



133 – OFFSHORE NORGE
RECOMMENDED GUIDELINES
FOR
FIT TESTING OF RESPIRATORY PROTECTIVE
EQUIPMENT

Translated version

Preface

These guidelines were prepared as part of the multipartite industry project, Chemical working environment in the oil and gas industry. The guidelines are recommended by Offshore Norges technical network for occupational hygiene, the technical network for health and working environment, the HSE Managers Forum and Norwegian Oil and Gas's Operations Committee. Furthermore, it is approved by Norwegian Oil and Gas's director general.

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These Offshore Norge guidelines have been prepared with broad-based participation from interested parties in the Norwegian petroleum industry and are owned by the Norwegian petroleum industry, represented by Offshore Norge is responsible for administration.

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1. INTRODUCTION

1.1 Objective

These guidelines recommend a method for leak testing respiratory protective equipment. The objective is for respiratory protective equipment to behave as a controlled barrier against chemical exposure, the performance of which may be documented. The user must be certain the respiratory protective equipment is adapted and is properly sealed, and the employer must have assurance that the respiratory protective equipment is functioning as intended.

Methods and procedures for leak testing other than those described in these guidelines may be used, provided that performance can be documented in an equivalent manner.

1.2 Regulations

According to the Working Environment Act, the employer is responsible for ensuring a fully acceptable working environment. Sections 6 and 7 of the Chemical Regulations require the employer to ensure that employees are prevented from being exposed to substances that are hazardous to health. Where prevention of exposure is not practicable, the employer must ensure that exposure is reduced to a level as low as reasonably practicable (ALARP). If it is not possible to adequately control and limit the exposure through other measures, the employer must stipulate the use of appropriate respiratory protective equipment.

Respiratory protective equipment that is available for use in the workplace must satisfy requirements stipulated in regulations relating to use of personal protective equipment in the workplace.

1.3 Terminology

The ALARP principle is stipulated in the petroleum regulations and requires risk to be reduced to a level that is as low as reasonable practicable.

Protection factor is a function of effectiveness of fit and the filter material's ability to absorb pollution in the inhaled air. The higher the number, the better the protection.

Fit factor is a measure of the effectiveness of the face mask's seal against the face.

Leak check is a simple check of the seal of the face mask carried out by the user before every use.

Leak test is a systematic quantitative or qualitative determination of the protection offered by a respirator for each individual user.

1.4 References

- Regulations relating to use of personal protective equipment in the workplace
<http://www.arbeidstilsynet.no/forskrift.html?tid=77989>
- Regulations relating to construction, design and production of personal protective equipment
<http://www.lovdatab.no/for/sf/jd/xd-19940819-0819.html>

- Norwegian Labour Inspection Authority (2007): Respiratory protective equipment, <http://www.arbeidstilsynet.no/artikkel.html?tid=79451>
- HSE OC 282/28 (2010) Fit testing of respiratory protective equipment facepieces http://www.hse.gov.uk/foi/internalops/fod/oc/200-299/282_28.pdf
- HSE HSG 53 (2005) Respiratory protective equipment at work
- Video on choosing and using respiratory protective equipment when performing hot work. <http://www.samarbeidforsikkerhet.no>

2 RESPIRATORY PROTECTIVE EQUIPMENT

The employer must have available documentation regarding the performance characteristics of the respiratory protective equipment being used. The documentation must include reports of leak tests of respiratory protective equipment with tight-fitting masks. These guidelines will facilitate the use of respiratory protective equipment in an acceptable manner, to ensure minimum exposure.

2.1 Choosing and using respiratory protective equipment

Respiratory protective equipment must be considered the final barrier in a hierarchy of measures to control exposure, and is used only if exposure cannot be adequately controlled by other means.

Respiratory protective equipment used must be suitable to ensure that employees are provided with adequate protection. It must be adapted to the work, the environment, the expected levels of exposure and the user. Respiratory protective equipment must reduce exposure as much as is reasonably practicable, and in any event, to an acceptable level.

Variations in facial features require that several respirators should be made available to ensure that the most suitable and comfortable respirator can be chosen by each individual, and it is therefore important that users should be involved with the selection process.

To ensure that the chosen respiratory protective equipment will provide sufficient protection for the individual user, leak testing of the respiratory protective equipment is recommended.

When using respiratory protective equipment, it must be ensured that:

1. There is a procedure for correct selection, use, storage and maintenance.
2. The respiratory protective equipment available to users is clean and well-maintained
3. When choosing tight-fitting face masks, an appropriate leak test should be performed. If necessary, the results of the leak test should be reviewed by an expert.
4. The respiratory protective equipment being evaluated during the leak test must be the same type, size and material as the mask used in the workplace.

