The UK
Nuclear Industry
Good Practice Guide
To:

Respiratory Protective Equipment

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

DECEMBER 2016

Revision History

Issue No.	Revision Date	Changes
1	December 2016	New document

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

Forward

This Nuclear Industry Good Practice Guide (GPG) has been written for radiological respiratory protective equipment (hereby referred to as RPE) used in the nuclear industry. Although the GPG was developed for RPE in the nuclear industry, it could form the basis for the use of enhanced protection factors in other industries.

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 assigned protection factors for the different forms of RPE.

This GPG follows recent protection factors studies undertaken at the Health and Safety Laboratory (on behalf of the nuclear industry and referenced in the relevant appendices), which concluded that a higher protection factor can be applied to some RPE provided rigorous management arrangements are applied. These required minimum management arrangements are detailed in the relevant appendix, with greater detail provided within the main body of this guide. It was recognised through the Industry Radiological Protection Co-ordination Group (IRPCG) that a GPG facilitates the application of consistent protection factors underpinned by a suitable level of management and use. This GPG describes the level of management and use required to underpin a higher Assigned Protection Factor (APF) being applied to the RPE. This GPG must be followed to use the APFs quoted.

The GPG is consistent with legislation and guidance listed in the References (page 21) and has been endorsed by the following organisations:

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

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 Industry Radiological Protection Coordination Group (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 Assigned Protection Factors, the European Basic Safety Standard Directive (BSSD) implementation and Radiological Protection Training Standards. 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

HSE = Health and Safety Executive

HSL = Health and Safety Laboratory

IRR99 = Ionising Radiations Regulations 1999

IRPCG = Industry Radiological Protection Co-ordination Group

NPF = Nominal Protection Factor

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 guidance document HSG53 "*Respiratory protective equipment at work*"[1] sets assigned protection factors for different forms of Respiratory Protective Equipment (RPE). These factors are considered to be pessimistic and are not necessarily based on relevant nuclear industry data. More realistic protection factors can and have been applied, with appropriate underpinning data and by having suitable management arrangements in place.

In compliance with Regulations 8, 9 and 10 of the Ionising Radiations Regulations 1999 (IRR99)[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. 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.

RPE is intended to prevent the inhalation of radioactive substances 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.

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

Respiratory Protective Equipment (RPE) 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 & assurance measures for RPE, in addition to those assumed in HSG53[1]. This GPG describes the measures which must be utilised to justify the use of the higher protection factor for RPE described within this GPG.

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 underpinned by suitable and sufficient risk assessed activities in the nuclear industry.

This GPG is only applicable to the RPE in the appendices.

3. RISK ASSESSMENT

A Prior Risk Assessment is required by Regulation 7 of the IRR99[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, and in adherence with the hierarchy of controls 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 APF for certain forms of RPE greater than those pessimistically provided in HSG53[1].

4. RPE MANAGEMENT AND CONTROL & ASSURANCE MEASURES USED IN THE NUCLEAR INDUSTRY

This section of the GPG details a number of management and control & 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 Prior Risk Assessment is required by Regulation 7 of the IRR99[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. 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 APF for certain forms of RPE greater than those pessimistically provided in HSG53[1].

The Radiation Employer is responsible for restricting so far as is reasonably practicable the extent to which his 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 will 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 pieces to ensure the RPE 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 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.

- Principles of fit testing methods, the difference between, and the appropriate use of quantitative and qualitative fit testing methods.

- Examination of RPE and the ability to identify poorly maintained face pieces.

- Ability to correctly fit a face piece and perform pre-use fit checks.

- Ability to recognise a poor fitting face piece.

- The purpose and applicability of fit testing, the differences between, and the appropriate use of quantitative and qualitative fit testing methods.

- The purpose of fit test exercises.

- Preparation of face pieces for fit testing.
- How to carry out diagnostic checks on the face piece and the fit test equipment.
- 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 approved codes of practice[1],[6] relating to fit testing.

4.3 User training

All users of RPE must be trained on each model with records 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 checking for:
    - 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 nuclear industry requires users to 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 12 hours of the end of wear) 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 by 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 Peer checking and supervision

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 and peer checking. Peer checking is probably the most effective method in that it occurs on every RPE task involving more than one person. It is informal and results are not recorded, but it enables users to check each other's equipment more thoroughly than they could do themselves and provide feedback to each other to reinforce correct standards.

