nuclear industry and nature of the radiological hazards. • More information is provided in Section 3 – Risk Assessment for clarity. • A clearer definition of “clean shaven” has been provided and referenced to BS EN 529. • The one page essential’s list in the appendices has been better defined and formatted, including the addition of a footnote reference to this Good Practice Guide for further information. • Specific full face PAPR pictures added to Appendix B to avoid confusing with negative pressure full face respirators.

It is recognised that – through the experience of using these Guides – there may be comments, questions and suggestions regarding its contents.

In the first instance, any such comments must be sent to the IRPCG secretary who can be contacted via the IRPCG website: www.irpcg.org

Foreword

This Nuclear Industry Good Practice Guide (GPG) has been written for radiological respiratory protective equipment (henceforth referred to as RPE) used within the nuclear industry. Many standard controls adopted within the UK Nuclear Industry are not routinely applied or necessarily feasible in other industries, such as workplace air sampling (some alarming), workplace monitoring of individual post task before the radiological respiratory protective equipment is removed, etc. The GPG has been produced to identify and facilitate consistent application of good practice within the nuclear industry regarding the management and use of RPE, including the application of Workplace Protection Factors (WPFs) for the different forms of RPE.

The UK Nuclear Industry has strong and robust management arrangements and expectations on employees. There is a long history of dosimetric evidence supporting the assertion that personnel wearing respiratory protective equipment in well managed practices (akin to those discussed in the Good Practice Guide) within the Nuclear Industry do not receive significant internal doses, other than following **some** unplanned incidents.

This Guide takes into account recent protection factors studies undertaken at the Health and Safety Laboratory (on behalf of the nuclear industry, which concluded that a higher protection factor could be applied to some RPE provided rigorous management arrangements are applied, these are detailed in Section 6 of this guide. It was recognised through the Industry Radiological Protection Co-ordination Group (IRPCG) that a Guide facilitates the application of consistent protection factors underpinned by a suitable level of management and use.

This Guide describes the good practice level of management (including auditing programme) and use arrangements which must be adopted to underpin a higher Workplace Protection Factor (WPF) being applied to the RPE. This GPG supplements and is not a replacement for HSG53[1].

The Guide is consistent with the legislation and guidance listed in the References (page 25) and has been endorsed by the following organisations:

- Atomic Weapons Establishment (AWE) plc;
- Defence Equipment & Support (DE&S);
- Devonport Royal Dockyard Ltd (DRDL);
- Dounreay;
- EDF;
- Low Level Waste Repository (LLWR);
- Magnox;
- Ministry of Defence (MoD);
- Rolls-Royce:
- Sellafield Ltd;
- URENCO.

The IRPCG would like to take this opportunity to thank all the volunteers from AWE and Sellafield who participated in this study, as well as thank the following five organisations for funding the study AWE, DRDL, EDF, Rolls-Royce and Sellafield Limited (sponsored by the Nuclear Decommissioning Authority).

Safety Directors' Forum

In a sector where safety, security and the protection of the environment is, and must always be the number one priority, the Safety Directors' Forum (SDF) plays a crucial role in bringing together senior level nuclear executives to:

- Promote learning;
- Agree strategy on key issues facing the industry;
- Provide a network within the industry (including with government and regulators) and external to the industry;
- Provide an industry input to new developments in the industry; and,
- To ensure that the industry stays on its path of continual improvement.

It also looks to identify key strategic challenges facing the industry in the fields of environment, health, safety, quality, safeguards and security (EHSQ&S) and resolve them, often through working with the UK regulators and Department for Business, Energy & Industrial Strategy (BEIS), both of whom SDF meets twice a year. The SDF members represent every part of the fuel cycle from fuel manufacture, through generation to reprocessing and waste treatment, including research, design, new build, decommissioning and care and maintenance. The Forum also has members who represent the Ministry of Defence nuclear operations, as well as "smaller licensees" such as universities and pharmaceutical companies. With over 25 members from every site licence company in the UK, every MoD authorised site and organisations which are planning to become site licensees the SDF represents a vast pool of knowledge and experience, which has made it a key consultee for Government and regulators on new legislation and regulation.

The Forum has a strong focus on improvement across the industry. It has in place a number of subject-specific sub-groups looking in detail at issues such as radiological protection, human performance, learning from experience and the implementation of the new regulatory framework for security (NORMS). Such sub groups have developed a number of GPGs which have been adopted by the industry. Further information on the GPGs can be found at http://www.nuclearinst.com/Publications.

IRPCG

The IRPCG is the United Kingdom's Nuclear Industry forum that considers significant occupational radiological protection issues at a strategic level and provides a coherent approach as the industry develops. It is a sub-group of the Nuclear Industry's SDF and its members represent the majority of the Nuclear Industry's Radiation Protection Managers and Leaders. Their current topics of discussion include Respiratory Protective Equipment (RPE), Radiological Protection Training Standards and the skills gap. The group is also a significant forum for exchange of operating experience, lessons learned and best practice sharing.