The provision of respiratory protective equipment should take into consideration and be consistent with the demands of the specific tasks being performed.

2.2 Types of respiratory protective equipment

Respiratory protective equipment can be categorised as filtering and air-fed respiratory protective equipment. There are three different types of filtering respiratory protective devices:

- Motorised respiratory protective equipment
- Full and half face mask with replaceable filters
- Filtering disposable masks

There are two types of air-fed respiratory protective equipment:

- masks supplied from a compressor via a hose
- portable self-supplied equipment (e.g. air bottles).

There is a difference between tight-fitting and loose respiratory protective equipment. Filtering masks, half face masks and full face masks (fig. 1,2 and 3) are tight-fitting respiratory protective equipment, whilst face shields, ventilated helmets, hoods and suits are loose-fitting respiratory protective equipment (see fig. 4, 5 and 6).



Fig.1 Filtering disposable mask
(tight-fitting)



Fig. 2 Half face mask
(tight-fitting)



Fig. 3 Full face mask
(tight-fitting)



Fig. 4 Ventilated face shield
(loose-fitting)



Fig. 5 Ventilated helmet
(loose-fitting)



Fig. 6 Hood/suit with air supply or fan-assisted
(loose-fitting)

When using a tight fitting respirator, it is crucial that there is no air leakage between the mask and face. The performance of the face mask very much depends on how well the mask fits the user's face. People with beards have very limited benefit from using tight-fitting face masks.

Loose-fitting respiratory protective equipment must have sufficient air flow through the face mask and are less dependent on fitting snugly on the user's face. These therefore do not require leak testing. However, it is important that loose-fitting respiratory protective equipment is the correct size to ensure the user is sufficiently protected. Loose-fitting respiratory protective equipment is more suitable for users who wear glasses and for people with facial hair. In most cases, loose-fitting alternatives to tight-fitting masks will be available, and should be chosen where necessary. Attention must be given to the fact that loose-fitting positive pressure masks can in some cases exhibit a net ingress of air, particularly at high breathing rates, resulting in inward leakage of polluted air.

2.3 Protection factor

The protection factor is a measure of the ratio of the concentration of contaminant inside the mask as compared to the outside ambient concentration, and is determined through laboratory tests. The protection factor is essential therefore in the assessment of the adequacy of a respiratory protective device in any particular situation. However, a respiratory protective device cannot be chosen based solely on the protection factor as indicated by the supplier, and in practice the protection factor may be significantly lower than anticipated or stipulated by the supplier.

Selection of equipment and risk assessments must be based on the equipment's total protection factor and not only the results of the leak test or nominal protection factors provided by the producer.

2.4 Maintenance

It is important that the respiratory protective equipment is inspected, maintained and kept clean throughout the usage period. The respiratory protective equipment must be examined and checked thoroughly at regular intervals, at least every six months, to ensure it meets the design specifications. Inspections should be carried out by trained personnel. If respiratory protective equipment is not used regularly, it should be examined and tested before every use. The routine inspections, carried out by trained personnel, are thorough and mandatory, but do not preclude ongoing daily inspections by users of the equipment.

2.5 Training

Users of respiratory protective equipment must receive sufficient basic and follow-up training. Training should be provided at least once a year by competent personnel and should cover:

- Correct selection
- Correct use
- Proper cleanliness
- Proper maintenance
- Safe storage

This is to ensure the respiratory protective equipment provides the desired level of protection and functions according to the manufacturer's specifications.

Offshore Norge recommended guidelines for fit testing of respiratory protective equipment

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Personnel who handle (purchase, manage, administer, etc.) respiratory protective equipment on behalf of the company must complete sufficient training to ensure that they are fully aware of the requirements of this guideline.

3 LEAK TESTING

3.1 Qualitative and quantitative methods

There are two basic types of leak tests of respiratory protective equipment: qualitative and quantitative.

A qualitative leak test is a simple pass/fail test with a basis in the user's subjective assessment of leakage through the mask using a test substance. It is relatively easy to conduct these tests and they are suited for half face masks and filtering face masks, but not full face masks. Qualitative leak tests are based on use of aerosol with a bitter or sweet taste or use of substances with a characteristic smell. The sense of smell cannot be used as an indicator of the amount of leakage due to significant individual variations in sensitivity to odours.

Use of qualitative leak tests is not recommended.

Quantitative leak tests provide a numeric value of how well the mask seals against the face. This figure is called a leak factor. The method requires special equipment and is more complicated than qualitative methods. This method is recommended as a preferred method in comparison to qualitative methods.

