Respiratory Protection
呼吸防护

Contents
目录

Program Logistics

- Make a request for Occupational Exposure Assessment to LHSD
  向 LHSD 提出职业暴露评估申请，针对工作环境及可能产生呼吸危害的作业进行评估。
- LHSD staff will conduct a risk assessment to evaluate the working environment and the operation which potentially generates respiratory hazards
  由 LHSD 员工进行风险评估，评估工作环境与可能产生呼吸系统危害的作业环节。
- Successfully complete safety course on respiratory protection (live or online)
  确保相关人员完成呼吸防护安全课程（现场或线上）并通过考试。
- Undergo a lung function examination，arrange a fit-testing with LHSD to determine the most suitable type and size of respirator
  由 LHSD 安排肺功能检查及呼吸防护用品的适合性测试，确定最合适的类型与尺寸
- Obtain respirator from Lab safety management system (a charge-back system)
  在实验室安全管理平台上领取LHSD认可的呼吸防护用品

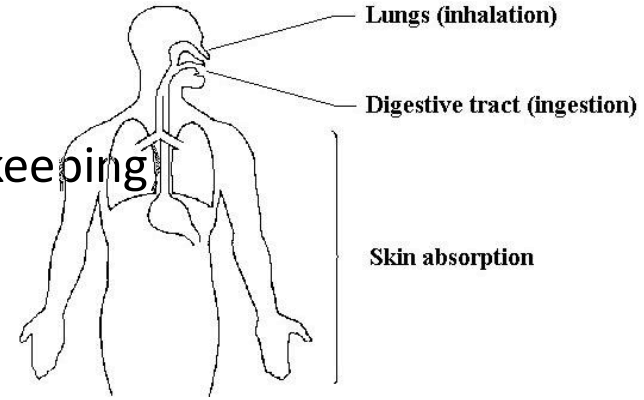
Respiratory Hazards
呼吸危害

- What are respiratory hazards? 呼吸危害物有哪些
  - Substances such as dusts, fumes, vapor, gases and even micro- organisms encountered at work can cause significant damage to health or, in extreme cases, death

    工作中的粉尘、烟雾、蒸气、气体，甚至微生物等物质，可能对健康造成损害，甚至在极端情况下导致死亡

- How these substances get into our body? 呼吸危害物怎样进入身体?
  - Inhalation 吸入
    (Most important industrially, Limited metabolism/ Direct access to blood stream / Can cause significant damage to health or, in extreme cases, death)
    最重要的工业暴露途径，人体对有害物代谢有限/直接进入血液、对健康造成严重损害，极端情况下导致死亡
  - Skin contact (Most common) 皮肤接触 （普遍情况）
  - Ingestion (Mainly Associated with poor personal hygiene or housekeeping)

    食入（主要与个人卫生习惯或环境卫生不好有关）



Respiratory Hazards
呼吸危害

- Gaseous contaminants: 气态污染物
  - Inert gas (helium, argon, nitrogen, etc.) displace air to produce an oxygen deficiency

    惰性气体（氦气、氩气、氮气等）置换空气，导致缺氧
  - Acid gases (SO_2, H_2S, HCl, etc.)

    酸性气体 （二氧化硫，硫化氢，氯化氢等）
  - Alkaline gases (NH3, amine, etc.)

    碱性气体 （氨气，胺，等）
  - Organic vapors/gases (butane, acetone, benzene, chloroform, etc.)

    有机蒸气/气体（丁烷、丙酮、苯、氯仿等）
  - Organometallic gases (tetraethyl lead, organo-phosphates, etc.)

    有机金属气体（四乙基铅、有机磷酸盐等）

Respiratory Hazards
呼吸危害

- Airborne particulate materials: 空气中的颗粒物
  - Bio-aerosols 生物气溶胶
  - Dusts: Mechanically generated solid particulate (0.5 to 10 µm)
    粉尘：机械产生的固体颗粒（0.5至10µm）
  - Fumes: Solid condensation particles of small diameter (0.1 to1.0 µm)
    烟雾：小直径（0.1至1.0µm）的固体冷凝颗粒
  - Mists: Are liquid particulate matter (5 to 100 µm)
    雾：是液体颗粒物（5至100µm）
  - Smoke: Chemically generated particulate (solid and liquid) of organic origins (0.01 to 0.3 µm)
    烟雾：有机来源的化学产生的颗粒物（固体和液体）（0.01至0.3µm）

Respiratory Hazards
呼吸危害

- Hazardous operations that generate airborne substances:
  产生空气传播物质的危险作业
  - Bio-aerosols operation: centrifuging 操作产生生物气溶胶：离心机
  - Solid operations: pouring and mixing 产生固体颗粒物：浇注和混合
  - Pressurized spraying: cleaning parts and applying pesticides
    加压喷雾：清洁零件和施用杀虫剂
  - Shaping operations: cutting and grinding 成型作业：切割和研磨
  - Hot operations: welding, chemical reactions, soldering, melting, burning
    热作业：焊接、化学反应、钎焊、熔化、燃烧
  - Liquid operations: painting, degreasing, spraying, coating, etching, cleaning, plating, mixing, chemical reactions especially with epoxy or organic solvent coatings
    液体作业：涂漆、脱脂、喷涂、涂层、蚀刻、清洁、电镀、混合、化学反应，特别是与环氧树脂或有机溶剂涂层的化学反应