The following companies and organisations are participating members of the IRPCG:

Disclaimer

This UK Nuclear Industry Good Practice Guide has been prepared on behalf of the Safety Directors Forum by a Technical Working Group. Statements and technical information contained in this Good Practice Guide are believed to be accurate at the time of writing. However, it may not be accurate, complete, up to date or applicable to the circumstances of any particular case. This Good Practice Guide is not a standard, specification or regulation, nor a Code of Practice and must not be read as such. We shall not be liable for any direct, indirect, special, punitive or consequential damages or loss whether in statute, contract, negligence or otherwise, arising out of or in connection with the use of information within this UK Nuclear Industry Good Practice Guide.

This Good Practice Guide is produced by the Nuclear Industry. It is not prescriptive, but offers guidance and in some cases a toolbox of methods and techniques that can be used to demonstrate compliance with regulatory requirements and approaches.

Contents

ACRONYMS

ALARP	As Low As Reasonably Practicable
APF	Assigned Protection Factor
FF	Fit Factor
GPG	Good Practice Guide
HSE	Health and Safety Executive
HSL	Health and Safety Laboratory
IRR17	Ionising Radiations Regulations 2017
IRPCG	Industry Radiological Protection Coordination Group
NPF	Nominal Protection Factor
ONR	Office for Nuclear Regulation
PAPR	Powered Air Purifying Respirator
PPE	Personal Protective Equipment
RPA	Radiation Protection Adviser
RPE	Respiratory Protective Equipment
SWPF	Simulated Workplace Protection Factor
WPF	Workplace Protection Factor

1. INTRODUCTION

The UK Nuclear Industry has strong and robust management arrangements and expectations on employees. There is a long history of dosimetric evidence supporting the assertion that personnel wearing respiratory protective equipment (RPE) in well managed practices (akin to those discussed in the Good Practice Guide) within the Nuclear Industry do not receive significant internal doses, other than following some unplanned incidents. Many standard controls adopted within the UK Nuclear Industry are not routinely applied or necessarily feasible in other industries, such as workplace air sampling (some alarmed), workplace monitoring post task of individual before the radiological respiratory protective equipment is removed, etc. This GPG has been produced to identify and facilitate consistent application of good practice within the nuclear industry regarding the management and use of RPE, including the application of Workplace Protection Factors (WPFs) for the different forms of RPE.

In compliance with Regulations 9, 10 and 11 of the Ionising Radiations Regulations 2017 (IRR17)[2], every radiation employer, in relation to any work with ionising radiation, must take all necessary steps to restrict the extent to which their employees and other persons are exposed to ionising radiation to a level which is as low as reasonably practicable (ALARP). The measures which contribute to the restriction of exposure are fundamental to radiation protection, as is the quality of information and training provided to employees to enable the measures to be implemented correctly and effectively.

For some tasks in the nuclear industry, the use of personal protective equipment (PPE) may be the only appropriate means of controlling the residual hazard, after the application of the hierarchy of controls. The considered controls include remote operations, containment, ventilation, real-time alarmed air sampling (to highlight an increased challenge) and workplace monitoring, etc. PPE, such as RPE, protective clothing, or other special equipment that is issued to protect each exposed worker, must offer suitable protection against the hazard that it is being worn for. It is essential that all persons involved in the management and use of PPE are aware of its capabilities and limitations, in order to ensure that an adequate, reliable and planned degree of personal protection is provided. Different PPE may be used to protect against external and internal exposures.

In the context of this GPG, RPE is intended to prevent the inhalation of radioactive particulate which would lead to radiation doses.

Where RPE is used as a control measure, it is essential that the selected RPE is adequate and suitable for its intended purpose. For RPE to be suitable it must be matched to the task, the environment, the anticipated airborne contaminant exposure level and the wearer. This includes considering an all hazards perspective, before selecting a particular form of RPE.

Wearers of RPE have different face shapes and sizes; it is unlikely that one particular type or size of RPE will fit everyone. To ensure that the selected RPE has the potential to provide adequate protection for individual wearers, where tight-fitting RPE face piece is selected, the RPE must be fit tested as part of the selection process. This will help to ensure that inadequately fitting face pieces are not selected for use. Ill-fitting face pieces can offer inadequate protection and can create inward leakages of airborne contaminants and reduce the protection factor.

2. SCOPE

In the context of this GPG, RPE is intended to prevent the inhalation of radioactive particulate which would lead to radiation doses. Where RPE is used as a control, it is essential that the selected RPE is adequate and suitable for its intended purpose. For RPE to be suitable, it must be matched to the task, the environment, the anticipated airborne contaminant exposure level and the wearer.

Respiratory Protective Equipment (RPE) is not considered as the first line of defence and is only utilised as a control following a suitable and sufficient risk assessment, and in adherence with the hierarchy of controls In the nuclear industry there are well established management and control and assurance measures for RPE, in addition to those assumed in HSG53[1]. These include remote operations, containment, ventilation, real-time alarming air sampling (to highlight an increased challenge) and workplace monitoring, etc. This GPG describes general good practice, as well as the measures which must be utilised to justify the use of the higher assigned protection factors for RPE described within this guide.

