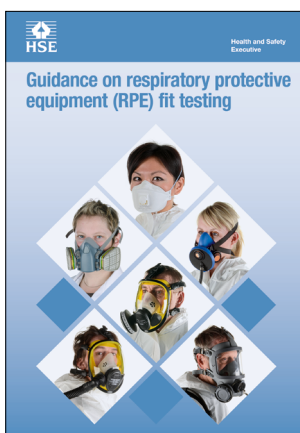


Guidance on respiratory protective equipment (RPE) fit testing



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Introduction

This guide gives advice on fit testing for the employer and those conducting fit tests.

This guide provides:

- information on fit test methods;
- information on what can be achieved from a fit test; and
- the core information to be included in a fit test report.

Following this guidance is not compulsory and you are free to take other actions to comply with the requirements of the law. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustration of good practice.

HSE does not approve nor recommend any particular fit testing equipment. Any equipment included in this guidance provides representative information.

Further advice on the practical aspects of fit testing is provided by the British Safety Industry Federation (BSIF); this can be found at www.fit2fit.org.

Fit testing should be conducted by a competent person. Competence can be demonstrated by accreditation under the Fit2Fit RPE Fit Test Providers Accreditation Scheme. This scheme has been developed by the BSIF, together with industry stakeholders, and is supported by HSE. The scheme is not compulsory and employers are free to take other action to comply with the law. Further details on the scheme can be found at www.fit2fit.org.

Where respiratory protective equipment (RPE) is used as a control measure under health and safety legislation, it is vital that the selected RPE is both adequate and suitable. General advice on selection of RPE is covered in the HSE guidance document *Respiratory protective equipment at work: A practical guide* (HSG53).¹

To ensure that the selected RPE has the potential to provide adequate protection for individual wearers, the Approved Codes of Practice (ACOPs) supporting the Control of Substances Hazardous to Health Regulations (COSHH),² the Control of Lead at Work Regulations,³ the Control of Asbestos Regulations,⁴ the Confined Spaces Regulations⁵ and the Ionising Radiations Regulations⁶ stipulate that tight-fitting RPE should be fit tested as part of the selection process.

The performance of tight-fitting facepieces depends on achieving a good contact between the wearer's skin and the face seal of the facepiece. People's faces vary significantly in shape and size so it is unlikely that one particular model or size of RPE facepiece will fit everyone. Inadequate fit will significantly reduce the protection provided to the wearer. Any reduction in protection may lead to immediate or long-term ill health or can even put the RPE wearer's life in danger.

Fit testing is therefore a method for checking that a specific model and size of tight-fitting facepiece matches the wearer's facial features and seals adequately to the wearer's face. It will also help to identify unsuitable facepieces which should not be used.

A pre-use wearer-seal check should be carried out each time a fit-tested facepiece is worn and before entering the hazardous environment. This check is to determine whether the wearer has correctly donned a facepiece before entering a contaminated work area. The RPE manufacturer will provide instructions on how to carry it out. Note, however, that a pre-use wearer-seal check is **not** a substitute for fit testing.

Tight-fitting facepieces (often referred to as masks) rely on having a good seal with the wearer's face. These are available as both non-powered and powered respirators, and breathing apparatus (BA) with either a half mask or a full-face mask. Their performance, irrespective of whether they are non-powered (negative pressure), powered or constant-flow airline BA relies heavily on the quality of fit of the facepiece to the wearer's face. An inadequate fit will significantly reduce the protection provided to the wearer.

Examples of types of tight-fitting facepieces are shown in Figures 1, 2 and 3.



Figure 1 Disposable half mask



Figure 2 Reusable half mask



Figure 3 Full-face mask

Guidance for employers

This guidance assumes that you have chosen to use tight-fitting RPE as part of your control regime following an appropriate risk assessment. It also assumes that you have considered the wider aspects of RPE provision found on the HSE website at <http://www.hse.gov.uk/respiratory-protective-equipment/index.htm> and in the guidance document *Respiratory protective equipment at work: A practical guide* (HSG53).

It is important to know that some pre-existing medical conditions (for example, breathing disorders such as asthma; skin allergies; or even heart problems) may restrict or prevent some workers wearing any RPE, or certain types of RPE. You will need to ensure that workers are fit to wear the selected and required RPE. If you are unsure, you (the employer) should arrange for appropriate medical assessment.