Respiratory Protection Equipment
呼吸防护设备

- **How can we prevent ourselves from breathing in hazardous substances？** 我们如何防止自己吸入有害物质
  - Engineering Control (most reliable control measure) 工程控制（最可靠的控制措施）
    1. Use of a chemical fume hood to handle hazardous chemicals 使用化学通风柜处理危险化学品
    2. Use of biological safety cabinet for bioaerosol generating processes 使用生物安全柜处理生物样品

Respiratory Protection Equipment
呼吸防护设备

- How can we prevent ourselves from breathing in hazardous substances ? 我们如何防止自己吸入有害物质
  - Use of Respiratory Protective Equipment (Respirator) 使用呼吸防护装备
  1. Recommended ONLY when engineering control is not possible or used as extra protection in additional to the existing engineering control **仅在**无法进行工程控制或用作现有工程控制之外的额外保护时才建议使用
  2. Many limitations !! (will be discussed later on)

     呼吸防护装备的使用有很多限制！！（后面会讨论到）

What is a Respirator?
什么是呼吸器？

- A device that filters the air in the work area or supplies clean air from connecting to a breathable air source:

  一种过滤工作区域空气或通过连接到可呼吸空气源提供清洁空气的装置

  - Tobe worn in a contaminated atmosphere and to protects your lung from airborne hazards in forms of particulates, gases and vapours

    在受污染的大气中佩戴，保护您的肺部免受颗粒物、气体和蒸汽等空气传播的危害

  - Includes a very wide range of devices/types, NO one type of respirator can protect wearer from all types of hazard

    包括非常广泛的设备/类型，**没有**一种类型的呼吸器可以保护佩戴者免受所有类型的危险

What is a Respirator?
什么是呼吸器？

- **Respiratory Inlet Covering:** 阻止污染物进入呼吸系统的防护用品
  - Tight-fitting coverings (usually called facepiece) 密合式面罩
    - Facepieces are made of flexible molded rubber, silicone, neoprene, or other materials. 面罩由柔性模压橡胶、硅胶、氯丁橡胶或其他材料制成。
    - There are three basic configurations: 面罩有三种形式
      1. quarter-mask ¼ 面罩
      2. half-mask (most common type used in our campus) 半面罩（我们学校最常用的类型）
      3. full-face 全面罩
  - Loose-fitting Covering: 宽松式面罩
    - Hoods, are light flexible device covering only the head and neck, or head, neck and shoulders 头罩是一种轻便灵活的装置，仅覆盖头部和颈部，或头部、颈部和肩部
    - Helmets are rigid protective headgear 头盔是刚性的防护安全帽
    - Suits and blouses are covering extend down to the waist and some have wrist-length sleeves 罩衣的覆盖范围延伸到腰部，有些有手腕长的袖子

What is a Respirator?
什么是呼吸器?

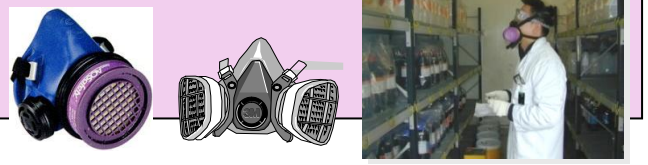
空气净化式呼吸器
Air-purifying respirator (APR)

Negative pressure, Wearer-powered 无动力

Quarter / Half-facepiece

弃置式口罩
(Disposable, single-use)

重复使用式面罩 Re-usable



全面罩

Full Facepiece

powered 动力式

电动送风
Power Air-Purifying Respirator (PAPR)

供气式
Supplied Air Respirator (SAR)

输气管面罩 Supplied Air Half and Full Facepiece, hoods or helmets

自携式呼吸器 Self-Contained Breathing Apparatus (SCBA)