The technical reports underpinning the new protection factors are summarised and referenced in the relevant appendices.

This GPG covers the management and use of RPE for suitably and sufficiently risk assessed activities in the nuclear industry.

This GPG details general good practice in the use of RPE and the detailed aspects are only applicable to the RPE stipulated in Section 6, used in the nuclear industry.

3. RISK ASSESSMENT

A Radiation Risk Assessment is required by Regulation 8 of the IRR17[2] and Risk Assessment by Regulation 3 of the Management of Health and Safety at Work Regulations 1999 (MHSWR99)[3]. Regulation 3 of the MHSWR99 requires a suitable and sufficient "all hazards" approach to risk assessment.

RPE is only utilised as a control following a suitable and sufficient risk assessment (in consultation with the Radiation Protection Adviser), and in adherence with the hierarchy of controls; that is RPE is not utilised as the default first line of control. Risk Assessment must be utilised to assess and determine the need for and required use of RPE. Compliance with this GPG would support the use of a WPF for certain forms of RPE greater than the Assigned Protection Factor (APF) provided in HSG53[1], if appropriate.

For work involving, or potentially involving mobile radioactive contamination, the risk assessment will consider the RPE, filter, duration of work, work-rate and ambient temperatures to ensure that they do not impact detrimentally on the WPF or the RPE's suitability. Specific consideration should be given to the duration of the work, work-rate and ambient temperatures, if these vary significantly from the protection factors studies undertaken at the Health and Safety Laboratory[10]. For potentially higher risk operations, as determined by the risk assessed in the radiation risk assessment, it would be good practice to utilise real-time alarming air sampling, which would give early indication of an increasing challenge to the RPE and permit consideration of contingency implementation.

Respiratory protective equipment (RPE) must not be the first line of defence considered, but may be the only appropriate means of controlling the residual hazard, after the application of the hierarchy of controls. RPE that is issued to protect each exposed worker, must offer suitable protection against the hazard that it is being worn for. This includes considering an all hazards perspective, before selecting a particular form of RPE. It is essential that all persons involved in the management and use of RPE are aware of its capabilities and limitations, in order to ensure that an adequate, reliable and planned degree of personal protection is provided.

4. GOOD PRACTICE RPE MANAGEMENT, CONTROL AND ASSURANCE

This section of the GPG details a number of management, control and assurance measures used in the nuclear industry for RPE. These measures are listed below. Measures that must be followed for each RPE type are listed in the appendices.

- User fit testing,
- User training,
- User requirements / medicals,
- Pre-use inspection and checks,
- Peer checking and supervision,
- Donning and doffing,
- Post-task cleaning and monitoring,
- Maintenance and cleaning,
- Work area airborne monitoring and alarms,
- Internal monitoring, and
- Auditing.

4.1 Restriction of Exposure

A Radiation Risk Assessment is required by Regulation 8 of the IRR17[2] before conducting work with ionising radiations. RPE is only selected as a control following a suitable and sufficient risk assessment, and in adherence with the hierarchy of controls. This would include consideration of remote operations, containment, ventilation, real-time alarming air sampling (to highlight an increasing challenge) and workplace monitoring, etc. The Risk Assessment must be utilised to assess and determine the need for and required use of RPE. Compliance with this GPG supports the use of WPF for certain forms of RPE greater than those provided in HSG53[1].

The Radiation Employer is responsible for restricting so far as is reasonably practicable the extent to which employees and other persons are exposed to ionising radiation, that is maintaining doses at a level which is As Low As Reasonably Practicable (ALARP). This must consider the hierarchy of control, specifically engineering controls including ventilation [4].

4.2 User Fit Testing

User fit testing is required for tight-fitting face piece RPE to ensure that it can protect the wearer and is carried out using one of two types of test:

- Qualitative fit testing where an airborne substance is introduced and the test subject is asked if they can taste or smell it. If they can taste or smell it they fail the test. This method is not suitable for full face respirators.
- Quantitative fit testing, for example where airborne concentrations of a substance are measured inside and outside of the RPE and the ratio of these concentrations is calculated as a fit factor.

Whilst either of these fit tests is performed, the test subject carries out simulated work movements which typically include:

- Standing; and
- Range of head movements;

In addition to this, during the quantitative fit test, the test subject carries out:

- Talking whilst undertaking light exercise;
- Light exercise; and
- Brisk exercise.

Records are maintained of the latest fit test for each individual and these tests are repeated at least every two years. These records include the correct model and size of respirator for that individual to achieve the required fit factor.

