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Protection strategies in case of a nuclear detonation

Use of respirators to protect the population after the explosion of a nuclear weapon

Recommendation by the German Commission on Radiological Protection

Adopted at the 323rd SSK meeting on 3 February 2023

The German original of this English translation was published in 2023 by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the title:

**Schutzstrategien bei Nuklearwaffeneinsatz -
Verwendung von Atemschutzmasken zum Schutz
der Bevölkerung bei Explosion nuklearer Waffen**

Empfehlung der Strahlenschutzkommission

As the risk of nuclear weapons being used in Europe has increased, the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection commissioned the Commission on Radiological Protection (SSK) to review suitable protection measures. This document sets out recommendations for the use of respiratory protection masks.

The SSK has already published a recommendation on using particle filtering half masks in radiological emergencies (SSK 2019) with a focus on the intake of radioactive iodine by the thyroid after nuclear power plant accidents. The recommendation dealt with whether and under which circumstances the range of early protection measures (evacuation, staying inside, iodine thyroid blocking[1]) should be expanded to include commercial particle filtering half masks (referred to as FFP masks in the following). FFP masks protect against aqueous and oily aerosols, particulate matter and smoke, but not against gases. In a worst-case scenario, accidents in nuclear power plants can release 90% of radioactive iodine in gaseous form.

Under DIN EN 149 (DIN EN 149:2009-08), FFP3 and FFP2 masks must have a protection factor of 30 or 10 respectively against particulate pollutants. There is also a difference between FFP3 and FFP2 masks with regard to the total leakage allowed (2% and 8%, respectively). An exhalation valve makes breathing easier but does not impair the protective effect of the mask. With a view to mask fastenings to avoid leakage, an adjustable continuous headband offers advantages compared to the very common ear straps. One of the reasons that FFP2 and FFP3 masks offer considerably better protection than surgical masks is that they are a tighter fit.

For emergency and relief forces sufficiently trained in the use of FFP3 masks, the SSK considered wearing these masks useful in 2019 if particulate radioactivity is likely to occur (e.g., radioactive cloud pollution due to a nuclear accident). For the general public, it does not recommend the use of FFP masks for youths and adults in addition to protection measures already in place (e.g., staying inside and iodine thyroid blocking), since they do not protect against released gaseous radioactive iodine and their protective effect can therefore be considered negligible. The SSK also pointed out that there are no adequate FFP masks in Europe for toddlers and children, who require special protection. The SSK finds that the protective effect of commercially available masks cannot be reliably assessed. Furthermore, children cannot be expected to wear such masks properly for an extended period of time (SSK 2019).

The SSK re-evaluated the use of respiratory protection masks specifically in the context of protecting the population after the explosion of a nuclear weapon. If a nuclear weapon explodes close to ground level, it is likely that particulate radioactivity will be high. The assessment of the use of respiratory protection masks also considered that FFP2 and even FFP3 masks are widely available and present in many households, and that the population has experience in using them due to the Covid-19 pandemic. This also applies to youths and children above the age of six, but only with limitations to younger children.

The intake of gaseous radioactive iodine only plays a subordinate role when a nuclear weapon explodes. In areas affected by fallout, the external dose from short-lived nuclides dominates the exposure. For this reason, limiting external exposure by staying inside for the first 24 to 48 hours is the most important protective measure. Exposure by inhalation during fallout generally contributes little to the expected total dose. Wearing FFP2 or FFP3 masks, however, can reduce exposure to aspirated particulate radionuclides. For adults, youths and children above the age

[1] Iodine thyroid blocking means the precautionary intake of stable (i.e. non-radioactive) iodine. It serves to prevent uptake of radioactive iodine by the thyroid after a large amount of radioactive iodine has been released, for example after a nuclear accident, and thus helps to prevent thyroid cancer. Generally, the iodine is taken in form of pills.

of six, masks can therefore be considered an additional useful protection measure in certain situations (e.g., outside when going to buildings or shelters, rescuing injured persons, procuring urgently needed medication or within buildings with defective windows or ventilation that has poor filtering or cannot be switched off).

While children are not considered a vulnerable group with regard to Covid-19, they are at significantly greater risk than adults of developing stochastic effects such as cancer from the intake of radioactive isotopes. This must be taken into account in a cost-benefit-analysis of protective measures.

When considering the age group from birth to six years, the protective effect of masks heavily depends on whether the masks fit the shape of face and head, something that differs according to age. Commercial FFP2 masks are not very comfortable for children and have a high breathing resistance (Stiftung Warentest 2021). There are no certified FFP2 masks on the market specifically for children under the age of six.

In the context of the Covid-19 pandemic, the potential risks of FFP masks were debated in connection with the respiratory physiology in children, especially an increase in CO_2 levels arising from the larger dead space volume in small children. Paediatric expert associations[2,3] have stated that children's bodies, too, adapt to higher CO_2 concentrations in the bloodstream through increased respiratory effort and can therefore compensate for the increased dead space volume created by FFP2 masks.

However, paediatricians do not recommend using masks for children under the age of two when asleep or unconscious, since the proper use is hard to control in these scenarios[2].

Currently, studies are being carried out to establish standards and certifications for FFP2 masks for children with regard to infection protection. Until then, surgical masks of sizes small, mini or xs, possibly using a mask hook extension, can be used as provisional protection. Owing to the protective measures during the pandemic, a lot of experience was gained with the use of FFP2 masks by youths and children older than six.

In summary, the SSK makes the following recommendations on the use of respiratory protection masks to protect the population after the explosion of a nuclear weapon while giving due consideration to further protection measures:

1) The most important protection measures are getting and staying inside buildings or shelters (keeping windows and doors closed and ventilation switched off).
2) Taking iodine tablets (iodine thyroid blocking) is not considered a primary protective measure (also see SSK 2022) because the release of radioactive iodine isotopes is limited in relation to the total released activity.
3) All citizens should stock FFP2 masks. They can reduce intake of radioactive particles from nuclear explosions. They should be worn especially if the protection from radiation input through outside air into indoor spaces is insufficient or when obliged to leave indoor spaces or shelters. Preferably, masks with an exhalation valve and the higher

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[2] Deutsche Gesellschaft für Kinder- und Jugendmedizin e.V. (https://www.dgkj.de/fachinformationen-der-kinder-und-jugendmedizin-zum-corona-virus/faqs-maske-kinder-und-coronavirus, [25 January 2023]).

[3] Gemeinsame Stellungnahme der Deutschen Gesellschaft für Pädiatrische Infektiologie (DGPI), Berufsverband der Kinder- und Jugendärzte e.V. (DGKJ), Gesellschaft für Pädiatrische Pulmologie (GPP) and Süddeutsche Gesellschaft für Kinder- und Jugendmedizin (SGKJ) (https://dgpi.de/covid19-masken-stand-10-11-2020/, [25 January 2023]).

classification FFP3 should be used. However, using a mask should not lead to a false sense of security.

4) FFP masks must be worn properly and fit as tightly as possible. For fastening, a continuous headband is the better choice.

5) Used masks should not be used again as they could be contaminated. Like contaminated clothes, they should be taken off and stored outside of rooms where people are staying to avoid spreading contamination and reduce external exposure.

6) The SSK points out that ongoing processes to standardise and certify FFP masks for children should be concluded as quickly as possible. If there is a deficiency of data with regard to respiratory physiology or medical devices, this should be remedied through suitable research projects as quickly as possible.

7) As long as these research projects are not concluded, certified medical respiratory protection masks in small sizes can be a reasonable temporary solution. Especially children under the age of two, however, should not wear them unsupervised or over a longer period of time.

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