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Appropriate Ventilation and Fume Extraction in Welding Shops

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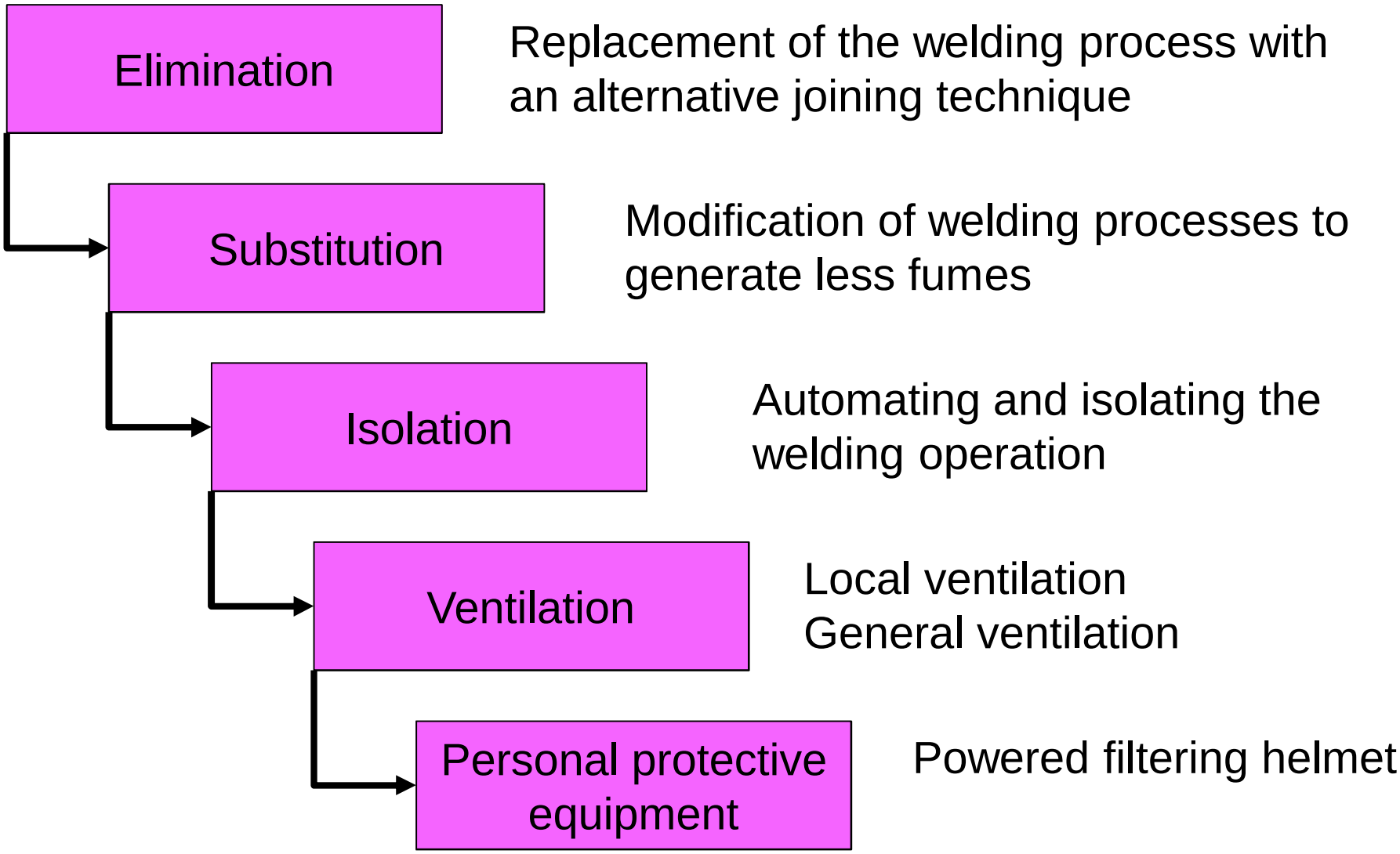
Contamination control measures