Fit testing must be conducted by a competent person who is suitably qualified and experienced, for example this can be through the Fit2Fit accreditation scheme[5] or equivalent process. To be deemed competent, the person must have adequate knowledge and have received adequate instruction and training in the following areas[6]:

- Confirmation of adequate and suitable RPE based on fit test.
- The importance of fit testing.
- The purpose, applicability and principles of fit testing methods, the difference between them, and the appropriate use of quantitative and qualitative fit testing methods.
- The examination of RPE and the ability to identify poorly maintained face pieces.
- The ability to correctly fit a face piece and perform pre-use fit checks.
- The ability to recognise a poor fitting face piece.

- The purpose of fit test exercises.
- The preparation of face pieces for fit testing.
- How to carry out diagnostic checks on the face piece and the fit test equipment.
- The capabilities and limitations of the fit test equipment.
- How to perform a correct fit test with the chosen method.
- How to prevent and correct problems during fit testing.
- Interpretation of fit test results.
- An understanding of the differences between fit factor (FF), workplace protection factor (WPF), Assigned Protection Factor (APF) and nominal protection factor (NPF).
- An understanding of regulations[2] and relevant guidance, etc.[1],[6] relating to fit testing.

4.3 User training

All users of RPE must be trained on each model with records being kept of this training. This training includes:

- Identification of the correct model and size of RPE.
- Where fit testing is required, this must be performed at a frequency not exceeding two years. Any changes to face shape in this time will necessitate a new fit test, for example dental work, facial surgery, significant weight loss / gain.
- Pre-use inspection and checks to be carried out, which include:
    - Correct donning of the RPE must be done in accordance with the manufacturer's instructions, including a seal check where specified to be carried out before entering areas.
    - Correct doffing of the RPE.
    - Potential failures or faults.
    - Awareness of facial hair and jewellery issues with RPE.
    - Emergency response to faults or changed conditions.
    - Suitability and limits of the RPE, e.g. filter types and level of protection.
    - Cleaning, maintenance and storage where this is carried out by the user.

Training is refreshed at set periods or whenever protective equipment or arrangements are changed. Training is assessed by observation of the individual correctly undertaking pre-use

checks, donning the RPE, passing a fit test and demonstrating awareness of facial hair and jewellery issues with RPE.

4.4 User requirements / medicals

Dependent upon the type of RPE in use, the user must satisfy a number of requirements before they can use it.

Where the RPE depends upon a seal onto the skin of the user (e.g. full face or half face respirators) user requirements are:

- Wearers must be clean shaven (i.e. shaven within 8 hours before the start of their shift, as referred in BS EN 529[7]) and have no hair around the area of the seal.

- Wearers must not wear cosmetics or anything else that will interfere with the seal. This includes face cream which can increase the movement of a respirator on the face reducing the effectiveness of the seal and it can cause hygiene and maintenance problems for reused respirators.

- Wearers with respiratory or other conditions which could impair their ability to use a respirator (or require them to remove it in order to breathe) are identified through medical assessments.

RPE used with or incorporated in fully enclosed suits (such as non-ventilated suits used with separate RPE or ventilated air fed or powered suits) have other user requirements:

- Wearers health/fitness must be assessed.

- Wearers must be adequately hydrated prior to donning the protective equipment and have their fitness to work confirmed prior to use.

- Wearers with medical conditions that could affect their ability to carry out “hot working” are identified through medical assessment and wholly or partially restricted from significant work in fully enclosed suits accordingly. (See Section 5 for more details on heat stress).

- Working in a fully enclosed suit must be adequately assessed with respect to heat stress, with appropriate time limits applied to address ambient temperature, work rate and combination of PPE types worn, for example ventilated or non-ventilated suits.

Both types of user requirements are applied as appropriate where the RPE requires both a face seal and is used with, or is, a fully enclosed suit.

4.5 Pre-use inspection and checks

Pre-use checks are carried out prior to every use of the RPE. Depending upon the complexity of the equipment and the work arrangements these may be carried out by the wearer, a co-worker or a support worker who has undergone the training to wear the RPE. Any faults

discovered are recorded and reported in order to mitigate against / prevent further occurrences, and the RPE is removed from service and quarantined.

The specific checks for each model of RPE are in accordance with manufacturer's recommendations and learning from operating experience. Examples of these checks include:

- Integrity of material (scratches, splits, cracks, discolouration);
- Condition of straps / buckles or other securing features;
- Debris in the face piece, valve, etc.
- Condition of visors / face pieces and seals;
- Cleanliness;
- Condition of valves / connector hoses;
- Battery charge / connections (where applicable);
- Filters (type, use by date and fitting); and
- Secure fitting of RPE to user's face.

4.6 Checking RPE fit

The level of protection provided by RPE is dependent upon it being used correctly in the right environment. This is ensured through a combination of line manager supervision, independent inspection, self and peer checking. Peer checking is an effective method as it occurs on every RPE task involving more than one person. If there is no peer available, an equivalent standard of checking could be achieved by utilising an appropriately positioned mirror. Checks would include head harness position, hair in the face seal, etc.

Whether 'Self' and 'Peer' checks are recorded (including the correct type of RPE, appropriate fit and the correct size utilised) should be in compliance with site based arrangements. The risk assessed in the radiation risk assessment will determine when it is proportionate to make to recording the checks mandatory, which can also be used to reinforce correct standards. Checks would include head harness position, hair in the face seal, etc.