Powered or constant-flow airline BA RPE with loose-fitting hoods or helmets do not require fit testing.

Tight-fitting powered or constant-flow airline BA RPE under positive pressure still requires fit testing as studies have shown that during heavy exertion, inward leakage is possible.

A fit test should be carried out as part of the initial selection of the RPE.

A fit test should be repeated whenever there is a change to the RPE type, size, model or material or whenever there is a change to the circumstances of the wearer that could alter the fit of the RPE; for example:

- weight loss or gain;
- substantial dental work;
- any facial changes (scars, moles, effects of ageing etc) around the face seal area;
- facial piercings;
- introduction or change in other head-worn personal protective equipment (PPE).

As part of your RPE programme, it is good practice to have a system in place to review when a repeat fit test may be required. For example, face shape will change through ageing alone.

There are two basic types of RPE fit testing – qualitative and quantitative.

Qualitative fit testing (QLFT)

Qualitative fit testing (QLFT) is a pass/fail test based on the wearer's subjective assessment of any leakage through the face seal region by detecting the introduction of bitter- or sweet-tasting aerosol as a test agent. QLFT methods are suitable for disposable and reusable half masks; they are not suitable for full-face masks. Although this type of test is based on subjective detection and response by the wearer of the RPE, it is important that it is administered by a fit tester competent in using this method.

Quantitative fit testing (QNFT)

Quantitative fit testing (QNFT) provides a numerical measure of how well a facepiece seals against a wearer's face; this is called a fit factor. These tests give an objective measure of face fit. QNFT methods are suitable for disposable and reusable half masks and full-face masks. Examples of QNFT methods are:

- ambient particle counting;
- controlled negative pressure (CNP).

The fit factor, which is calculated by the fit test equipment, uses the following formulas:

For the ambient particle counting method, the quantitative fit factor (QNFF) is calculated as the ratio of the two aerosol concentrations measurements as shown in formula (1):

$$\text{QNFF} = \frac{C_o}{C_i} \quad (1)$$

Where

C_o is the challenge aerosol concentration outside the facepiece;

C_i is the challenge aerosol concentration inside the facepiece.

For the CNP method, the QNFF is calculated as the ratio of the inspiratory flow rate and the mean leakage flow rate as shown in formula (2):

$$QNFF = \frac{IFR}{LFR} \quad (2)$$

Where

IFR is the inspiratory flow rate associated with CNP challenge pressure;

LFR is the mean leakage flow rate measured with the head held in a motionless position at the end of each test exercise.

For half masks, the CNP challenge pressure should be 15 mm (0.58 inches) H₂O and the inspiratory flow rate should be 53.8 litres/min. For full-face masks, the CNP challenge pressure should be 25 mm (1 inch) H₂O and the inspiratory flow rate should be 55.8 litres/min.

The type of fit test method used depends on the type of RPE to be fit tested. Table 1 shows which fit test methods are applicable.

Table 1 Fit test method selection

Fit testing method				
RPE (type and mask)		Quantitative (QNFT)		Qualitative (QLFT)
		Ambient particle counting	Controlled negative pressure ^a	Taste
Disposable respirator ^b	Half mask	Yes	No	Yes
Reusable respirator	Half mask	Yes	Yes	Yes
	Full-face mask	Yes	Yes	No
Powered respirator	Half mask	Yes	Yes	Yes
	Full-face mask	Yes	Yes	No
Constant flow airline BA	Half mask	Yes	Yes	Yes
	Full-face mask	Yes	Yes	No
Fresh air hose BA	Half mask	Yes	Yes	Yes
	Full-face mask	Yes	Yes	No
Demand valve BA	Half mask	Yes	Yes	Yes
	Full-face mask	Yes	Yes	No
Escape BA	Full-face mask	Yes	Yes	No

^a Any leakage through the exhalation valve has to be eliminated.

^b The ambient particle counting instrument may require additional functionality, such as the TSI N95 technology, to eliminate penetration of ambient particles through the filter material for masks with assigned protection factors (APFs)* of 4 (FFP1) and 10 (FFP2).

* APF is the workplace level of respiratory protection the facepiece is expected to provide, and is used when selecting adequate RPE.