Filter Media
过滤介质

- Function: to remove targeted air contaminant

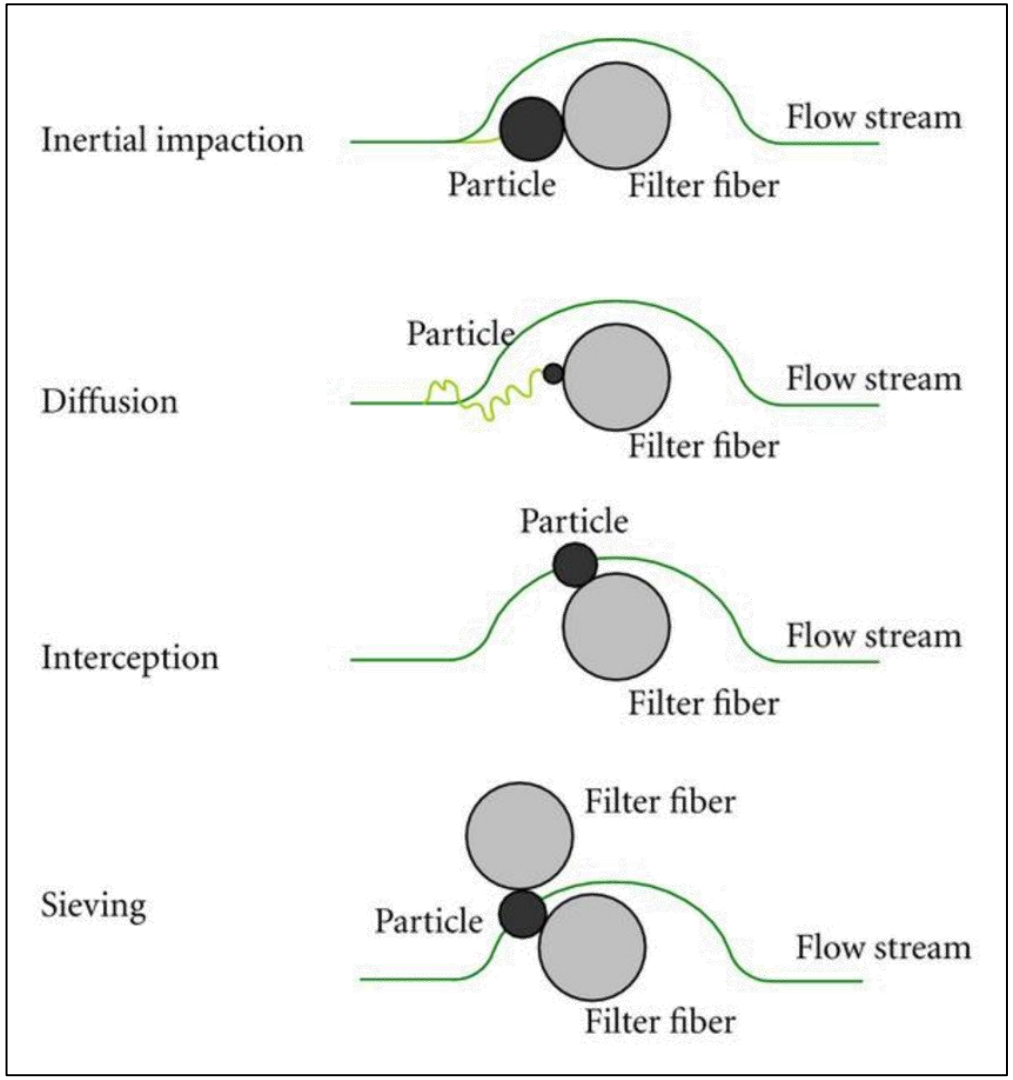
  功能：去除目标空气污染物

- Filtration mechanism Interception, sedimentation, inertial impaction, diffusion and electrostatic

  过滤机理包括：拦截、沉降、惯性冲击、扩散和静电

- Efficiency: depends on particle size, velocity, shape and electrical charge

  过滤效率：取决于颗粒大小、速度、形状和电荷



Chemical Cartridges and Canisters
化学滤毒罐

- Removal mechanisms:去除机理
  - Adsorption - retains the contaminant molecule on the surface of the sorbent granule by physical attraction, e.g. activated charcoal

    吸附-通过物理吸引将污染物分子保留在吸附剂颗粒的表面，例如活性炭
  - Absorption - retains the contaminant molecule chemically, e.g. mixture of sodium or potassium hydroxide with lime and/or caustic silicates

    吸收-以化学方式吸收污染物分子，例如氢氧化钠或氢氧化钾与石灰和/或碱性硅酸盐的混合物
  - Catalysis - uses catalyst to react with the contaminant to produce a less toxic gas or vapor, e.g. Hopcalite, a mixture of porous granules of manganese and copper oxides which speeds the reaction between toxic carbon monoxide and oxygen to form carbon dioxide

    催化-使用催化剂与污染物反应，产生毒性较小的气体或蒸汽，例如：Hopcalite，一种锰和铜氧化物多孔颗粒的混合物，可以加速有毒一氧化碳和氧气之间的反应，形成二氧化碳