Supervision involves observation of team members carrying out tasks whilst using the RPE, assessing user competence in the field and providing feedback to reinforce good practice and correct bad practice such as adjusting masks on the face whilst in the hazardous area. Tasks are stopped if unsafe acts are observed and not restarted until this has been corrected. Additional control and assurance measures must be implemented for high hazard activities as recommended by the risk assessment and must be proportional to risk, for example.

- Direct supervision of team leaders.
- Pre-task team brief.

- Entry / Access controllers to ensure everything is in place and correctly implemented.

To verify that good practice is being implemented, independent inspections must be carried out. This will take a number of forms, but must involve suitably competent personnel, independent from the direct line management conducting the work. The independent inspections will observe work being carried out, audit records, confirm (or otherwise) the effectiveness of the training and check procedures. Such personnel may include health physicists, safety representatives, safety advisers, PPE specialists and independent assessment teams/corporate inspectors/internal regulators.

4.7 Donning and doffing

Donning and doffing of the RPE must be done in accordance with the manufacturer's recommendations. Donning is done before entering the hazardous area and doffing is done following exit from the hazardous area.

On completion of a task requiring RPE, before doffing the user should move to the boundary of the (potentially) hazardous area and undergo radiological contamination monitoring, utilising appropriate calibrated and tested equipment. The RPE can be removed and the area exited if no activity is detected, otherwise appropriate contingency arrangements will be implemented to protect the user.

4.8 Post-task cleaning and monitoring

RPE is either retained for further use by the same user, disposed of, or returned to a central facility for processing for reuse. Which of these options is used is clearly defined depending upon the equipment concerned and the circumstances.

Where RPE is reused, there must be local arrangements specifying the conditions in which they can be reused, (i.e. no contamination found on the RPE and no contamination found during the task). The user must either be trained and provided with equipment / materials to monitor the RPE for contamination and carry out cleaning for hygiene purposes, or have access to facilities and personnel where this can be suitably conducted. Significantly contaminated RPE would always be disposed of or returned for more comprehensive cleaning than would be done on plant. Users always have the option of exchanging RPE if there is any doubt over its condition or cleanliness. Typically, contamination monitoring would be carried out by taking swabs (smears) whilst cleaning is achieved using disinfectant disposable wipes. Secure storage is expected to be provided for users who retain and reuse RPE.

Disposable, single use RPE and RPE which is damaged or grossly contaminated and requires disposal, is placed into an appropriate waste stream.

RPE returned to a central facility is subject to a wider range of cleaning and monitoring up to and including laundering and monitoring by hand or using automated equipment.

4.9 Maintenance and cleaning

Maintenance is a requirement for all RPE, except for disposable (single use) RPE. HSG53[1] Section 5 gives guidance on maintaining RPE which must be followed.

- RPE in continuous use is maintained, thoroughly examined and tested at least monthly.

- RPE subject to single use from a pool are maintained, examined and tested at least three monthly.

Maintenance, examination and testing are in accordance with manufacturer's guidance and must be carried out by properly trained personnel.

4.10 Work area airborne monitoring and alarms

Work areas with elevated airborne activity levels (or the potential for such conditions to arise) must have airborne monitoring arrangements appropriate to the risk established. This means that the actual levels of airborne contaminant are well known and are considered when selecting RPE with the appropriate protection factor. This monitoring may be installed at a fixed location or, for temporary work / specific hazards, be portable and placed directly in or sampling from the immediate work area, as determined by the suitable and sufficient risk assessment, including formal advice from a Radiation Protection Adviser (RPA).

Appropriate airborne monitoring shall be considered during tasks with users of RPE, including real-time alarming instrumentation should the risk support it. This monitoring is undertaken for the following purposes:

- To demonstrate the adequacy of the selected RPE.

- To identify any anomalies that may yield the selected RPE as inadequate protection.

- To provide reassurance to personnel involved in the work.

4.11 Internal monitoring

As discussed, the UK Nuclear Industry has a long history of dosimetric evidence supporting the assertion that personnel wearing respiratory protective equipment (RPE) in well managed practices (akin to those discussed in the Good Practice Guide) within the Nuclear Industry do not receive significant internal doses, other than following some unplanned incidents. Many standard controls adopted within the UK Nuclear Industry are not routinely applied or necessarily feasible in other industries, such as workplace air sampling (some alarmed), workplace monitoring of individual post task before the radiological respiratory protective equipment is removed, etc.

Internal dosimetry regimes vary from site to site depending upon the circumstances, radionuclides present and the likelihood of exposure. This may range from large numbers of workers on periodic or continuous monitoring to there being no requirement for internal monitoring unless something unexpected occurs.

Appropriate internal dosimetry regimes shall be considered for users of RPE and be implemented should the risk support it. This monitoring is undertaken for the following purposes:

- To assess individual internal doses as a result of chronic exposures.