Examples of methods for quantitative leak tests include:

- Use of test chamber in laboratory
- Use of device to check underpressure
- Use of device to count particles

The method of using a test chamber in a laboratory is conducted as a standardised internal leak test for product certification pursuant to the EU directive relating to personal protective equipment. This is a useful, sensitive and recognised method, but is costly to implement. The method is not recommended for use in Norwegian petroleum activities, but may be suited in connection with research and investigative tasks.

The method involving use of a device for controlled underpressure requires the test person to hold his/her breath and not move during the measuring. It is difficult to use this method for filter masks and it is not recommended for use in Norwegian petroleum activities.

The recommended method is leak testing masks during dynamic exercises using a particle counter. The recommended procedure for this method is found in Appendix A.

3.2 Leak testing

A leak test should be carried out as part of the initial selection of respiratory protective equipment or where an un-tested face mask is already in use.

A leak test does not preclude correct and exact daily fitting of the face mask.

For employees with personal respiratory protective equipment, it is recommended that the personal mask is used for the test. If this is not practicable, or if shared equipment is used, a corresponding type and model must be used. Cleaning is very important.

If employees use more than one type of tight-fitting face mask, the leak testing must be carried out with each mask type.

Leak testing is recommended at least every other year or more frequently if the user has experienced significant weight gain or loss, has had considerable dental work, changes to the face (scars, birthmarks, etc.) or if required by the employer's guidelines.

Positive pressure equipment must also be tested (under negative pressure) if the consequences of leakage in the face mask can be serious. This applies, for instance, to a full face mask that can be used along with positive pressure equipment in particularly noxious environments, where even brief leaks can lead to serious exposure.

It is recommended that leak tests be conducted in accordance with the recommended procedure to leak test respiratory protective equipment using a particle counter, Appendix A.

3.3 Interpreting results

When using devices for quantitative leak tests, such as TSI Portacount, as stated in the procedure in Appendix A, these will indicate leak factors. This is a measure of how well the face mask fits on the face. Higher numbers indicate better fit and thus better protection.

The lowest recommended leak factor, which must be achieved to pass every test exercise, is:

- 2000 for full face masks
- 100 for half face masks and filtering disposable masks with P3 filters

It is important to emphasise that leak tests of face masks are not necessarily representative of the level of protection the respiratory protective device provides during daily use at the workplace.

It is also important to keep in mind that there is a difference between the measured leak factor during a leak test and the protection factor indicated by the supplier.

If it is not possible to achieve a good fit between the mask and face, a different size or product should be tested. If the mask still does not fit well, a loose-fitting respiratory protective device should be selected.

3.4 Nonconformities

The lack of a leak test (valid leak-free certificate) in a work situation should be reported and treated as nonconformity in the company's HSE management system.

Use of leaky masks that could have led to noxious exposure should be documented in the relevant person's health journal.

3.5 Report

The main result of a leak test is a report or certificate which indicates whether the leak test was passed. The report can include other details such as the condition of the face mask which was utilised by the user, as well as the user's knowledge regarding correct use of respiratory protective equipment.

Reports from leak tests must be available for all employees using respiratory protective equipment with tight-fitting face masks. The reports from the leak tests must be kept by the employer. These reports must be available for inspection upon request.

Reports from leak tests should contain the following:

- a) name of the person who completed the leak test
- b) information about the face mask; model, material and size
- c) whether the user's own personal mask, the company's shared mask or the test supplier's sample mask was used
- d) test exercises carried out during the test
- e) which test method was used
- f) measured leak values for each exercise and the average for the test as a whole
- g) requirements for protection factor, acceptance criteria
- h) the date the test was carried out and the length of the approval
- i) information regarding the supplier of the leak test
- j) serial number or other identification of equipment used during the leak test

3.6 Expertise requirements

Leak tests of respiratory protective equipment must be carried out by an expert. In order to have expert status the person should possess sufficient knowledge and have received sufficient training in the following areas:

1. selection of suitable respiratory protective equipment
2. inspection and control of respiratory protective equipment
3. adaptation and control of face masks
4. objective and application of leak tests
5. objective of the tasks in the leak tests
6. preparation of face masks for leak test
7. calibration, use and restrictions of the test devices
8. how to carry out a correct leak test using the chosen method
9. interpretation of results from leak tests
10. relevant regulations

Manufacturers of equipment for leak testing will offer proper training. There is currently no approved certification of people who carry out leak tests of respiratory protective equipment in Norway.

3.7 Factors that impact air tightness

Leak testing respiratory protective equipment has the objective of verifying that the face mask is adapted to the user's face and that the air tightness of the mask is satisfactory. The test will ensure that incorrectly adapted face masks are not used.