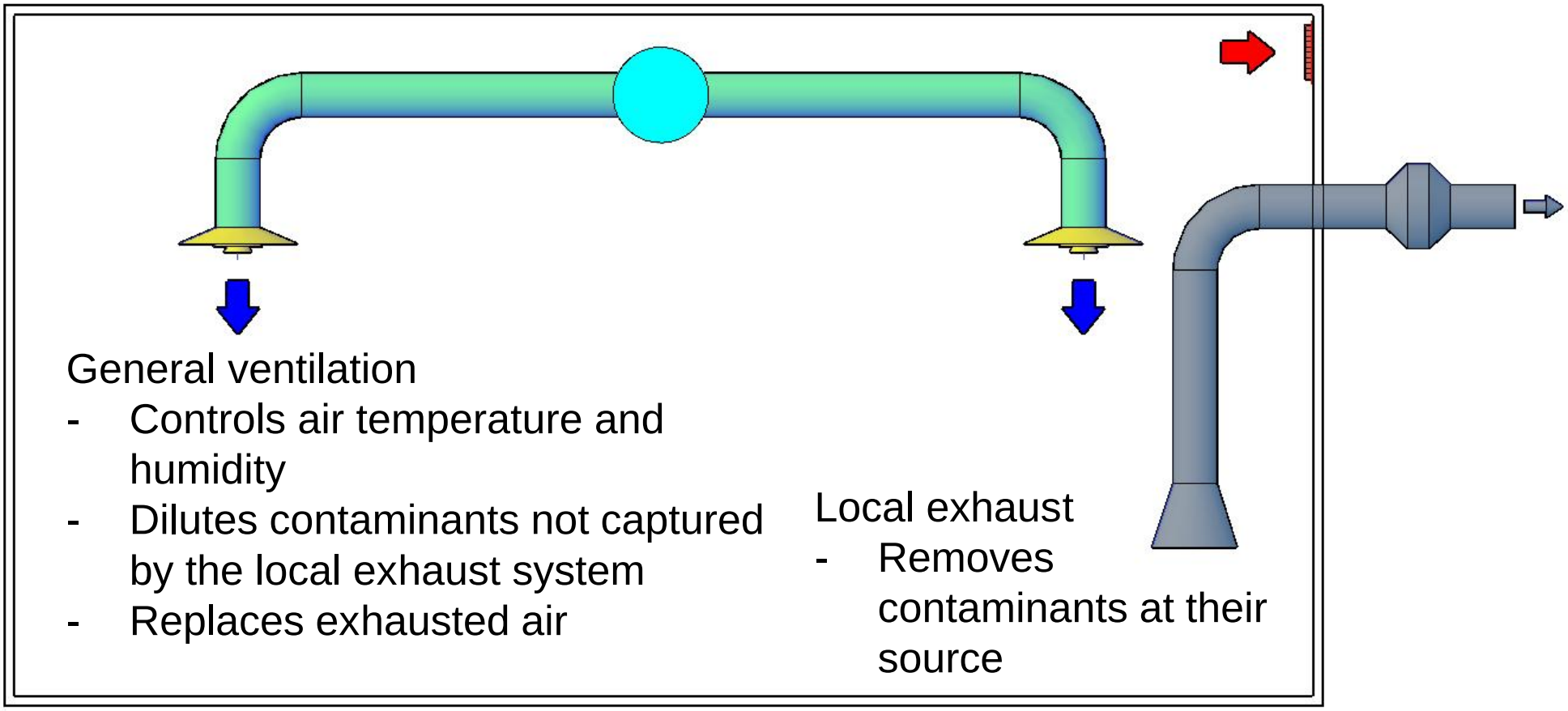
Hierarchy of control measures



Welding shop ventilation systems

Ventilation system

- Consists of local and general ventilation

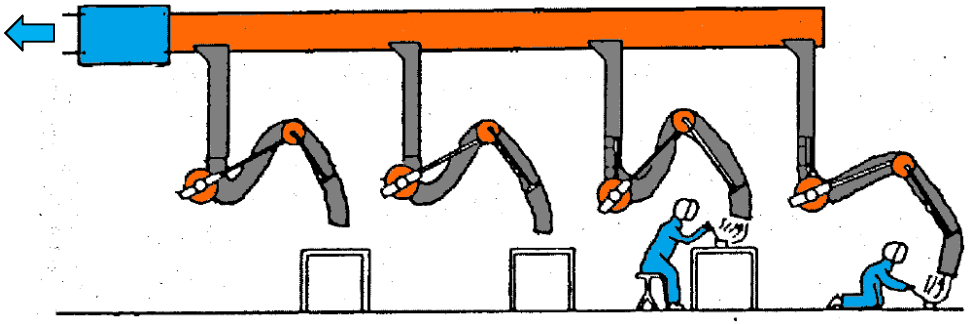


Local exhaust ventilation systems

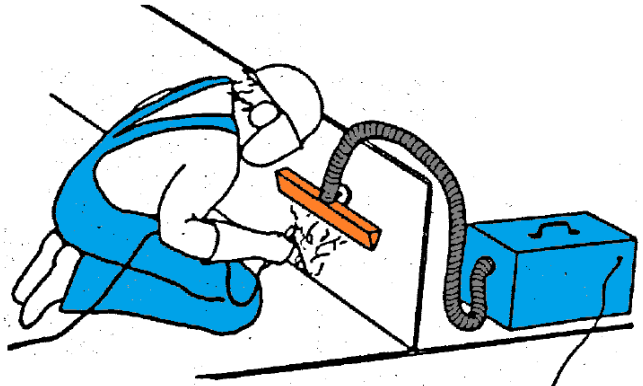
Local Exhaust Ventilation

- Removes contaminants at the source before they are released into the workplace air
- Creates controlled air flows towards the exhaust hood
- Components:
  - Hood to capture the contaminants
  - Ducting to transport the contaminants
  - Fan to provide sufficient air flow rate
  - Discharge

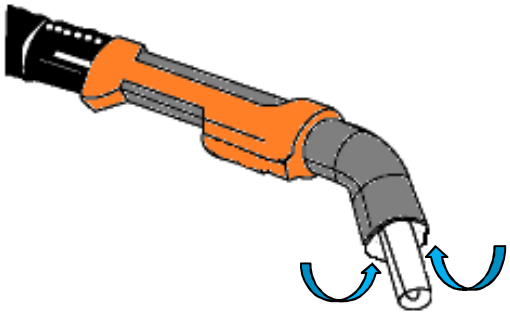
Types of welding fume extractor solutions



Central Low Velocity High Volume extraction

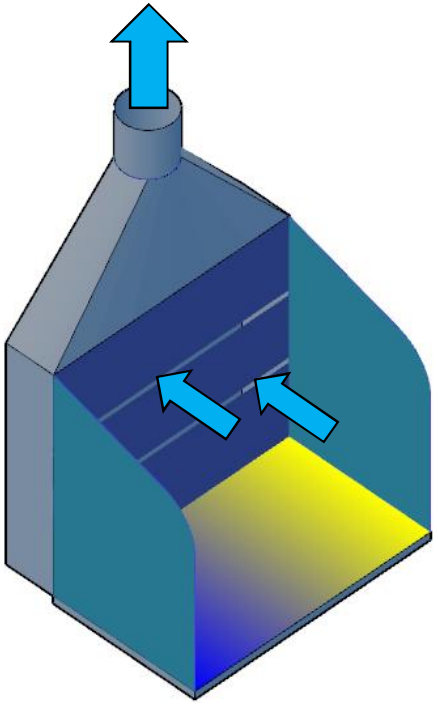


Portable fume extractor with built-in filter and fan (HVLV)