- To assess individual internal doses following an acute abnormal event (e.g. elevated airborne activity levels).

- To provide reassurance to a workforce that internal doses are not being systematically missed.

- To provide reassurance to an individual.

- To confirm RPE and arrangements are performing as expected.

It is good practice for personnel likely to become regular users of RPE, to be subject to baseline internal dose assessment prior to undertaking work as a user of RPE and to have subsequent periodic follow-up assessment.

4.12 Auditing

To verify that good practice of this GPG are complied with, independent inspection must be carried out. This will take a number of forms, but must involve suitably competent personnel, independent from the direct line management conducting the work. The independent inspections will observe work being carried out, audit records, confirm (or otherwise) the effectiveness of the training and check procedures. Such personnel may include health physicists, safety representatives, safety advisers, PPE specialists and independent assessment teams/corporate inspectors/internal regulators.

5. HEAT STRESS

For workers requiring PPE (including RPE) for the task / job they are undertaking, consideration must be given to heat stress. Whilst working in a respirator for long periods may not necessarily degrade the seal, it may cause increases in core body temperature. This must be taken into account when undertaking or reviewing the risk assessment (see Section 3).

Factors must be taken into account in setting time limits for workers in RPE which must take in to consideration[8],[9]:

- Ambient temperature and humidity;
- Weight, thickness and permeability of PPE clothing;
- Number of layers of clothing;
- Additional PPE to be worn;
- Work rate;
- Worker's fitness level;
- Regional climate;
- Time of day;
- Time of year; and
- Other appropriate factors.

The RPE trials undertaken at the Health and Safety Laboratory (HSL)[10] were carried out at an environment temperature consistent with workplace conditions, with tasks carried out at higher work rates than those in the nuclear industry for normal routine use. However, the physiological effects of non-airfed suits must be considered where the environmental conditions may affect the worker, reducing the safe wear duration, as well as part of the risk assessment which will affect the final choice of RPE.

As the final selection has to demonstrate that the overall risk to the operative is ALARP, the factors mentioned within this GPG need to be considered which may require alternative RPE/PPE with a lower standard of protection to protect the operator against a more significant hazard.

6. SUMMARY OF WORKPLACE PROTECTION FACTORS

It is good practice to have a site based procedure, or similar that details how the essential and other good practice controls were applied at the location. This could include details of additional controls, such as physiological ones that are to be applied.

The RPE workplace protection factors that can be used in use in the nuclear industry are given in the following appendices. These appendices follow a standard format with each appendix covering one type of RPE. This GPG currently only includes tight fitting full face negative pressure respirators or powered air purifying respirator (PAPR), Appendix A and B respectively. Other appendices will be added (through up-issue of this document) where changes to protection factor are underpinned with suitable test data.

RPE Type	Fit Factor	WPF
Full face negative pressure respirator (P3 filter)	2000	1000*
Full face powered air purifying respirator (P3 filter)	2000	1000*

** Eliminating the effects of poor fit masks before use and avoiding non-fit tested masks, the use of a protection factor (PF) of 1000 as the lower limit of the 95% Confidence Interval for the overall 5th percentile for the data excluding the observed poor fits provides a PF of 1000*

List of Appendices

A. Full face negative pressure respirator with P3 filter
B. Full face powered air purifying respirator with P3 filter

Potential Appendices for future issues of this guide

- *Half Face reusable negative pressure respirator (P3)*
- *Half Face disposable negative pressure respirator (P3)*
- *Effect of ABEK filter vs P3 filter*
- *Effect of Hoods (untapped/taped)*
- *BA set*
- *Battery powered pressurised suit*
- *Independent air supplied pressurised suit*

REFERENCES

[1] Health & Safety Executive Guide - Respiratory protective equipment at work, HSG53

[2] The Ionising Radiations Regulations 2017 (Approved Code of Practice), SI 2017/1075

[3] Management of Health and Safety at Work Regulations 1999

[4] Controlling airborne contaminants at work – A guide to local exhaust ventilation (LEV), HSG258

[5] Fit2Fit accreditation (http://fit2fit.org)

[6] HSE operational circular OC 282/28 – Fit testing of respiratory protective equipment face pieces

[7] BN EN 529:2005 Respiratory protective devices – Recommendations for selection, use, care and maintenance – Guidance document

[8] Office of Nuclear Regulation Guidance – Air fed suits in nuclear decommissioning - Safe working practices

[9] Health & Safety Executive Presentation – Physiological safety of air fed suit work in the Nuclear Industry

[10] HSL Report PE/15/05 – Simulated Workplace Protection Factor Study for the Nuclear Industry Radiological Protection Co-ordination Group

APPENDIX A

Full Face Negative Pressure Respirator with P3 Filter

Description of RPE

This appendix covers any make or model of full face negative pressure respirator fitted with a P3 filter, meeting a fit factor of 2000. The P3 filter may be front or side fitting. The visor may be single piece, separate eye pieces, impact resistant or non-impact resistant.