Various factors that impact the air tightness of the mask:

- Face shape and size
- Scars, birthmarks, etc.
- Facial hair
- Respiration (frequency and depth)
- Movement
- Shape, size and quality of the mask
- Correct use and adaptation of the mask

- Other equipment used simultaneously: glasses, communications equipment, helmet, etc.

3.8 Leak check

A leak check before use is required each time the face mask will be used and before entering a noxious environment. The leak check is carried out by the user according to the supplier's directions for a leak check, unless even better methods are used.

APPENDIX A

Procedure for leak testing respiratory protective equipment

The recommended method is testing the air tightness of the mask during dynamic exercises using a particle counter (*such as TSI Portacount Pro Respirator Fit Tester*). The method is recommended for normal use in Norwegian petroleum activities.

The test procedure must be carried out in accordance with the manufacturer's instructions.

A particle counter instrument counts the number of particles in the room and compares this with the number of particles on the inside of the face mask while the user completes a number of specific exercises. This method can either use particles already existing in the room or in the event that particulate concentrations are low, using generated particulate such as salt particulate. Normally, there will be a need to generate particles.

Preparation

Location and equipment

A suitable premise must be selected for completion of the leak test. This must be a closed room, such as a medium-size meeting room or a large office. Environments with significant dust and smoke should be avoided.

The premises must have a minimum ambient airborne concentration of 1000 particles/cm³. In many instances, particles from a suitable particle generator must be added to the ambient atmosphere (using equipment such as the *TSI Portacount Particle Generator*.)

All metering equipment must be calibrated and maintained according to the manufacturer's recommendations.

Personnel

Personnel must be clean-shaven.

Smokers must not smoke during the last hour prior to testing. Smoke particles can be exhaled for at least 60 minutes after smoking and can lead to incorrect measurements.

The test must be completed by qualified personnel.



Face mask

The respiratory protective device is equipped with a sampling probe placed in the user's breathing zone and near the user's mouth and nose. Respiratory protective equipment with pre-installed sampling probes is in many cases available from the manufacturer. Adapters for testing the user's own equipment are also available in many cases.

Full face and half face masks should be leak tested under negative pressure by fastening a P3 filter directly on to the mask.

Face masks using fan-assisted or compressed air must be tested under negative pressure.

The face masks being tested must be whole and in good condition. The exhalation valve must be clean and in good condition.

Implementation

The metering equipment must be prepared in line with the manufacturer's recommendations.

The user should personally don and wear the face mask for a few minutes before the leak test starts to empty the mask of particles, and should adjust the mask himself/herself.

A test programme with at least seven exercises is carried out. Each test exercise should be conducted for at least one minute and should simulate normal work activities within the workplace. The exercises should therefore be carried out on a treadmill, an ergometer bike or as step exercises.

During the exercises, samples must be taken in the face mask for at least 60 seconds. The exercises are:

| | |
|----------------------------------|---|
| I. Normal breathing | The user breathes normally without head movements or talking. |
| II. Deep breathing | The user breathes slowly and deeply, tries to avoid hyperventilation. |
| III. Move head from side to side | The user moves his/her head slowly from side to side as far as possible (approx. 15-20 times per minute). The head lingers for a moment on each side so the user can take a breath. |
| IV. Move head up and down | The user moves his/her head slowly up and down (approx. 15-20 times per minute). The user must take a breath when the head is up (i.e. when looking at the ceiling). |
| V. Leaning forward | The user stands upright and bends from the hip as if to touch his/her toes several times. |
| VI. Talking | The user should speak loudly and slowly, and loudly enough to be heard by the person administering the test. The user should read from a prepared text or count to 100. |
| VII. Normal breathing | Same as exercise (I). |

The recommended metering equipment will guide users through the test procedure and will give a signal when the test is completed. The metering equipment will indicate whether the test was passed/failed.

The user must achieve the recommended minimum requirement in each test exercise. The software can give the result “passed” based on the average protection factor even though a protection factor below the minimum requirement has been achieved in one or more test exercises. In such instances, the test must be repeated to see whether the user can achieve the minimum requirement in every test exercise.

A grimace test is also recommended, i.e. to make faces with the mask on, in an attempt to break the seal. The objective is to see whether the mask re-seals when the face returns to normal.

In the event of a failed test, the cause of this must be examined, and the test can be re-taken.

Significant moisture in the face mask or in the sampling hose can lead to condensation droplets being detected by the particle counter. This can lead to an artificially low result. The face mask and sampling hose should be dried or replaced between tests as necessary.

Supplementary work

Reports from leak tests must be available for all employees using respiratory protective equipment with tight-fitting face masks. The reports from the leak tests must be kept by the employer. These reports must be made available for inspection upon request.