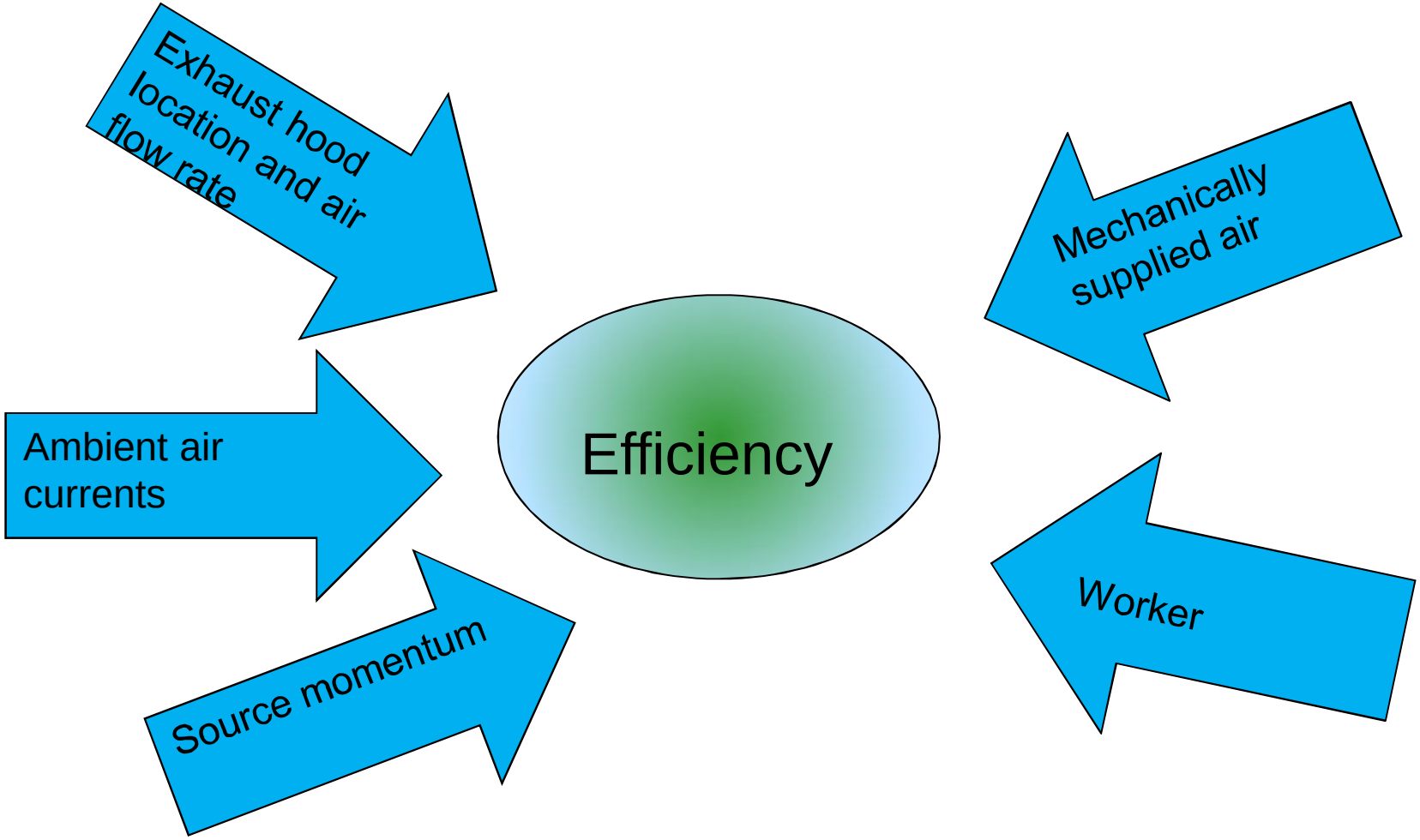
Fume Extraction Gun

Welding bench hood

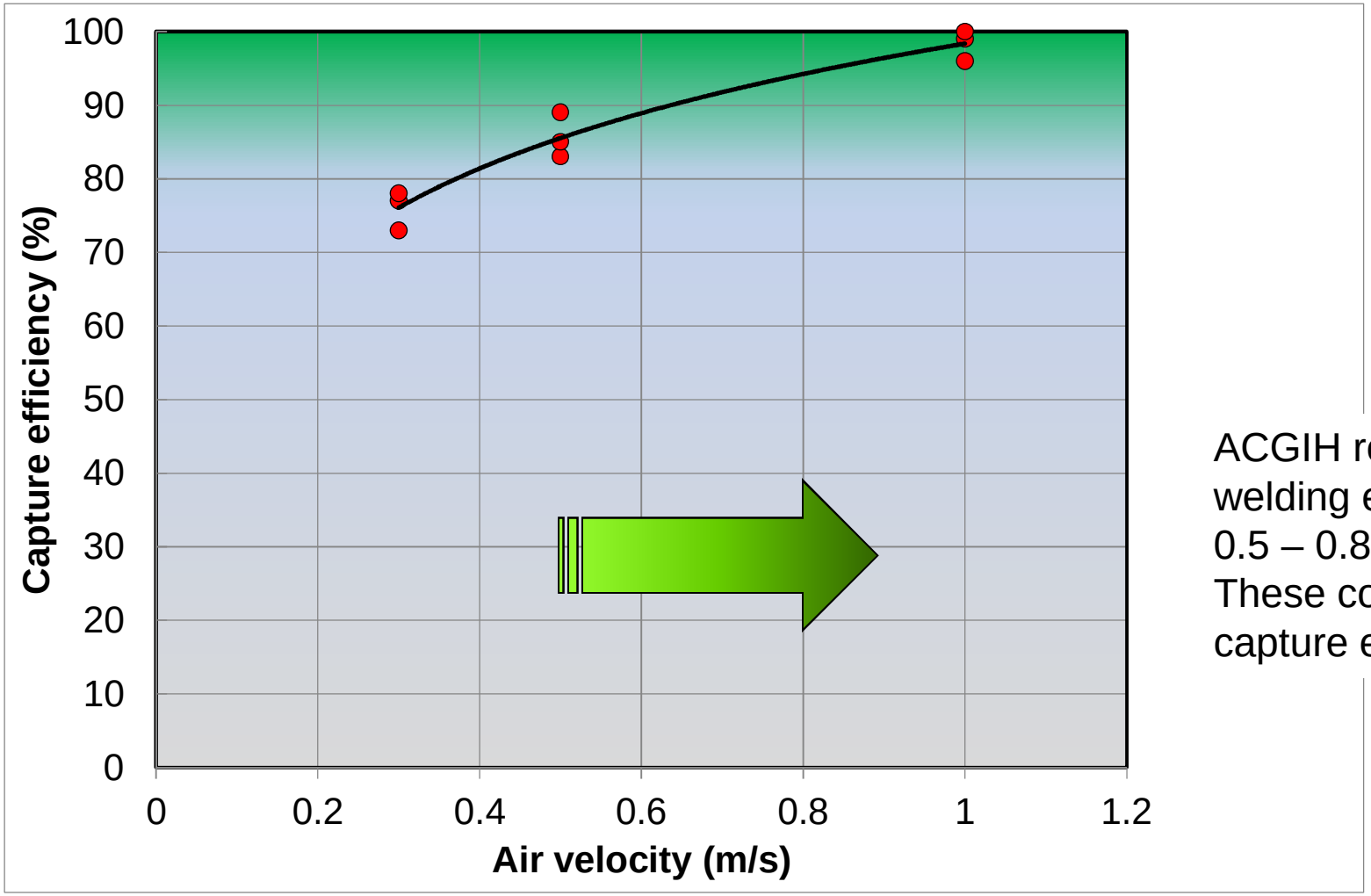


Capture efficiency

- LEV performance is characterised by capture efficiency, which is defined as the percentage of emissions directly captured by the exhaust ventilation