Half Face Air Purifying Respirator
半面式空气过滤呼吸器

- Works by negative-pressure

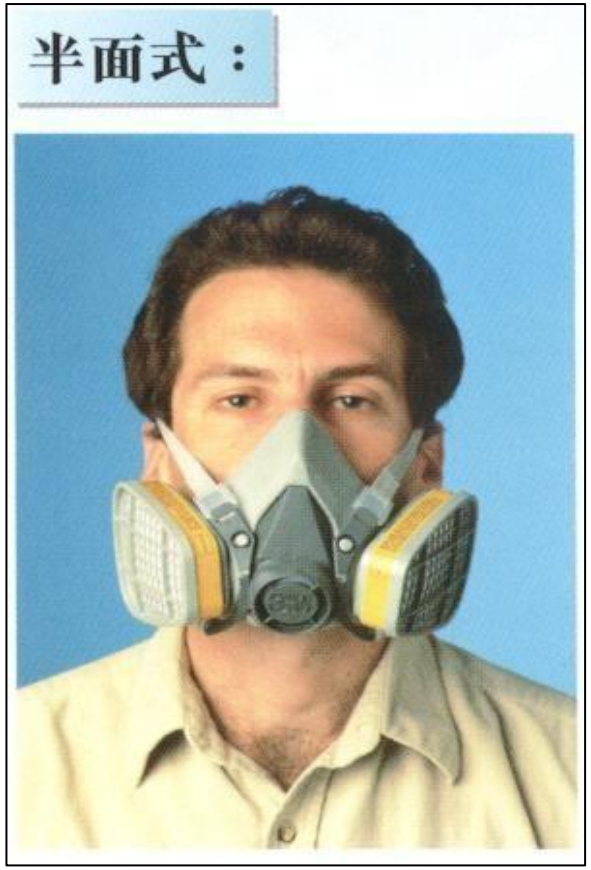
  负压工作

- The wearer draws air through the filters or cartridges during inhalation

  佩戴者吸入的空气通过过滤器或滤毒罐后，进入呼吸系统

- Tight-fitting: has to fit perfectly on your face to form an airtight seal

  紧密贴合：必须完美贴合面部，形成气密密封



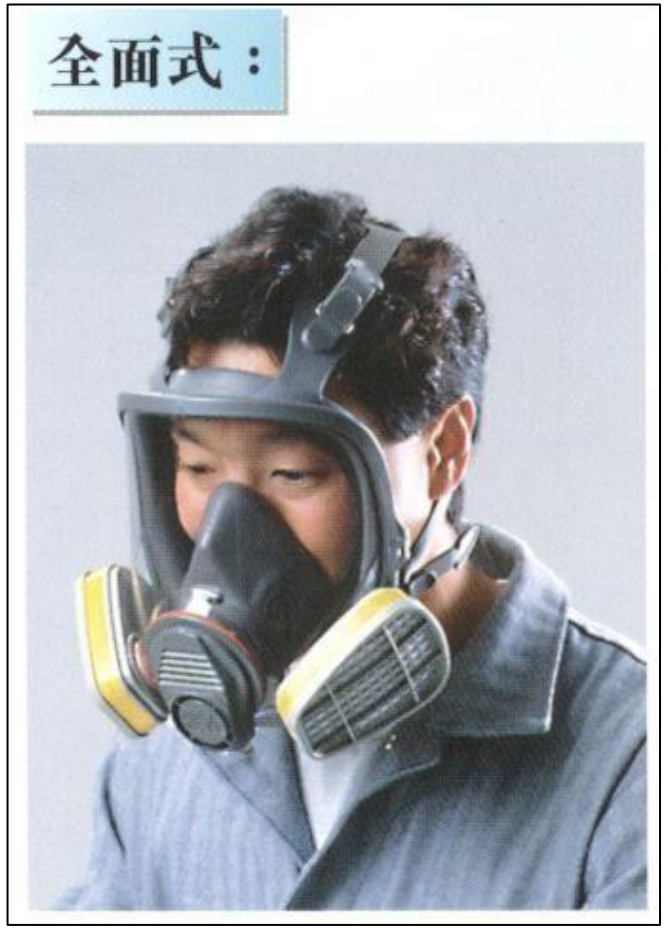
Full Face Air Purifying Respirator
全面式空气过滤呼吸器

- It fits the same way as a half- mask: negative pressure respirator and has to fit perfectly

  它和半面罩一样：负压呼吸器，必须完美贴合
- Filters or cartridges 连接滤棉或者滤毒罐
- Provides additional protection to your face and eyes

  给你的眼睛和面部提供额外的保护
- Has problem with corrective glasses

  如果佩戴近视眼镜，需要额外配置镜架



Powered air-purifying respirator (PAPR)
电动送风过滤式呼吸器

- It looks like a negative-pressure respirator with an air blower
  它看起来像一个带鼓风机的负压呼吸器
- Tight-fitting face piece or a loose-fitting helmet, hood or suit
  紧贴面部的面罩或宽松的头罩、罩衣
- The pump pulls / blower pushes the air through the filters/ cartridges and then supplies purified air through a hose into a mask or hood
  泵拉动/鼓风机推动空气通过过滤器/滤芯，然后通过软管将净化空气供应到面罩或头罩中

Particulate Respirator Classifications
颗粒物防护呼吸器分类

Filter Series滤棉型号	Filter Efficiency过滤率		
	95%	99%	99.97%
N for Not resistant to oil N代表过滤非油性颗粒物	N-95	N-99	N-100
R for Resistant to oil R代表在一定程度上过滤油性颗粒物	R-95	R-99	R-100
P for oil Proof P代表过滤油性颗粒物	P-95	P-99	P-100

- Likely Non-Oil Compounds 非油性颗粒
  - Water-based pesticides 水基杀虫剂
  - Cadmium 镉
  - Cotton dust 棉尘
  - Wood dust 木尘
  - Metal Fumes 金属烟
  - Asbestos 石棉
  - Paint stray 喷漆

- Likely Oil Compounds 油性颗粒物
  - Mineral Oil 矿物油
  - Vegetable Oil 植物油
  - Glycerin 甘油
  - Phthalates 邻苯二甲酸酯
  - PCBs 多氯聯苯
  - Triphenyl Phosphate 磷酸三苯酯
  - Coke Oven Emissions 焦炉排放
  - Asphalt Fumes 沥青烟雾
  - Coal Tar Pitch Volatiles 煤焦油沥青挥发物
  - Oil/Solvent-Based Pesticides 油/溶剂型农药

Air-Line Respirator
长管呼吸器

- Respirable air from a hose from a compressor or compressed air cylinder
  通过软管从压缩机或压缩空气钢瓶输送可呼吸空气
- Exhaled air passes to the ambient atmosphere through a valve in face piece, helmet, suit, or hood

  呼出的气体通过面罩、头盔、防护服或头罩上的阀门排放到周围大气中。

Air-Line Respirator
长管呼吸器

- Breathing Air Requirement for ASR 呼吸空气的质量要求
  - Carbon monoxide < 5 ppm 一氧化碳浓度 < 5 ppm
  - Carbon dioxide < 500 ppm 二氧化碳浓度低于 500 ppm
  - No odor of oil 没有油味
  - Temperature 15 to 22 °C 温度在 15 至 22 摄氏度
  - RH < 85% with no condensed water 相对湿度低于 85%，无冷凝水
  - Airflow capacity: minimum of 120 litres per minute for each person
    空气流量：每人每分钟至少 120 升
  - Impurities: kept to a minimum and not exceed the PEL
    杂质：含量保持在最低水平，且不得超过容许暴露限值 (PEL)