If it is not possible for the wearer to obtain an adequate fit with the first choice of facepiece you should attempt fit testing using an alternative make, model or size of tight-fitting facepiece. Where you cannot achieve an adequate fit you should select another type of RPE that does not rely on a tight-fitting face seal, such as a loose-fitting respirator hood or helmet.

You should record the fit test by means of a report or certificate which should clearly state whether the result of the fit test was a pass or fail. Annex 1 shows the content that you should provide in a fit test report.

The fit test report should be available to the employee and accessible to others such as enforcement authorities. Collective reports should be available to safety representatives. You should record RPE examinations and tests – and, where appropriate, any repairs made – and retain them for at least five years.

The employer is responsible for meeting the cost of fit testing.

Guidance for fit testers

General

As a fit tester you have duties under health and safety at work legislation because if you do not carry out a fit test properly the wearer could be exposed to substances hazardous to health due to facepiece leakage.

RPE fit testing should be carried out by a competent person. A fit tester should have adequate knowledge, and have received adequate instruction and training in the following areas:

- selection of adequate and suitable RPE;
- examination of RPE and the ability to identify poorly maintained facepieces;
- ability to correctly fit a facepiece and perform pre-use wearer-seal checks;
- ability to recognise a poorly fitting facepiece;
- awareness of external factors that may affect the fit of the facepiece or the fit test result;
- the purpose and applicability of fit testing;
- the differences between, and the appropriate use of, QNFT and QLFT methods;
- the purpose of the fit test exercises;
- preparation of facepieces for fit testing;
- how to carry out diagnostic checks on the facepiece and the fit test equipment;
- capabilities and limitations of the fit test equipment;
- how to perform a correct fit test with the chosen method;
- awareness and knowledge of how to prevent and correct problems during fit testing;
- interpretation of fit test results;
- an understanding of the differences between fit factor, workplace protection factor (WPF),[†] assigned protection factor and nominal protection factor (NPF)[‡]; and
- HSE ACOPs and guidance that deal with fit testing of RPE.

[†] WPF is the protection provided by the RPE when used and measured in the workplace and is the ratio between the breathing zone concentration of the contaminant inside and outside of the facepiece.

[‡] NPF is the level of respiratory protection the facepiece is expected to provide under laboratory conditions and is the pass/fail for the particular European standard.

Facepieces used for fit testing can be one of the following:

- the wearer's individually assigned facepiece;
- a test facepiece of the same type, class and size; or
- a surrogate facepiece with the same sealing surfaces, materials, head straps and breathing resistance as the facepiece assigned to the wearer. You should confirm this with the RPE manufacturer/supplier.

Where facepieces are issued on an individual basis it is recommended that the wearer is fit tested using their issued facepiece.

Where this is not practicable use a test facepiece that exactly matches the wearer's facepiece.

Fit test half and full-face masks as negative-pressure facepiece respirators by attaching a P3 filter, or a combined filter that incorporates a P3 filter, directly to the facepiece. Where practicable, the filter (or facepiece adapter) should be identical to, or similar to, the type of filter normally used with the respirator, ie of similar breathing resistance and weight. You will need to temporarily convert facepieces used with compressed-air-supplied BA and power-assisted respirators to negative-pressure respirators. Alternatively you may use an identical negative-pressure respirator facepiece with the same sealing surface (ie same mould of face blank and material) if available.

Facepieces are available in several different sizes and shapes. The wearer may obtain a better fit (ie pass a fit test) by trying a respirator of a different size, model or make.

The practice of multiple repeat fit tests with the aim of achieving a pass with a given facepiece, ie force fitting, should not be carried out. If after two fit tests the result is still a fail, an alternative facepiece should be tried.

Visually examine the facepiece to be used for fit testing before carrying out a fit test. The examination should include the condition of the facepiece, especially around the face seal and facepiece connectors, the exhalation valve(s) and the head harness. You should properly inspect test facepieces and maintain them in accordance with the manufacturer's instructions.

The fit tester should ensure that test facepieces are cleaned and disinfected before being used by different individuals. Test facepieces that cannot be adequately disinfected (eg disposable half masks) should not be used by more than one individual.