Supervision involves observation of team members carrying out tasks whilst using the RPE, assessing users competence in the field and providing feedback to reinforce good practice and correct bad practice. 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.

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.

4.8 Post-task cleaning and monitoring

On completion of a task requiring RPE, the equipment 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 as well as formal advice from a Radiation Protection Adviser (RPA) / Health Physicist.

4.11 Internal monitoring

The details of the internal monitoring regimes vary from site to site depending upon the circumstances, radionuclides present and 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.

Users of RPE shall be considered as part of an appropriate internal monitoring regimes. 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.

4.12 Auditing

To verify that the conditions stated in the appendices of this GPG are complied with, independent inspection must be carried out. This can take a number of forms but must involve suitable personnel, independent from the line management, observing work being carried out, auditing records, confirming effectiveness of training and checking procedures. Such personnel may include, safety advisers, PPE specialists, safety representatives, corporate inspectors (e.g. Health Physicist, Radiation Protection Supervisor, Subject Matter Expert).

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[7],[8]:

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

The RPE trials undertaken at the HSL[9] 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 ASSIGNED PROTECTION FACTORS

In compliance with this GPG, the RPE protection factors in use in the nuclear industry are given in the following appendices. These appendices follow a standard format with each appendix covering one class of RPE. Initially this GPG will only include the full face negative pressure respirator and the full face 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	APF
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
C. To follow in future document issues

Potential Appendices for Future Document Issues

- *Half Face reusable negative pressure respirator (P3)*
- *Half Face disposable negative pressure respirator (P3)*
- *Effect of ABEK filter vs P3 filter*
- *Effect of Hoods (untaped, 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 1999 (Approved Code of Practice), SI 1999/3232

[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] Office of Nuclear Regulation Guidance - Airfed suits in nuclear decommissioning - Safe working practices

[8] Health & Safety Executive Presentation - Physiological safety of airfed suit work in the Nuclear Industry

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

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

APPENDIX A
– Full Face Negative Pressure Respirator with P3 Filter –

Description of RPE

Any make or model of full face negative pressure respirator fitted with a P3 filter. The P3 filter may be front or side fitting. The visor may be single piece, separate eye pieces, impact resistant or non-impact resistant.

Assigned Protection Factor

Guide APF = 1000, subject to risk assessment for material increases in work rate, duration and/or ambient temperature from the Simulated Workplace Protection Factor Study for the Nuclear Industry Radiological Protection Co-ordination Group[9]

Protection Factor Assessment

This following report and work it describes were undertaken by the Health and Safety Laboratory under contract to IRPCG.

Title: Simulated Workplace Protection Factor Study for the Nuclear Industry Radiological Protection Co-ordination Group[9]

Reference: PE/15/05

Date of Issue: 16 June 2015

Lead Author: Mike Clayton BSc

HSL Project Number: PE05629

Summary:

- A common APF can 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 harness is not centred on the back of the head then the protection can be degraded.
- HSL concluded that an APF of 1000 was deemed appropriate if excluding individuals who were observed to have a poor mask fit before testing.

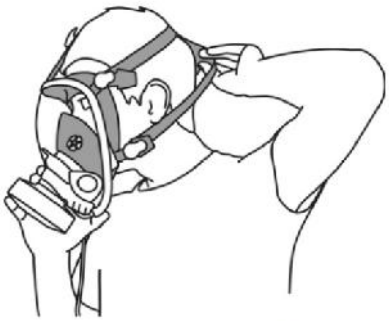
The IRPCG would like to take this opportunity to thank all volunteers from AWE and Sellafield who participated in this study, as well as thank the following five organisations that funded the study: AWE, DRDL, EDF, Rolls-Royce, and Sellafield.