How to select an appropriate respirator?
怎样选择合适的呼吸器？

- Step 1: Assess the hazardous operation and the working environment

  第一步：评估危险操作和工作环境

  - Nature of the individuals task/ procedures including frequency

    工作任务/作业的性质，包括频率

    - duration and physical demands 持续时间和体力要求
  - Identification of released airborne contaminant(s) 识别空气污染物
  - General working environment: 一般工作环境

    1. open shop or confined spaces 开放或密闭的空间
    2. potential for oxygen-deficient atmosphere 可能的缺氧环境
    3. temperature of a job area 工作区域的温度

How to select an appropriate respirator?
怎样选择合适的呼吸器？

- **Step 2: Gather information for the contaminant**

  第二步：收集污染物的信息

  - Physical (gas, vapour, aerosol, or combination), chemical, and toxicologic properties of the contaminant (MSDS is a good reference source)

    污染物的物理（气体、蒸汽、气溶胶或组合）、化学和毒理学特性（MSDS 是一个很好的参考资料）
  - Odor threshold data 嗅阈值
  - Eye irritation and skin absorption pot 是否对眼部刺激和皮肤吸收
  - Estimated exposure concentration 估计暴露浓度
  - Applicable occupational exposure limit (PEL, OEL) 职业接触限值（PEL，OEL）
  - IDLH concentration 可立即引起死亡或严重健康影响的浓度

$$\text{Hazard ratio (HR)} = \frac{\text{Airborne contaminant concentration}}{\text{Exposure rate}}$$

危害率（HR）　　空气污染物浓度　　暴露率

How to select an appropriate respirator?
怎样选择合适的呼吸器？

- **Step 3: Characteristics of respirator**

  第三步：了解呼吸器的特点

  - The APF listed for the respirator type 了解呼吸器的防护系数
  - Information on service life of cartridges or canisters 了解滤毒罐的使用寿命
  - Comfort and acceptance of the respirator 呼吸器佩戴是否舒适

Respirator Type 呼吸器类型	APF (NIOSH)防护系数
AP (half face) 空气净化式（半面罩）	10
AP (full face)空气净化式（全面罩）	50
PAPR (loose-fitting hood or helmet) 电动送风（宽松头罩）	25
PAPR (half face)电动送风（半面罩）	50
PAPR (full face） 电动送风（全面罩）	100
SAR (full face, positive pressure) 供气式 （全面罩，正压）	1000
SCBA 自携式呼吸器	10000

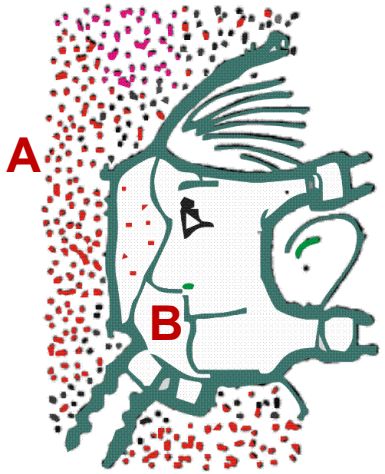
How to select an appropriate respirator?
怎样选择合适的呼吸器？

- Protection factor = the concentration of contaminant outside / the concentration of contaminant inside the mask
  - Example:举例
    dust conc. outside = 300 mg/m^3 周边空气粉尘浓度为 300 mg/m^3
    dust conc. Inside = 0.3 mg/m^3 口罩内粉尘浓度为 0.3mg/m^3
    protection factor = 300 / 0.3 = 1000 防护系数= 300 / 0.3 = 1000
  - Protection Factor x PEL = Maximum Exposure Concentration Allowable

    防护系数x可允许浓度=最大可暴露浓度

$$\text{防护系数} = \frac{\text{周边空气中污染物的浓度 A}}{\text{呼吸器内污染物的浓度 B}}$$

防护系数越高即防护效能越大



Even a most appropriate respirator has limitations
即使是最合适的呼吸器也有其局限性

- Limitations of Air-Purifying Respirators 空气净化式呼吸器的局限性
  - Must not used in environments of IDLH or oxygen deficiency
    不能用于缺氧环境以及可立即导致死亡及严重健康损害的浓度环境
  - Knowing the limitations of the sorbent packings (e.g. breakthrough time, chemical cartridge service life)
    了解吸附填料的局限性 （例如：穿透时间，滤毒罐的使用寿命）
  - When working in environments where concentrations are irritating to the eyes (e.g SO_2), full face units must be used
    在眼睛会受到刺激的环境中工作时（例如二氧化硫浓度较高时），必须使用全面罩式防护设备。
  - Appropriate protective clothing must be worn to prevent absorption of chemicals through skin
    必须穿合适的防护服，以防止化学物质经皮肤吸收。
  - Physiological burden upon wearer 佩戴者的体力上的负担
  - Other factors, facial hair, corrective lens, voice communications, fogging
    其他因素，如面部毛发、矫正眼镜、说话交流、起雾

Limitations of Chemical Cartridges
化学滤毒罐的局限性

- Limitations of Air-Purifying Respirators 空气净化式呼吸保护器的局限
  - Chemical cartridges are designed to remove very specific chemicals and may not be effective for other chemicals, selecting the correct type of cartridge or canister is important

    化学滤毒罐旨在去除非常特定的化学物质，可能对其他化学物质无效，因此选择正确的滤芯或罐体类型非常重要。
  - Must not be used if the chemical is extremely toxic at very low concentrations (e.g HCN)

    如果某种化学品在极低浓度下就具有极强的毒性（例如：氰化氢），则绝对禁止使用。
  - Must not be used for exposures to air contaminants with poor warning properties(e.g bromomethane), or the chemical is detectable by odor at harmful concentrations