The fit tester should ensure that the fit testing equipment is in good working order, properly set up and checked or tested before conducting the fit test. Maintain and calibrate the fit test equipment in accordance with the manufacturer's instructions.

Variation from the procedures and fit test equipment specified in this guidance may invalidate the fit test results unless the procedures and equipment used have previously been validated. The criteria for evaluating fit test methods given in BS ISO 16975-3 Annex C⁷ are recommended.

The following standards are recommended as suitable references:

- *BS ISO 16975-3:2017, Respiratory protective devices – Selection, use and maintenance. Part 3: Fit-testing procedures*
- European Standards covering inward leakage testing: BS EN 136,⁸ BS EN 140⁹ and BS EN 149.¹⁰

Preparing the wearer

The fit tester should explain to the wearer the purpose of the fit test, what they will have to do, and the meaning of the fit test results.

When you are conducting a qualitative fit test, you should advise wearers not to eat, drink (except still, unflavoured water), smoke or chew gum for at least 30 minutes before the test. When you are conducting an ambient particle counting fit test the wearer should refrain from smoking (including e-cigarettes) for at least 60 minutes before the fit test.

Do not conduct fit tests if there is any hair growth between the wearer's skin and the facepiece sealing surface, such as stubble beard growth, beard, moustache, sideburns or low hairline, which cross the respirator sealing surface. You should ensure that any type of non-PPE apparel or adornment (eg piercing) does not interfere with the fit of the facepiece.

Inform wearers that they should be clean-shaven in the region of the face seal whenever they wear a tight-fitting facepiece at work.

The fit tester should instruct the wearer in the test exercises appropriate to the fit test method used as shown in Annex 2.

The fit tester should ascertain that the wearer is medically fit to wear RPE and seek confirmation (preferably in writing) from the employer.

The wearer should have received training in correct donning of the facepiece before the fit test. If you are also providing RPE training, you should show the wearer how to put on a facepiece, position it on the face, set the strap tension and determine an acceptable fit. A mirror should be available to assist the wearer in evaluating the fit and positioning of the facepiece.

The wearer should be able to don the facepiece in accordance with the manufacturer's instructions, in the manner in which they have been trained, and without assistance from the fit tester.

If the wearer needs to use in-facepiece spectacles they should wear them during the fit test.

Wearers should wear any other PPE that could potentially interfere with the fit of the facepiece during the fit test. If they cannot wear the PPE properly without affecting the function of the RPE or vice versa, choose alternative PPE.

Preparing for a quantitative fit test – all methods

Use, maintain and calibrate QNFT equipment in accordance with the manufacturer's recommendations. Before using the equipment, check its stability as instructed by the manufacturer. Retain all records of maintenance, calibration and pre-use checks.

The minimum fit factor in a quantitative face-fit test, that should be achieved to pass a fit test, will depend on the type and class of facepiece being tested. Table 2 shows the HSE-required minimum fit factors that should be achieved in each of the fit test exercises used with a particular type of fit testing device.

Table 2 Required minimum fit factors for quantitative fit testing

Facepiece type	Quantitative fit test methods	
	Ambient particle counting	Controlled negative pressure
Disposable half mask APF 4 (FFP1) ^a	100	n/a
Disposable half mask APF 10 (FFP2) ^a	100	n/a
Disposable half mask APF 20 (FFP3)	100	n/a
Half face mask	100	100
Full-face mask	2,000	2,000

^a When using a PortaCount, APF 4 (FFP1) and APF 10 (FFP2) disposable half masks can only be fit tested if N95 technology is employed.

Preparing for a quantitative fit test using the ambient particle counting method

The fit test exercises for the ambient particle counting method are given in Table 3.

Fit the facepiece with a sample probe positioned so that the air sample withdrawn from the facepiece is representative of the air breathed by the wearer. Position the open end of the sampling tube in the wearer's breathing zone, close to the face and approximately mid-way between the nose and mouth. Do not isolate the sample probe from the nose and mouth region by a physical partition; for example, by the inner mask of a full-face mask. For half masks and full-face masks, use a suitable fit test adapter and position the open end of the sampling tube as described above.

When fitting the sample probes to half and full-face masks, use suitable sampling adapters to avoid puncturing the facepiece. RPE manufacturers and fit test equipment suppliers can provide suitable fit test adapters to fit most facepiece types. These adapters should enable fit testing on wearer-issued facepieces. When fitting the sampling adapter to the facepiece, take care not to block off or restrict the flow of air through the sampling tube.