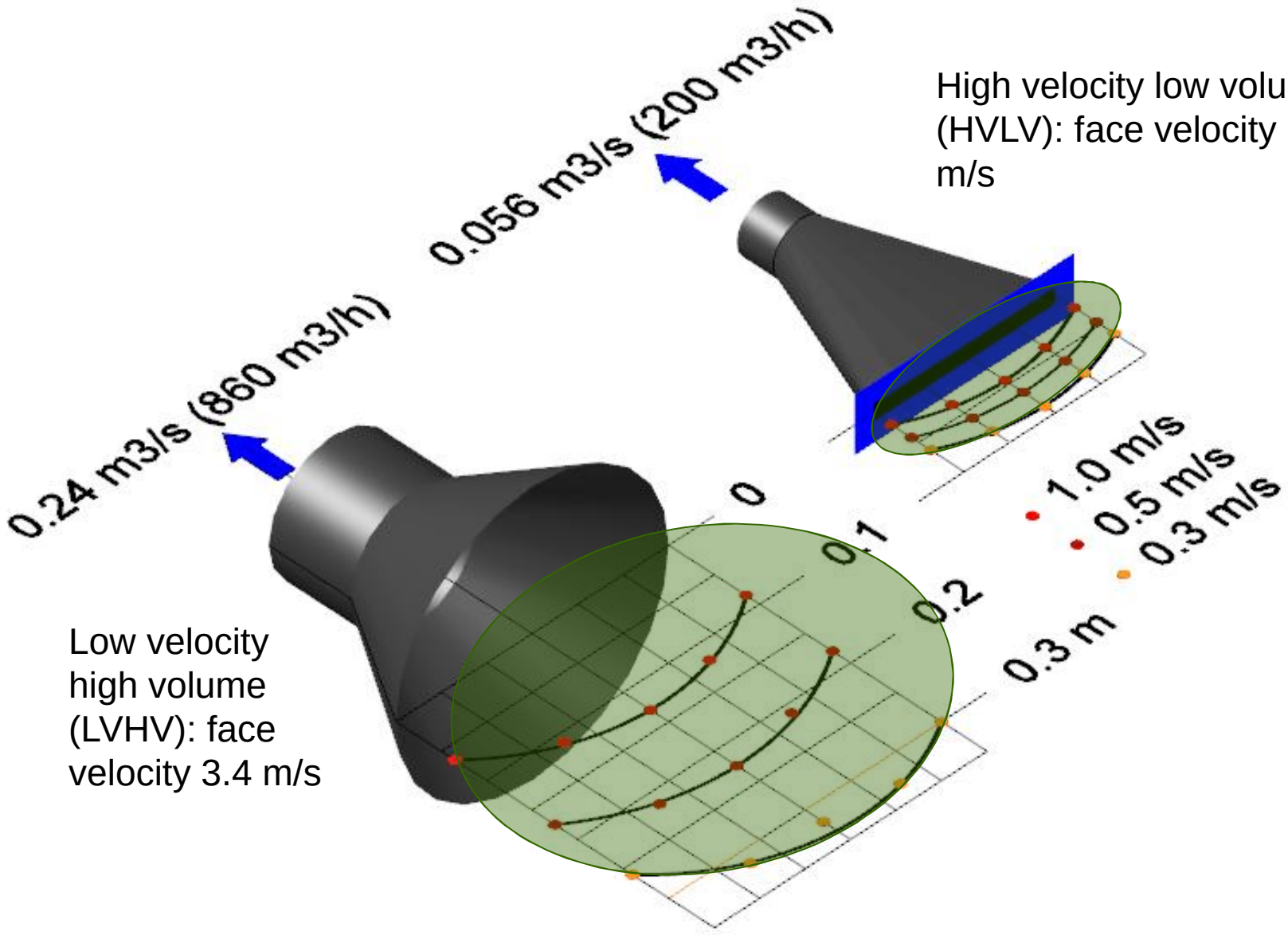


Measured capture efficiencies for Shielded Metal Arc Welding



ACGIH recommended values for welding exhaust:
0.5 – 0.87 m/s (100 – 170 fpm)
These correspond to measured capture efficiencies 85 - >95%