    不得用于暴露于预警性能差的空气污染物（例如溴甲烷）或闻到气味时，化学品已经达到了有害浓度的化学物质。

Limitations of Chemical Cartridges
化学滤毒罐的局限性

- Factors affecting the service life of a chemical Cartridges 影响化学滤毒罐使用寿命的因素
  - Sorbent type, mesh size and quantity 吸附剂类型、网孔尺寸和数量
  - Concentration of the contaminant in air 空气中污染物的浓度
  - Wearers breathing rate 佩戴者的呼吸率
  - Temperature and humidity 环境温度和湿度
  - Mixture of chemicals can shorten the service life for each individual chemical
    多种化学物质混合使用会缩短每种化学物质的使用寿命

Change of Cartridges / Filters
滤毒盒/滤棉的更换

- Warning signs of cartridge or filters failure: 滤毒盒或滤棉失效的警告信号
  - Particulate Air-purifying 颗粒物空气净化器
    1. experience of filter resistance 滤棉过滤阻力增大
    2. encounter breathing difficulty 感到呼吸阻力增大
  - Gas / Vapour Air-purifying 气体/蒸气净化器
    1. chemical sorbent is expended 化学吸附剂被消耗
    2. warning properties occur (odor, taste, eye irritation, respiratory irritation)警告特性包括（气味、味道、眼睛刺激、呼吸道刺激）
  - Atmosphere-supplied respirator 自携式呼吸器
    compressor or air pressure alarm went off 压缩机或气压报警器启动

Respirator Fit testing
呼吸器适合性测试

- Todetermine the ability of each individual respirator wearer
  确定每位呼吸器佩戴者的能力
- To obtain a satisfactory fit with any air-purifying respirator
  为了与任何空气净化呼吸器完美贴合
- Quantitative (QNFT) and qualitative (QLFT) fit testing
  定量适合性测试和定性适合性测试
- Personnel must successfully pass the fit test before being issued an air-purifying respirator
  人员必须成功通过适配性测试后才能获得空气净化呼吸器

Particle Counting Instrument
粒子计数仪（呼吸器定量适合性测试使用）

- Accurately measure respirator fit by comparing the dust concentration in the surrounding air with the dust concentration inside the respirator.

  通过比较周围空气中的粉尘浓度与呼吸器内部的粉尘浓度，准确测量呼吸器的贴合度。
- The ratio of these concentrations is called the fit factor. 这些浓度的比值称为适合因子。
- A modified filter cartridge (or a modified respirator facepiece) equipped with a sampling port is used to collect air from inside the respirator.

  使用带有采样口的改良型滤芯（或改良型呼吸器面罩）来收集呼吸器内部的空气。
- With the sampler attached, the wearer is asked to: breath deeply, move head side to side, move head up and down, and talk. During these movements, any leakage is measured by the particle counting device.

  佩戴采样器后，受试者需要进行以下动作：深呼吸、左右摇头、上下摇头以及说话。在这些动作过程中，粒子计数装置会测量任何泄漏量。
- The fit test data is stored by a computer and a final fit test report is generated. 适配性测试数据由计算机存储，并生成最终的适配性测试报告。
- An acceptable fit test is a measured fit factor at least 10 times greater than the assigned protection factors (APF). APF's are respirator design characteristics. A fit factor of at least 10 times the APF is used as acceptance criteria because APF's are not considered reliable predictors of performance levels that will be achieved during actual use.

  合格的密合度测试结果是指测得的密合度系数至少是指定防护系数 (APF) 的 10 倍。APF 是呼吸器设计特性。密合度系数至少是 APF 的 10 倍被用作验收标准，因为 APF 被认为不能可靠地预测实际使用中达到的性能水平。

Qualitative Fit Testing
定性适合性测试

- Perform the test in test environment, i.e. an atmosphere containing an odorant, e.g. Isoamyl acetate在测试环境中进行测试，即在含有气味剂（例如乙酸异戊酯）的环境中进行测试。
- Breath deeply 深呼吸
- Move head side to side and up and down 左右上下摆动头部
- Talk or read the "Rainbow Passage“ showed in next page 朗读一段话或说话
- The wearer reports any noticeable odor, taste or nasal irritation that is leaking into the mask.佩戴者应报告任何通过口罩泄漏的明显气味、味道或鼻腔刺激感。

Odorant for QLFT
定性测试的气味剂

- Isoamyl acetate (Banana Oil) 异戊酸异戊酯（香蕉油）
  - Has a pleasant, easily detectable odor具有令人愉悦且易于辨别的气味
  - Respirator equipped with an organic cartridge 呼吸器应配备有机物滤罐
  - If the user detects any odor, it is an indication that the fit is faulty, and that adjustment to the respirator seal is required 如果用户察觉到任何气味，则表明呼吸器不密合，需要调整呼吸器以达到密封性。
  - Two limitations; the odor threshold varies widely among individuals and odor fatigue can occur 有两个局限性：一是嗅觉阈值因人而异，二是可能出现嗅觉疲劳。
- Irritant Smoke 刺激性烟雾
  - Exposing the wearer to an irritating aerosol produced by a smoke tube使佩戴者暴露于烟管产生的刺激性气溶胶中
  - If the user detects any irritant smoke, it is an indication that the fit is faulty, and adjustment to the respirator seal is required 如果用户闻到任何刺激性烟雾，则表明呼吸器佩戴不当，需要调整呼吸器以达到密封性。
  - Has an advantage in that the wearer usually reacts involuntarily to any leakage by coughing or sneezing 其优势在于，佩戴者通常在察觉到刺激性烟雾时，会通过咳嗽或打喷嚏等非自主反应来应对。
  - Only properly trained personnel should conduct the irritant smoke fit test.只有经过适当培训的人员才能进行刺激性烟雾密合度测试。

