

Future Technologies for Breathing Air Supplies

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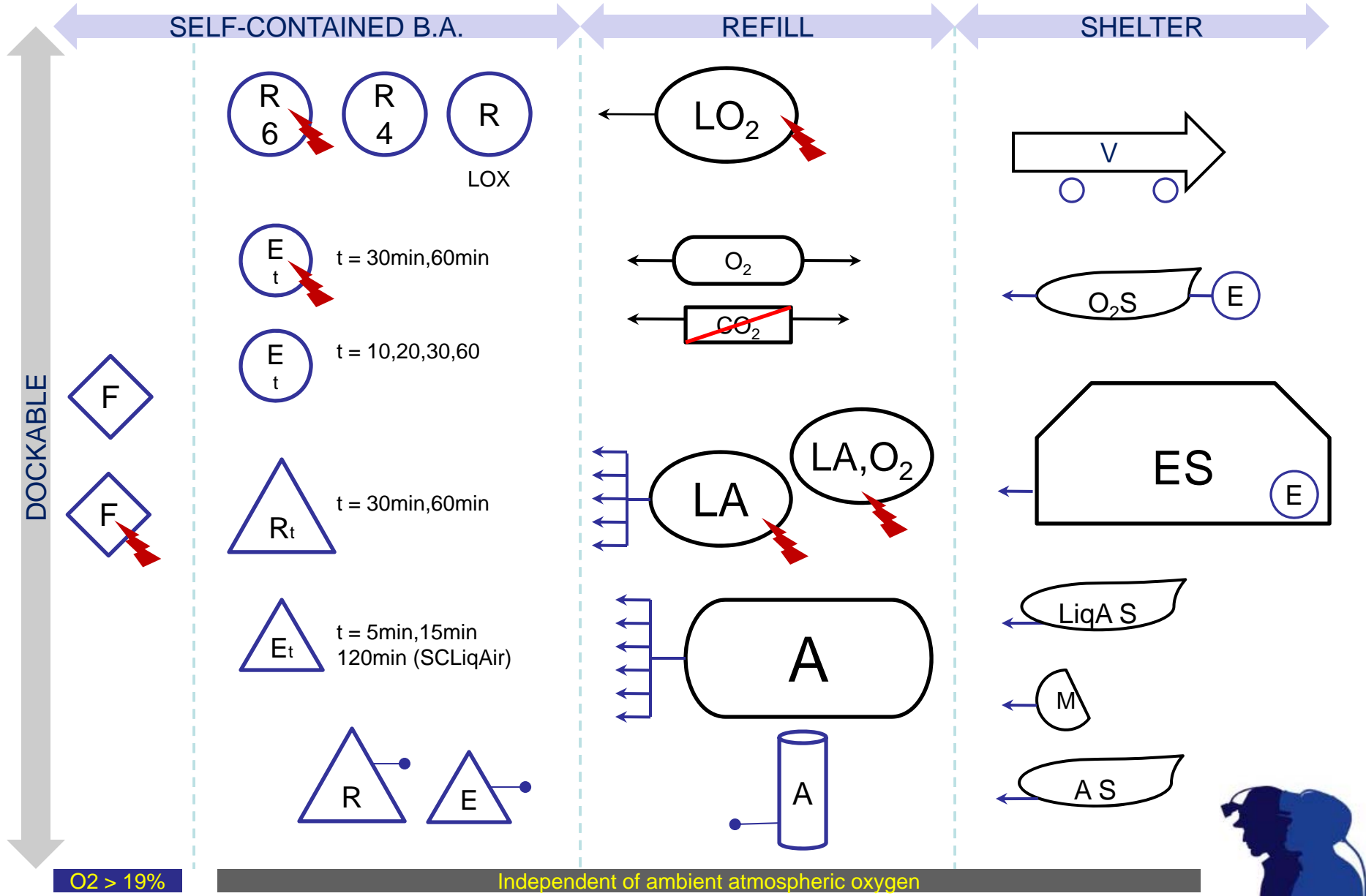


Breathing Air Supplies in Underground Mining

Breathing Air Supplies (BAS) for underground mining refers to a range of devices and systems that offer respiratory protection to miners in the event of an emergency.



Overview - Breathing Air Supplies



Two components to breathable air requirement for mine escape

- 1. Immediate response at the working section –**
Initial donning of breathing apparatus to escape from the working section.
- 2. Response once outby the working section –**
Donning of additional units and/or refilling or recharging of initial unit as needed for complete escape from the mine.