Velocity fields generated by exhaust hoods



High velocity low volume (HVLV): face velocity 15 m/s

Low velocity high volume (LVHV): face velocity 3.4 m/s

Challenges with local ventilation

- Welding operations are characterised by frequent changes in location and welding position
- This makes it more difficult to control fume exposures than in fixed workplaces
- The effective working range of local exhausts is limited, especially with HVLV systems
- Correct positioning of the hood and sufficient exhaust flow rates are essential for efficient operation
- Work practices which include the active operation and management of the exhaust device are critical for successful outcomes

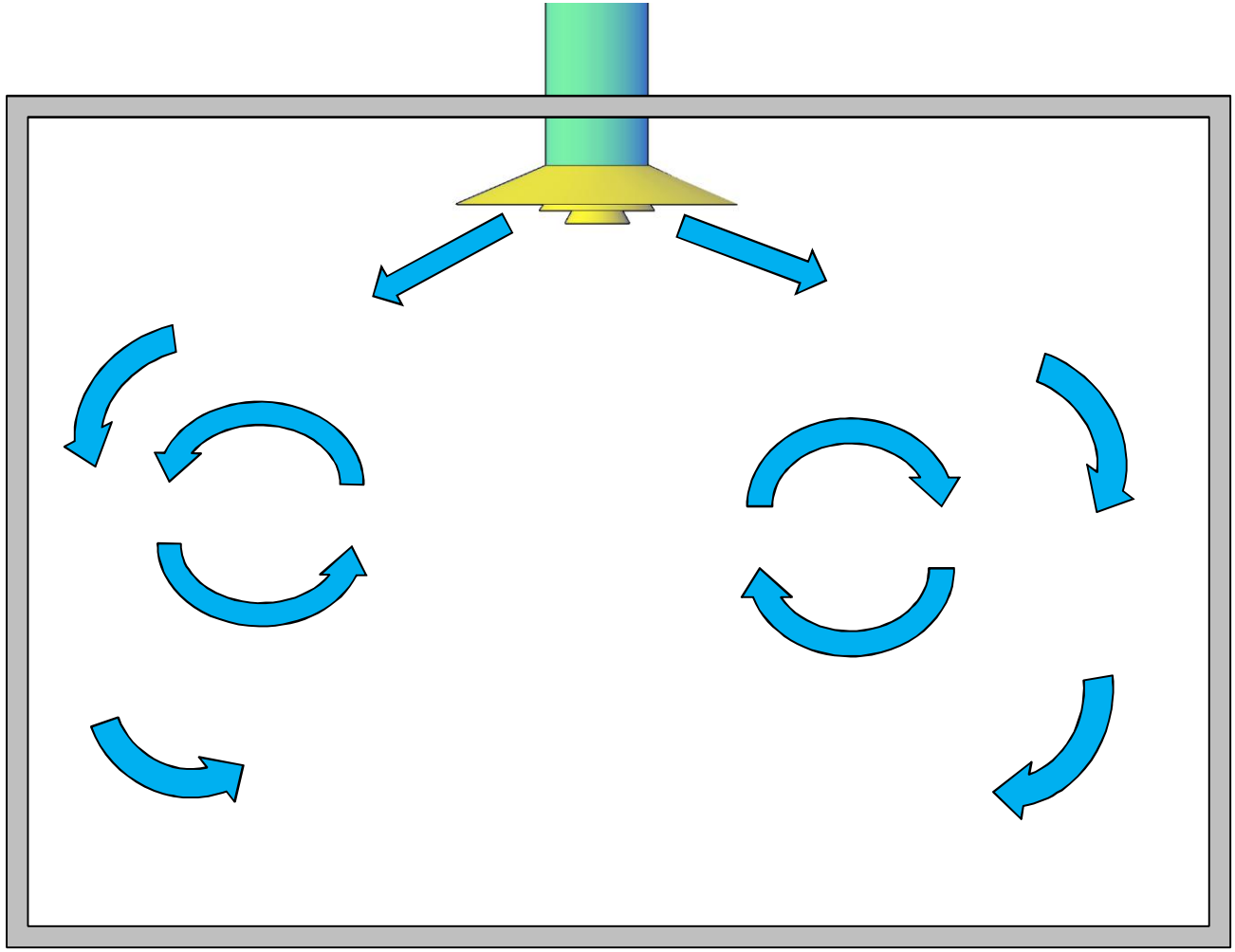
General ventilation air distribution

General ventilation air distribution

- Mixing ventilation
- Displacement ventilation
- Hybrid ventilation

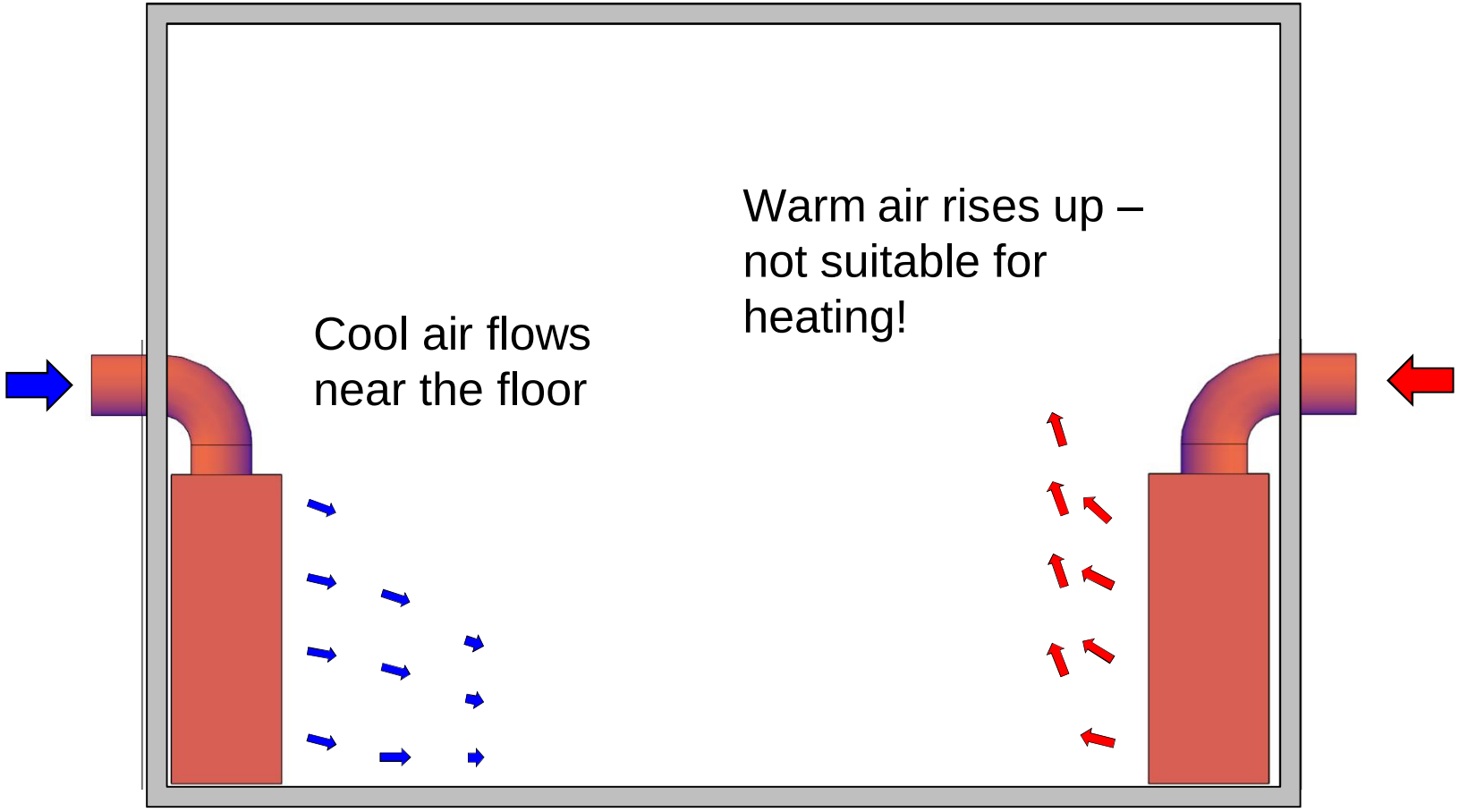
Mixing ventilation

- Air is supplied with high velocity near the ceiling which causes the air in the room to mix
- This results in nearly uniform temperature and contaminant concentration distributions
- Suitable for heating