User Seal Check
佩戴者对口罩进行密封检查

- Perform the seal check immediately before and periodically during respirator use in the field.在现场使用呼吸器之前和使用过程中应进行密封性检查，并定期进行检查。

Positive Pressure Check **正压测试**

Cover the exhalation valve with your hand and exhale gently into the facepiece. 用手盖住呼气阀，轻轻地对着面罩呼气

If a slight positive pressure is built up inside the facepiece without any evidence of leakage, the fit is satisfactory. 如果面罩内产生轻微的正压，且没有泄漏迹象，则说明面罩佩戴合适

Negative Pressure Check 负压测试

Cover the cartridges with your hands, inhale gently to collapse the facepiece slightly, and hold your breath for 10 seconds.用双手盖住滤芯，轻轻吸气使面罩略微塌陷，屏住呼吸 10 秒钟。

If the facepiece remains slightly collapsed and no leakage is detected, the respirator fits properly.如果面罩保持略微塌陷状态且未发现泄漏，则说明呼吸器佩戴合适。

Considerations For Proper Fit
呼吸器正确密合的注意事项

- Facial Hair 面部毛发
  - A person who has hair (stubble, moustache, sideburns, beard, low hairline or bangs) which passes between the face and the sealing surface of a tight-fitting facepiece shall not be permitted to wear a respirator. 头发（胡茬、胡子、鬓角、胡须、低发际线或刘海）进入面部与紧密贴合面罩密封面之间的人不得佩戴呼吸器。
  - A person who has hair (moustache, beard) which interferes with the functions of the respirator valve(s) shall not be permitted to wear a respirator. 面部毛发（胡须、胡子）妨碍呼吸器阀门功能的人员不得佩戴呼吸器。

- Glasses and Eye/Face Protective Devices 眼镜和眼/面部防护设备
  - If a spectacle, goggle, face shield or welding helmet must be worn with a respirator, it shall be worn so as not to adversely affect the respirator seal. 如果必须佩戴眼镜、护目镜、面罩或焊接头盔才能佩戴呼吸器，则应佩戴得当，以免对呼吸器的密封性产生不利影响。
  - A spectacle which has temple bars or straps which pass between the sealing surface of a respirator facepiece and the wearers face shall not be used.眼镜的镜腿或镜带穿过呼吸器面罩的密封面和佩戴者的脸部之间，这种眼镜不得使用。
  - If a full-facepiece respirator is used, special prescription glasses are available if needed. 如果使用全面罩呼吸器，必要时可提供特制的镜架。

Repeat of Fit Test
什么时候再次进行适合性测试

When there is condition that may interfere with face piece sealing:当存在以下可能影响呼吸器密封的情况时:

- Significant change in weight (10%) 体重显著变化（增加或减少10%）
- Significant scarring in the area of face seal, dental changes, cosmetic surgery 面部轮廓区域有明显疤痕，牙齿发生变化，进行了整形手术
- Job duties change and necessitate a change in respirator equipment 工作职责发生变化，需要更换呼吸器设备。
- Full face respirator and regular users (over 20 hours a month): fit tested annually is recommended 全面罩式呼吸器及频繁使用者（每月使用超过20小时）：建议每年进行一次贴合性测试。

Maintenance and Care
呼吸器维护和保养

- Cleaning and Disinfecting 清洁和消毒
  - respirators or emergency use respirators: cleaned and disinfected after each use 呼吸器或应急呼吸器：每次使用后均进行清洁和消毒
  - personal respirator: weekly or monthly cleaning is usually adequate 个人呼吸器：通常每周或每月清洁一次就足够了。
  - shared respirators or emergency use respirators: cleaned and disinfected after each use 共用呼吸器或应急呼吸器：每次使用后均进行清洁和消毒
  - remove any filters or cartridges 取下所有过滤罐或滤棉
  - wash the face piece and associated parts with a mild detergent and warm water用温和的清洁剂和温水清洗面罩及其相关部件。
  - rinse in clean warm water 用干净的温水冲洗干净。
  - disinfect in disinfectants or by disinfectant wipes (70% isopropyl alcohol) and rinse 用消毒剂或消毒湿巾（70%异丙醇）消毒，然后冲洗干净。
  - air dry, reassemble and re-inspect 自然风干，重新组装并重新检查

Maintenance and Care
呼吸器维护和保养

- Storage 储存
  - Kept in cleaned sealed plastic bag 将呼吸器放入干净的密封袋
  - Stored in a clean, dry, non contaminated environment 储存在一个干净、干燥，无污染的环境中
  - Positioned respirator in its natural configuration preventing deformation呼吸器储存时不应受到挤压，防止变形。
  - Kept emergency-use respirator in accessible work area应急呼吸器应放置在随时可以拿到的位置