The positioning and the combined weight of the fit test adapter, sample probe and sample tubes should not interfere with the fit of the facepiece. This is particularly important when fit testing disposable or lightweight half masks. Sample probes should be lightweight and the sample tubes must be supported to avoid any drag on the fit of the facepiece.

The wearer's exhaled breath can contain particles that can be detected by the particle counting device. These wearer-generated particles can result in a falsely low fit test result. Having an ambient challenge concentration of at least 3000 particles/cc for fit testing disposable and reusable half masks, and 10,000 particles/cc for fit testing full-face masks, will reduce the likelihood of false fails.

An ambient particle count that varies significantly over the duration of the test can also give rise to errors in the fit factor. Avoid excessively dusty and smoky environments. Seek further advice from the fit test equipment supplier if necessary.

Very high fit factors, ie figures over 100,000, could indicate a problem with the application of the fit test; if this happens check the validity of the result.

Preparing for a quantitative fit test using the controlled negative pressure method

The fit test exercises for the CNP method are given in Annex 2, Table 4.

During the CNP measurement the wearer should keep their mouth closed. They should be given time to practise the breath-hold procedure.

The CNP method requires the use of the appropriate fit test adapters for the type of filter connection present on the facepiece to be fit tested.

Preparing for a qualitative fit test based on taste

The fit test exercises for the qualitative method are given in Annex 2, Table 3.

To achieve a pass in a qualitative fit test the wearer must not taste the test agent at any time during any of the test exercises.

The test solution concentrations and the fit test equipment including hood size are specified in BS ISO 16975-3.

Maintain and use all QLFT equipment in accordance with the manufacturer's recommendations.

Before carrying out a qualitative fit test using a distinctive taste, establish the taste threshold of the wearer. This screening test is carried out to check that the wearer can detect the taste of the test aerosol. This is often referred to as a sensitivity test. If the wearer cannot detect the taste during the screening test, the fit test method cannot be used and you should choose a different method.

Conduct the fit test as a continuous test, allowing sufficient time between the sensitivity test and the fit test for the wearer to clear their palate. Should a fit tester not wish to continue directly from the sensitivity test to the fit test for practical reasons, they should complete the fit test on the same day. The wearer should refrain from smoking, eating or drinking (except for water) during the intervening period.

The nebulisers used to generate the aerosol for the screening test may clog during use and stop delivering the test substance. Therefore the fit tester should make periodic checks of the nebulisers during the test to ensure that it is not clogged. If clogging is found at the end of the test session, the test is invalid. Regular cleaning of the nebulisers should help to prevent clogging.

Conducting the fit test – all methods

Observe the wearer throughout the fit test to ensure that the correct test exercises are conducted. Also watch for facial and head movements that may cause face seal leakage. If the wearer sneezes or coughs during the fit test this can affect the fit test result and you may have to repeat the fit test.

You should also ensure the safety of the wearer – this is especially important if the wearer is walking on a treadmill or stepping during the fit test.

Inform the wearer of the fit test result; ie a pass or fail. Take care when providing information on the numerical fit factor results; informing a wearer that a high fit factor has been achieved may give them false confidence in the RPE and it may cause them to be less careful when donning and using the RPE in the workplace. Stress to the users that practical experience in the workplace has shown that the protection obtained is often less than that achieved in the fit test.

If a poor fit is likely to be caused by inadequate training, the wearer's employer should be informed.

Annex 1

Fit test report

A record of the fit test shall be produced. The fit test report should clearly identify the following (where applicable):

- a) the name of person fit tested;
- b) the make, model, material and size of the facepiece;
- c) the type of filters fitted to the facepiece during the fit test;
- d) the presence or absence of in-facepiece spectacles;
- e) the make and model of any PPE and/or RPE accessory worn during the fit test;
- f) whether the facepiece used was the subject's issued facepiece, a company pool facepiece or a test facepiece;
- g) the test exercises performed during the fit test;
- h) the fit test method employed; ie ambient particle counting device, CNP or qualitative taste test agents;
- i) for quantitative tests, the measured fit factor for each individual test exercise and the overall fit factor;
- j) the pass level used in the test;
- k) the result of the fit test in terms of a pass or fail;
- l) the date of the test; and
- m) the details of the person who performed the test, name of firm, address etc.