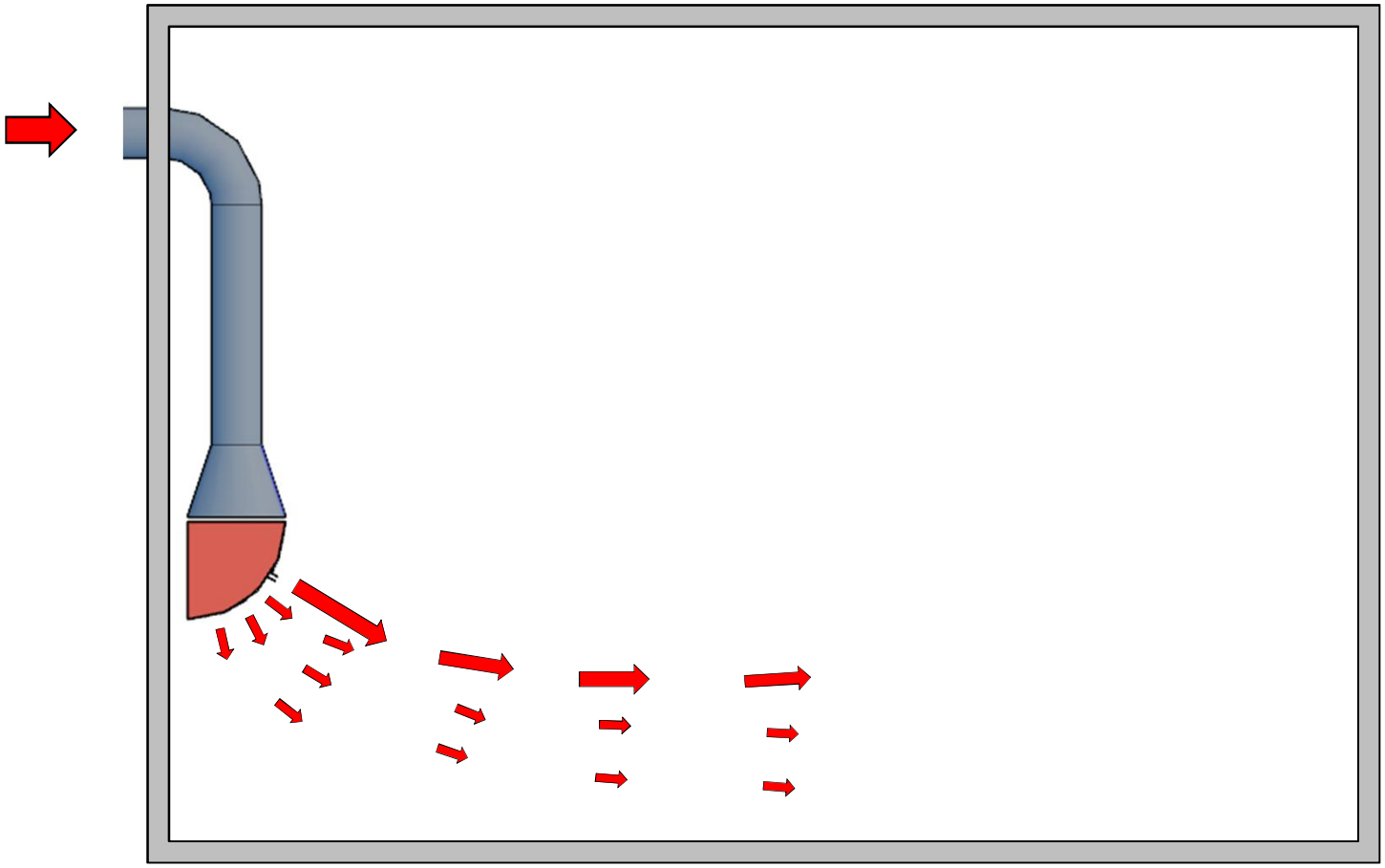
Displacement ventilation

- Air is supplied at slow velocity into the occupied zone
- Convection from heat sources creates vertical air motion into the upper zone, where the air is extracted
- Weak momentum – operation easily deteriorated by disturbances

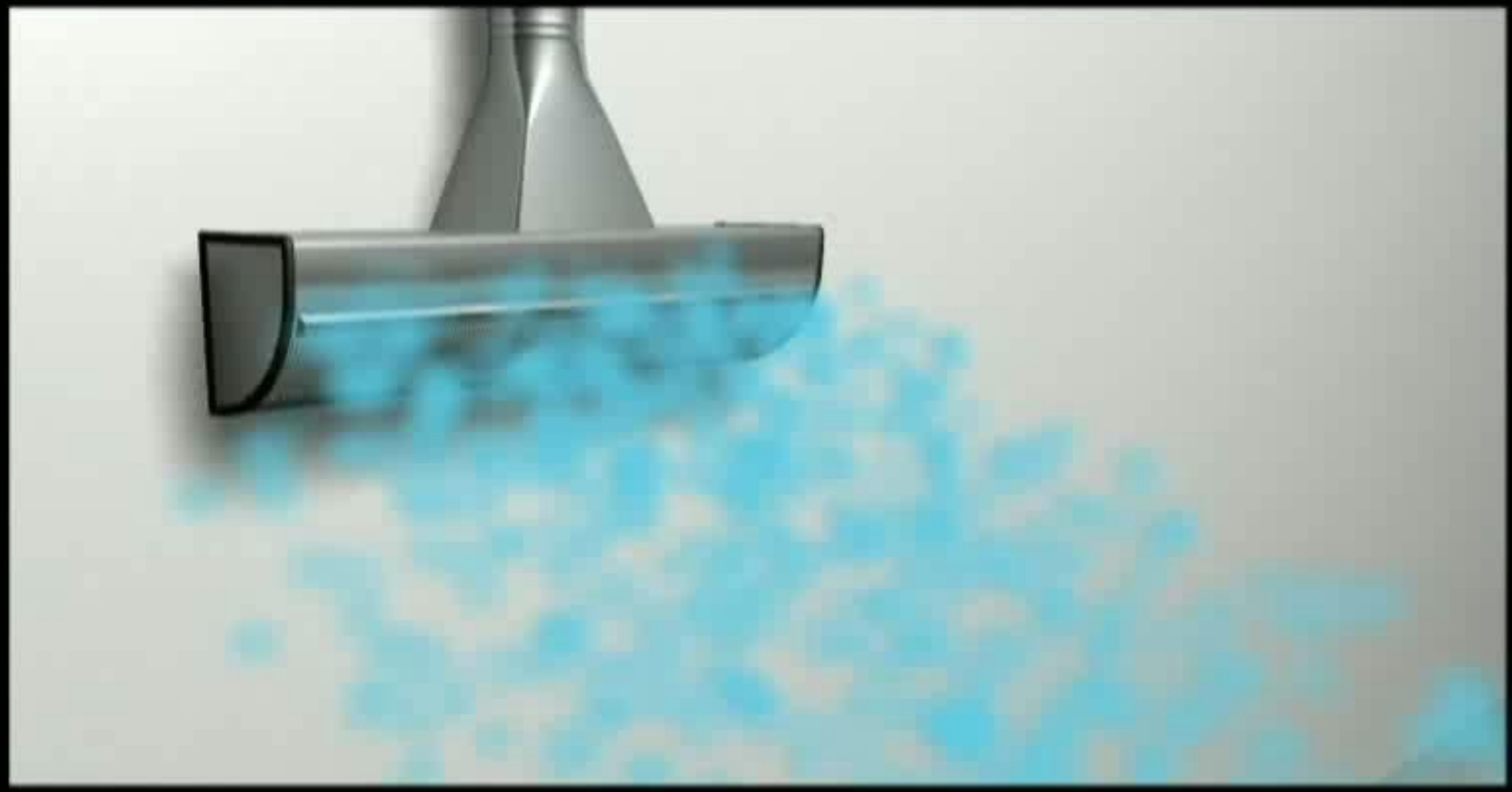


Hybrid ventilation

- Air is supplied through a displacement type diffuser assisted with a downward directed slot jet
- Facilitates a longer efficient operating range than with displacement ventilation
- Can provide a supply of warm air