New Technology & Future Generation Goals

Future generation BAS need to incorporate new technologies in order to improve performance and usability.

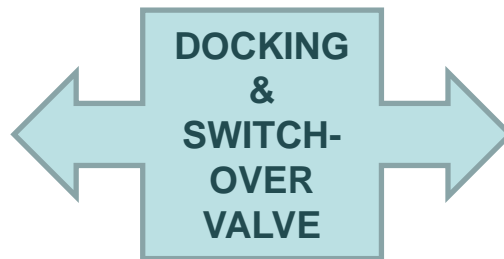
Desired features:

- Seamless changeover from one escape device to another
- Head/ face protection
- Communication
- Improving efficiency of breathing air supplies, i.e.
 - Reduce size/ weight while maintaining operating time
 - Increase duration for units similar to current sizes



Seamless Changeover (Dockability)

Dockable Self-Contained Self Rescuers (SCSR) to have continued breathing protection while escaping from underground.



User can connect and start a 2nd (new) SCSR or change to a SCBA while still breathing from the first unit and then switch over



Seamless Changeover (Dockability)

Technology development challenges

- Design for compact size, ease of use and quick connect.
- SCSR to SCBA switch-over (closed-circuit to open-circuit).
- Automatic function.

Policy, Training & Cultural challenges

- Standards on docking to dissimilar apparatus during change-over.
- Training on switching from mouth bite-piece to full-face mask or hood.



Hood/ Mask Adaptation & Communications

Full-face mask or hood adaptation to SCSR/ SCBA

- Head and face protection
- Nose or mouth breathing (no bite-piece)
- Passive or active (mic) communications



Hood/Facemask for SCSRs

Technology development challenges

- Effective sealing to face/ mouth area without bite-piece.
- Form factor (size, weight, carry ability). Small and compact packable size.
- Breathing gas concentration control. Minimizing dead space.

Policy, Training & Cultural challenges

- Fit & seal to mask or hood through clean shaven policy.
- Donning procedure from mouth bite-piece to full-face mask or hood.



Communications

Technology development challenges:

- Incorporation into a hood or mask.
- Effective passive speech transmitter.
- Microphone adaptation (*for connection to mine radio or phone*).
- Permissibility (microphone electronics).



Efficiency Improvement

Existing technologies in other breathing protection fields may be applied to mining BA for improving efficiency and usability

- Groups that have innovative technologies for protecting humans working in irrespirable atmospheres are the diving, submarine and space exploration communities
- Existing products in use by these groups cannot be adopted into mining in their existing form, but need to be modified
- Special consideration need to be given to:
 - Permissibility
 - Hardening to withstand mine conditions



Efficiency Improvement

Technology development challenges:

- Reducing SCSR size.
- Re-configuring SCSR for comfort (into a vest style for e.g.).
- Mechanical efficiency enhancement - oxygen volume management and carbon dioxide control.
- Designs of very high pressure vessels.
- Electronic control and monitoring.
- Use of cryogenics for escape SCBA.
- Use of cryogenics for refuge alternatives.
- Improved maintainability (modular construction).
- Ready for use in an emergency.
- Hardened systems (Survivable designs) for mine environments.
- Reliability of standby systems (long term leak effects).
- End of service life indicators.



Efficiency Improvement (cont.....)

Policy, Cultural, Training challenges:

- High pressure vessel certification.
- Repeated cylinder quick re-fills.
- Training on using new technology devices.



Future Technology

to be researched for improving mining BAS

Medium-term

- Miniature Oxygen, Carbon Dioxide and Carbon Monoxide Sensors
- New chemicals
 - for O₂ production
 - for CO₂ removal
 - for combined CO₂ removal & O₂ production
 - for CO elimination
 - for Particulate & Toxic gas capture
- Membrane technology for increasing O₂ concentration
- Heat Absorption and/or Removal
 - Moisture absorbents
 - Phase change material
- End-of-Service Life indicators (ESLI) for CO₂ absorbers

Long-term

- Amine technology for CO₂ absorption
- Fuel cell electrical power supply
- Heat Absorption and/or Removal
 - Heat pump
 - Nanoscale TEC



The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of NIOSH.

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC)



Thank You

Questions

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National Institute for Occupational Safety and Health (NIOSH)

Centers for Disease Control and Prevention (CDC)

Department of Health and Human Services (DHHS) www.hhs.gov

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