Maintenance and Care
呼吸器维护和保养

- Check 检查
  - Report any defects such as holes, cracks, missing valves, etc 报告任何缺陷，例如孔洞、裂缝、阀门缺失等。
  - Disposable respirator:一次性呼吸器
    1. Holes in filter 滤棉有孔洞
    2. Elasticity of straps 头带弹性
    3. Deterioration of straps and metal nose clip 绑带和金属鼻夹是否老化
  - AP respirators: 空气净化式呼吸器
    1. Face piece dirt, cracks, tears, holes, distortion, cracked, loose fitting lenses 面罩污垢、裂纹、撕裂、孔洞、变形、破损、松动的镜片
    2. Head bands breaks, loss of elasticity, broken buckles or attachment 头带断裂、失去弹性、扣环或连接件损坏
    3. Valves dust, dirt, cracks, distortion, loss 阀门的灰尘、污垢、裂纹、变形、损坏
    4. Filter elements, proper filter / cartridges; worn threads cracks in filter housing合适的滤芯/滤罐；滤芯外壳螺纹是否磨损或出现裂纹
    5. Deterioration, expired (service life indicator)劣化，已过期（使用寿命指标）
    6. Prefilter excessive breathing resistance 过滤器过大的呼吸阻力

Maintenance and Care
呼吸器维护和保养

- Repair 维修
  - Replace damage or missing parts and filters/ cartridges 更换损坏或缺失的零件和滤芯/滤罐
  - Repair or adjustments to respirators must be done only by appropriately trained personnel 呼吸器的维修或调整必须由经过适当培训的人员进行。
  - Report any problems or malfunction to LHSD 向LHSD报告任何呼吸器的问题和故障
- Exclusive Repair Usage 专属的使用保养
  - To prevent cross contamination, all individuals who wear respirator is to be supplied for their exclusive use 为防止交叉感染，所有佩戴呼吸器的人员均应配备专供其本人使用的呼吸器。
  - An exception to this practice, SCBA for emergency or rescue purposes and PAPR 但紧急情况或救援需要使用自给式呼吸器 (SCBA) 和动力送风式呼吸器 (PAPR) 时，则不适用此规定。

Case Study – Animal Care Facility
案例学习—实验动物中心

- Job nature: Custodial staff who are responsible for changing of animal bedding工作岗位：负责更换动物垫料的保洁人员
- Potential airborne contaminant: bedding dusts, excreta and waste.

  潜在的空气污染物：床上用品灰尘、粪便和废物。
- Working environment: animal house, sometime in hot sterilization room with long working hours 工作环境：动物房，有时需要在高温消毒室工作，工作时间较长
- Other factors: requires eye protection 其他考虑因素：需要佩戴护目镜
- Solution: loose fitting PAPR 解决方案：宽松式电动送风过滤式呼吸器

Case Study – FMO Workshops
案例学习—设备管理办公室工坊

- Job nature: repair of laboratory furniture, and operation involves using of glue, welding and spray paint

  工作内容：实验室家具维修，操作涉及使用胶水、焊接和喷漆。

- Potential airborne contaminant: organic vapor and welding fume

  潜在的空气污染物：有机蒸汽和焊接烟尘

- Control measures: local exhaust ventilation

  控制措施：局部排气通风

Important Recap
重要事情再说一遍

- Respirators are not perfect 呼吸保护器并不是最优选择
  - Choice depends on contaminant type and concentration 选择取决于污染物类型和浓度。
  - Different protection factor (PF) 不同的防护系数
  - Half face respirator do not offer eye protection 半面罩不能提供眼部保护
  - Filtration cartridges are chemical specific 要依据不同的化学品来选择化学滤罐
  - Respirators are sometimes uncomfortable, hot, and heavy 呼吸器有时会让人感到不舒服、闷热且沉重。

Important Recap
重要事情再说一遍

- Limitations 限制性
  - The possibility for human error - less reliable 因人为使用错误而造成呼吸器可靠性降低
  - Filter cartridge may be saturated 滤罐可能已经饱和
  - Problem with corrective glasses with full face respirators 全面罩要考虑佩戴者是否需要矫正眼镜
  - Cannot grow beard 呼吸器佩戴者不能有胡须
  - Users must be physically fit, fit tested, and trained. 呼吸器使用者必须身体适合，经过适合性测试及呼吸器使用培训
  - Some users may be claustrophobic 有些用户可能患有幽闭恐惧症

Important Recap
重要事情再说一遍

- Dosand Don’ts around Respirators关于呼吸器的注意事项
  - Engineering and administrative controls are always preferable to the use of a respirator.工程控制和管理控制始终优于使用呼吸器。
  - Do make sure you have a good fit. 确保呼吸器可以与你面部密合
  - Do get to fresh air immediately if you begin to smell or taste the chemical - your respirator is not working properly 如果你开始闻到或尝到化学物质的味道，请立即去到有新鲜空气地方——说明你的呼吸器没有正常工作。
  - Don't just buy a respirator and wear it yourself 不要自己买个呼吸器就戴。
  - Don't leave your respirator upside down or uncovered in your workplace. Keep it clean.不要将呼吸器倒置或暴露在工作场所，保持呼吸器清洁。
  - Don't use the wrong filter/cartridge 不要使用错误的滤芯/滤罐
  - Never borrow or lend a respirator 不要借用呼吸器

Last but not the least reminder
最后但同样重要的是提醒

- **"Using the wrong cartridge and filter may be like using no respirator at all“**
  “使用错误的滤芯和滤罐可能就相当于没有使用呼吸器。”
- **"Improper use of air-purifying respirators could result in injury and/or fatality"**

  “不当使用空气净化呼吸器可能导致受伤和/或死亡”

Reference

- 《呼吸防护 自吸过滤式防颗粒物呼吸器》(GB 2626-2019)
- 《个体防护装备配备规范 第1部分：总则》（GB 39800.1-2020）
- 《用人单位劳动防护用品管理规范》(2018年修订版)