Workplace Protection Factor

Where ALARP justifications supports the use **of these types of** RPE, an **WPF** of up to 1000 can be adopted, subject to certain conditions and risk assessment for material increases in work rate, duration and/or ambient temperature from those used in the Simulated Workplace Protection Factor Study[10] for the Nuclear Industry Radiological Protection Coordination Group (PE/15/05) by the Health and Safety Laboratory (HSL).

The work undertaken by the HSL showed and supported the following:

- A common WPF could be used for this class of RPE.
- No evidence of degraded protection with duration of wear during the testing (2.5 hours).
- Adjusting the fit / comfort of the respirator during use can temporarily reduce the protection provided.
- If the harness is not centred on the back of the head then the protection can be degraded.

HSL concluded that an WPF of 1000 was deemed appropriate if excluding individuals who were observed to have a poor mask fit before testing, which this GPG strives to do.

ESSENTIAL

To adopt an GPG WPF of up to 1000 for a Full Face Negative Pressure Respirator with P3 Filter, the following pre-requisites must be in place:

- Arrangements to ensure users are clean shaven (i.e. shaven within 8 hours before the start of their shift, as referred in BS EN 529) and have no hair or other obstructions, e.g. facial piercing, etc., where the respirator face seal is made.
- Arrangements to ensure users are not wearing cosmetics where the respirator face seal is made.
- Arrangements to peer check the RPE fitting.
- Users have passed a quantitative respirator fit test at least two yearly where they must achieve a fit factor of at least 2000 to be authorised for each make/model of full face respirator to be used. Any changes to face shape within the two years will necessitate a new fit test, for example dental work, facial surgery, significant weight loss / gain. This fit testing includes specifying the correct size of respirator for each user. (Further information is provided in section 4.3)
- Users trained on the use of the respirators at least two yearly and that training includes:
  - Pre-use visual checks of the respirator.
  - Checking that no hair is trapped in the face seal.
  - Confirming that the respirator straps are centred on the back of the head and that no straps / release catches are trapped forward.
  - Leakage test by blocking filter, breathing in and holding breath for 10 seconds. Corrective actions must be taken to correct the fit, if necessary, before entering the work area the respirator is to be worn in.
  - Not to adjust the respirator within the hazardous area the respirator is being worn in.
  - Importance of using the correct respirator size.
  - Not to over tighten respirator straps and how to tell if it is over tightened.
  - Arrangements / methods for cleaning / storage of respirator if it is re-issued.
- Checks of the fit of the respirator.
- The RPE has been maintained, inspected and tested in accordance with the manufacturer's instructions.
- Not used in oxygen-deficient atmospheres.

Typical Donning Instruction – Full Face Respirator

- Loosen all of the head harness straps.
- Fit the chin into the chin-cup and pull the harness over the head.
- Straps must be tightened in pairs but not overly so, starting with the neck straps and pulling the straps backwards (not outwards). Then moving upwards to next set of straps and repeat.
- Straps must lay flat against head / skin.
- Harness must be centralised.
- Care must be taken to ensure hair does not become trapped in the seal.

A seal check must be carried out before entering hazardous areas. This is done by:

- Placing palm of the hand over the filter inlet.
- Breathing in and on a count of 10 ensure there is no air leakage – the mask must pull onto the face.

APPENDIX B

Full Face Powered Air Purifying Respirator (PAPR) with P3 Filter

Description of RPE

This appendix covers any make or model **of tight fitting** full face PAPR fitted with a P3 filter, meeting a fit factor of 2000. The P3 filter(s) may be front or side fitting on face piece or attached to blower unit. The visor may be single piece, separate eye pieces, impact resistant or non-impact resistant.

Workplace Protection Factor

Where ALARP justifications supports the use **of this type of** RPE, a **WPF** of up to 1000 can be adopted, subject to certain conditions and risk assessment for material increases in work rate, duration and/or ambient temperature from those used in the Simulated Workplace Protection Factor Study[10] for the Nuclear Industry Radiological Protection Coordination Group **(PE/15/05)** by the Health and Safety Laboratory (HSL).

The work undertaken by HSL did not specifically cover PAPR, but It is reasonable to assume that a full face powered air purifying respirator (P3 filter) with a tight fitting full face mask will have at least the same protection factor as a negative pressure device with a full face mask.