The fit test report should also record, where appropriate:

- n) the condition of the wearer's own facepiece;
- o) whether the wearer required assistance donning and carrying out a wearer seal check before the fit test;
- p) how many repeat tests were needed to obtain a pass and the reasons why; and
- q) the serial number or other means of identifying the equipment employed in the fit test.

Annex 2

Fit test exercises

For QLFT and quantitative ambient particle counting methods, the fit test protocol should include a minimum of seven exercises; each test exercise should be performed for at least one minute. During the quantitative fit tests, the exercises should allow for an in-facepiece sample period of at least 60 seconds.

Table 3 Fit test exercises for qualitative methods and quantitative ambient particle counting methods

Exercise	Description
(i) Normal breathing	The wearer should breathe normally with no head movements or talking.
(ii) Deep breathing	The wearer should breathe slowly and deeply, taking care not to hyperventilate.
(iii) Turning head side to side	The wearer should slowly turn their head from side to side between the extreme positions on each side (approximately 15–20 times per minute). The head shall be held at each extreme momentarily so the wearer can inhale at each side.
(iv) Moving head up and down	The wearer should slowly move their head up and down (approximately 15–20 times per minute). The wearer should be instructed to inhale in the up position (ie when looking toward the ceiling).
(v) Talking	The wearer should talk slowly and loudly enough to be heard clearly by the fit tester. The wearer should read from a standard reading passage or count down from 100.
(vi) Bending over	From a normal standing position, the wearer should bend at the waist as if to touch their toes and then return to an upright position. Repeat approximately 10–15 times throughout the duration of the exercise.
(vii) Normal breathing	Same as exercise (i).

During QLFT the fit test exercises should be performed with the wearer standing.

During QNFT the fit test exercises (except for the bending exercise) should be performed while the wearer is doing one of the following:

1. cycling on an exercise bike;
2. walking on a treadmill; or
3. carrying out a stepping exercise.

Note: Take care when asking people to exercise and be aware of the risks of slips and trips.

When you are conducting a fit test using the CNP method you cannot measure the fit during the exercises. Therefore you should measure the static fit factors at the end of each exercise. Follow the procedure shown in Table 4.

Table 4 Fit test exercises applicable for the controlled negative pressure method

Exercise	Description
(i) Normal breathing	In a normal standing position, without talking, the wearer should breathe normally for one minute. After the normal breathing exercise, the wearer should face forward and hold their breath for approximately 10 seconds during the test measurement.
(ii) Deep breathing	In a normal standing position, the wearer should breathe deeply for one minute. After the deep breathing exercise, the wearer should hold their head straight ahead and hold their breath for approximately 10 seconds during the test measurement.
(iii) Turning head side to side	In a normal standing position, the wearer should slowly turn their head from side to side between the extreme positions on each side for one minute. After the turning head side to side exercise, the wearer should face to the left and hold their breath for approximately 10 seconds during the test measurement. Next, the wearer should hold their head fully right and hold their breath for 10 seconds during the test measurement.
(iv) Moving head up and down	In a normal standing position, the wearer should slowly move their head up and down (approximately 15–20 times) for one minute. After the moving head up and down exercise, the wearer should hold their head fully up and hold their breath for approximately 10 seconds during the test measurement. Next, the wearer should hold their head fully down and hold their breath for approximately 10 seconds during the test measurement.
(v) Talking	The wearer should talk slowly and loudly enough to be heard clearly by the fit tester. The wearer should read from a standard reading passage or count down from 100. After the talking exercise, the wearer should hold their head straight and hold their breath for approximately 10 seconds during the test measurement.
(vi) Bending over	From a normal standing position, the wearer should bend at the waist as if to touch their toes and then return to an upright position. Repeat approximately 10–15 times throughout the duration of the exercise. After the bending exercise, the wearer should hold their head straight and hold their breath for approximately 10 seconds during the test measurement.
(vii) Normal breathing	Same as exercise (i).

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Further information

For information about health and safety visit <https://books.hse.gov.uk> or <http://www.hse.gov.uk>.

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