ESSENTIAL:

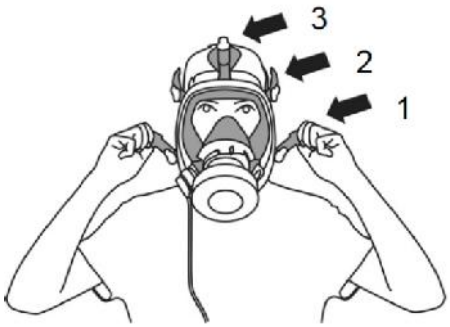
To claim the Guide APF of up to 1000 for a Full Face Negative Pressure Respirator with P3 Filter, the following pre-requisites must be in use:

- Arrangements in place to ensure users are clean shaven (i.e. shaven within 12 hours) and have no hair or other obstructions, e.g. facial piercing, etc., where the respirator face seal is made.
- Arrangements in place to ensure users are not wearing cosmetics where the respirator face seal is made.
- Users have to pass 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 are 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.
    - 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.
- Respirators are cleaned / maintained and inspected / tested to HSG53 standards.
- Do not use 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

Any make or model of full face PAPR fitted with a P3 filter. 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.

Assigned Protection Factor

Guide APF = 1000, subject to risk assessment for material increases in work rate, duration and/or ambient temperature from the Simulated Workplace Protection Factor Study for the Nuclear Industry Radiological Protection Co-ordination Group[9]

Protection Factor Assessment

Inferred from the Simulated Workplace Protection Factor Study for the Nuclear Industry Radiological Protection Co-ordination Group[9], HSG(53)[1] assigned protection factors (APFs) and Operational experience.

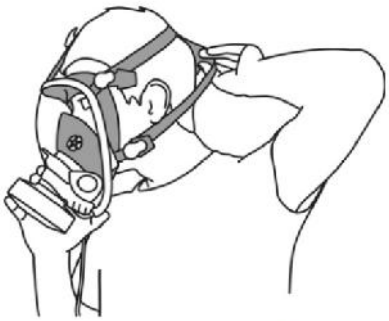
The IRPCG would like to take this opportunity to thank all volunteers from AWE and Sellafield who participated in this study, as well as thank the following five organisations that funded the study: AWE, DRDL, EDF, Rolls-Royce, and Sellafield.

ESSENTIAL:

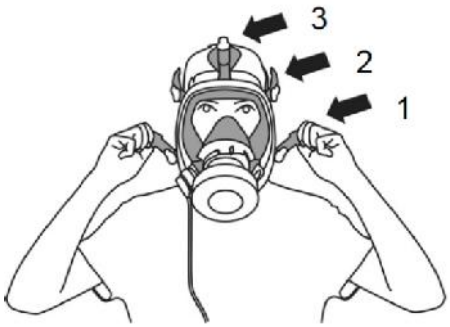
To claim the Guide APF of up to 1000 for a Full Face PAPR with P3 Filter(s), the following pre-requisites must be in use:

- Arrangements in place to ensure users are clean shaven (i.e. shaven within 12 hours) and have no hair or other obstructions, e.g. facial piercing, etc., where the respirator face seal is made.
- Arrangements in place to ensure users are not wearing cosmetics where the respirator face seal is made.
- Users have to pass 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 are 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).
  - 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 blower unit (refer to manufacturer's instructions)
  - 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.
- Respirators are cleaned / maintained and inspected / tested to HSG53 standards.
- PAPR (blower unit, hoses and respirator face piece) are cleaned/ maintained and inspected/tested to HSG53 standards and in accordance with manufacturer's instructions.
- Do not use 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.
- 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 5^{th} 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]:

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

IRR99 (Regulation 9) – Personal protective equipment

(1) Any personal protective equipment provided by an employer pursuant to regulation 8 (restriction of exposure) shall comply with any provision in the Personal Protective Equipment (EC Directive) Regulation 1992 which is applicable to that item or personal protective equipment.

(2) Where in the case of respiratory protective equipment no provision of the Regulations referred to in paragraph (1) applies, that respiratory protective equipment shall satisfy the requirements of regulation 8 only if it is of a type, or conforms to a standard, approved in either case by the Executive.

(3) Every radiation employer shall ensure that appropriate accommodation is provided for personal protective equipment when it is not being worn.

IRR99 (Regulation 10) – Maintenance and examination of engineering controls etc and personal protective equipment

Every radiation employer shall ensure that all personal protective equipment provided pursuant to regulation 8 is, where appropriate, thoroughly examined at suitable intervals and is properly maintained and that, in the case of respiratory protective equipment, a suitable record of that examination is made and kept for at least two years from the date on which the examination was made and that the record includes a statement of the condition of the equipment at the time of the examination.