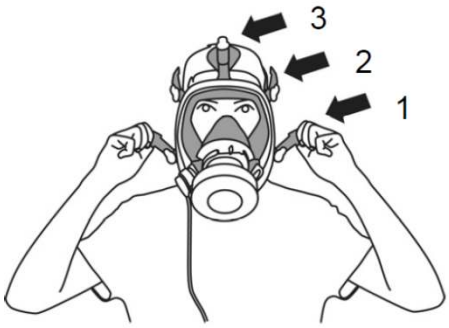
ESSENTIAL

To adopt an WPF of up to 1000 for a Full Face Powered Air Purifying Respirator (PAPR) with P3 Filter, the following pre-requisites must be in place:

- Arrangements to ensure users are clean shaven (i.e. shaven within 8 hours before the start of their shift, as referred in BS EN 529) and have no hair or other obstructions, e.g. facial piercing, etc., where the respirator face seal is made.
- Arrangements to ensure users are not wearing cosmetics where the respirator face seal is made.
- Arrangements to check RPE fitting.
- Users have passed a quantitative respirator fit test at least two yearly where they must achieve a fit factor of at least 2000 to be authorised for each make/model of respirator to be used. Any changes to face shape within the two years will necessitate a new fit test, for example dental work, facial surgery, significant weight loss / gain. This fit testing includes specifying the correct size of respirator for each user. (Further information is provided in section 4.3)
- Users trained on the use of the respirators at least two yearly and that training includes:
  - Pre-use visual checks of the PAPR face piece, filter(s), blower unit, hose if applicable, belt or shoulder harness and fittings (refer to manufacturer's instructions).
  - Pre use checks of powered blower unit (battery charge/air flow) as applicable (refer to manufacturer's instructions), including as a minimum:
    - Battery charge.
    - Air flow.
  - Checking that no hair is trapped in the face seal.
  - Confirming that the respirator straps are centred on the back of the head and that no straps / release catches are trapped forward.
  - Leakage test by blocking filter(s), breathing in and holding breath for 10 seconds, whilst power unit is switched off, or blocking inhalation valve port before attaching hose from the blower unit (refer to manufacturer's instructions). Corrective actions must be taken to correct the fit, if necessary, before entering the work area the respirator is to be worn in.
  - Not to adjust the respirator within the work area the respirator is to be worn.
  - Importance of using the correct respirator size.
  - Not to over tighten respirator straps and how to tell if it is over tightened.
  - Arrangements / methods for cleaning / storage of respirator if it is re-issued.
- PAPR (blower unit, hoses and respirator face piece) are cleaned, maintained, inspected and tested in accordance with manufacturer's instructions.
- Not used in oxygen-deficient atmospheres.

Typical Donning Instruction – Full Face PAPR

- Loosen all of the head harness straps.
- Fit the chin into the chin-cup and pull the harness over the head.
- Straps should tighten in pairs but not overly so, starting with the neck straps and pulling the straps backwards (not outwards). Then moving upwards to next set of straps and repeat.
- Straps should lay flat against head / skin.
- Harness must be centralised.
- Care must be taken to ensure hair does not become trapped in the seal.



A seal check should be carried out before entering hazardous areas. This is done by:

- Place palm of the hand over the filter inlet whilst power is switched off, or inhalation valve port before attaching the hose from blower unit. In accordance with manufacturer's instructions for the model of PAPR being used.
- Breathing in and on a count of 10 ensure there is no air leakage – the mask should pull onto the face.
- Where the PAPR model used has a blower with hose to facepiece the belt should be on the outside of clothing (as shown below).

GLOSSARY

Protection Factor

The term “Protection Factor” is ambiguous, so has been standardised within the respiratory protection field into the terms: Fit Factor, Workplace Protection Factor, Simulated Workplace Factor, Assigned Protection Factor and Nominal Protection Factor.

- Fit Factor (FF) is the number that is the direct result of a quantitative respirator fit test. It is a measurement made by an instrument during a simulation of workplace activities (the exercises). It is expressed as the challenge aerosol concentration outside the respirator divided by the challenge aerosol concentration that leaks inside the respirator during a fit test.

- Workplace Protection Factor (WPF) is the level of protection actually experienced by an individual while working in a hazardous environment. It is the ratio between the breathing zone concentration (outside the face piece) of a chosen hazardous substance and its concentration inside the face piece. A suitable sampler will be placed as near as possible to the mouth of the RPE wearer within the correctly worn RPE, and used in the work place. This technique is often used for conducting respirator research. The WPF may be expressed as[10]:

$$\text{WPF} = \frac{\text{Concentration inside the face piece), } C_i}{\text{Concentration within the breathing zone (outside the face piece), } C_o}$$

- Simulated Workplace Protection Factor (SWPF) is a study conducted in a controlled laboratory setting and in which C_o and C_i sampling is performed while the respirator user performs a series of set exercises. The laboratory setting is used to control many of the variables found in workplace studies, while the exercises simulate the work activities of respirator users. This type of study is designed to determine the optimum performance of respirators by reducing the impact of sources of variability through maintenance of tightly controlled study conditions.

- Assigned Protection Factor (APF) is the level of respiratory protection that can realistically be expected to be achieved in the workplace by 95% of adequately trained and supervised wearers using a properly functioning and correctly fitted RPE and is based on the 5th percentile of the WPF data.

- Nominal Protection Factor (NPF) is a number derived from the maximum percentage of total inward leakage permitted in relevant European Standards for a given class of RPE. The relationship between NPF and total inward leakage can be expressed as follows[10]:

$$\text{NPF} = \frac{100}{\text{Permitted maximum percentage total inward leakage}}$$