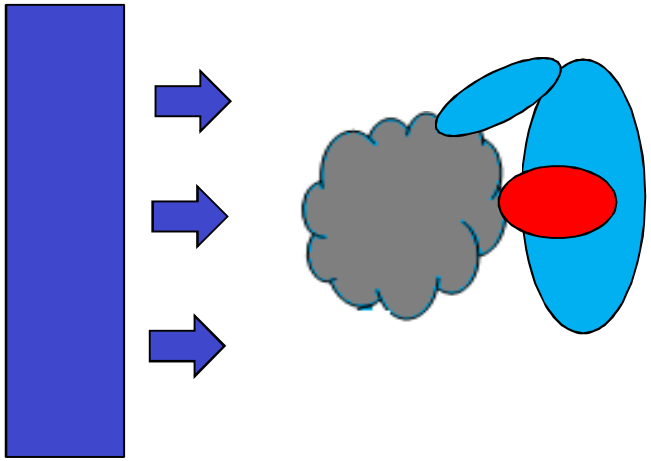


Hybrid ventilation

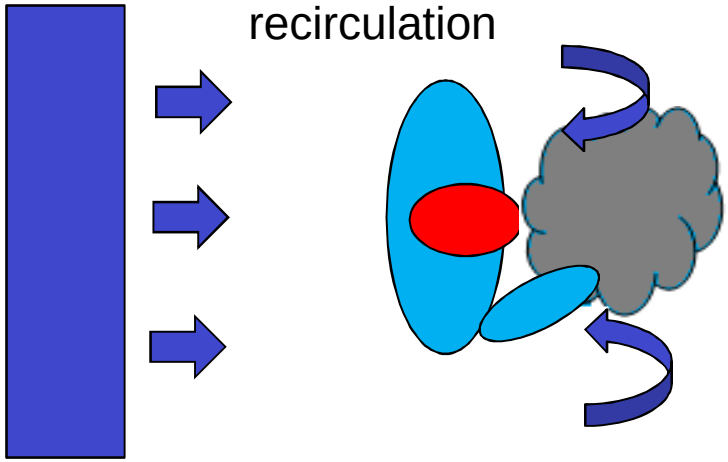


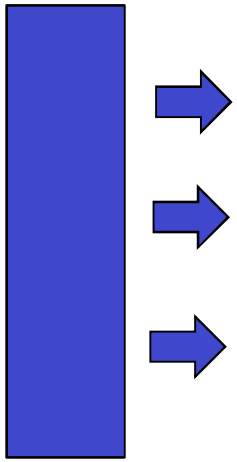
Correct position of the welder relative to the supply air

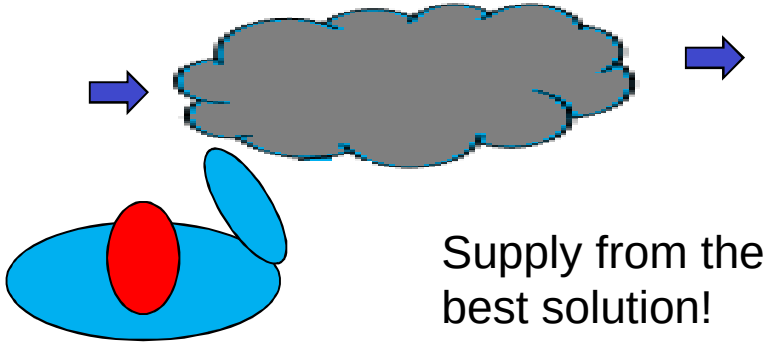
Supply from the front: exposure due to air flow towards the breathing zone



Supply from the back: exposure due to recirculation



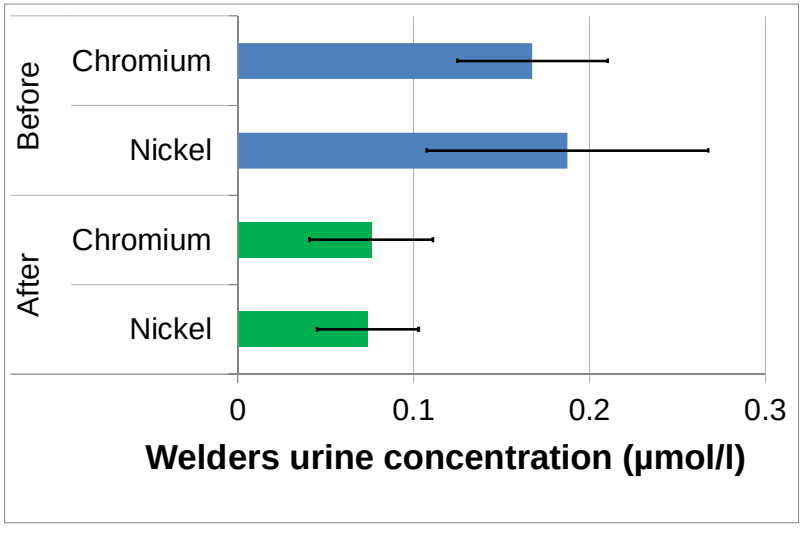




Supply from the side: the best solution!

Case study - effect of improvements on exposure

A welding shop was renovated by installing a new ventilation system which included heat recovery and hybrid air distribution systems. After the renovation, the workers exposure to contaminants was reduced significantly. The ímproved air quality is clearly evident in the following chart results.



Ventilation energy consumption

Energy required to heat the supply air

$$\emptyset = \rho \, q \, c \, \Delta T$$

Temperature difference, C

Air density

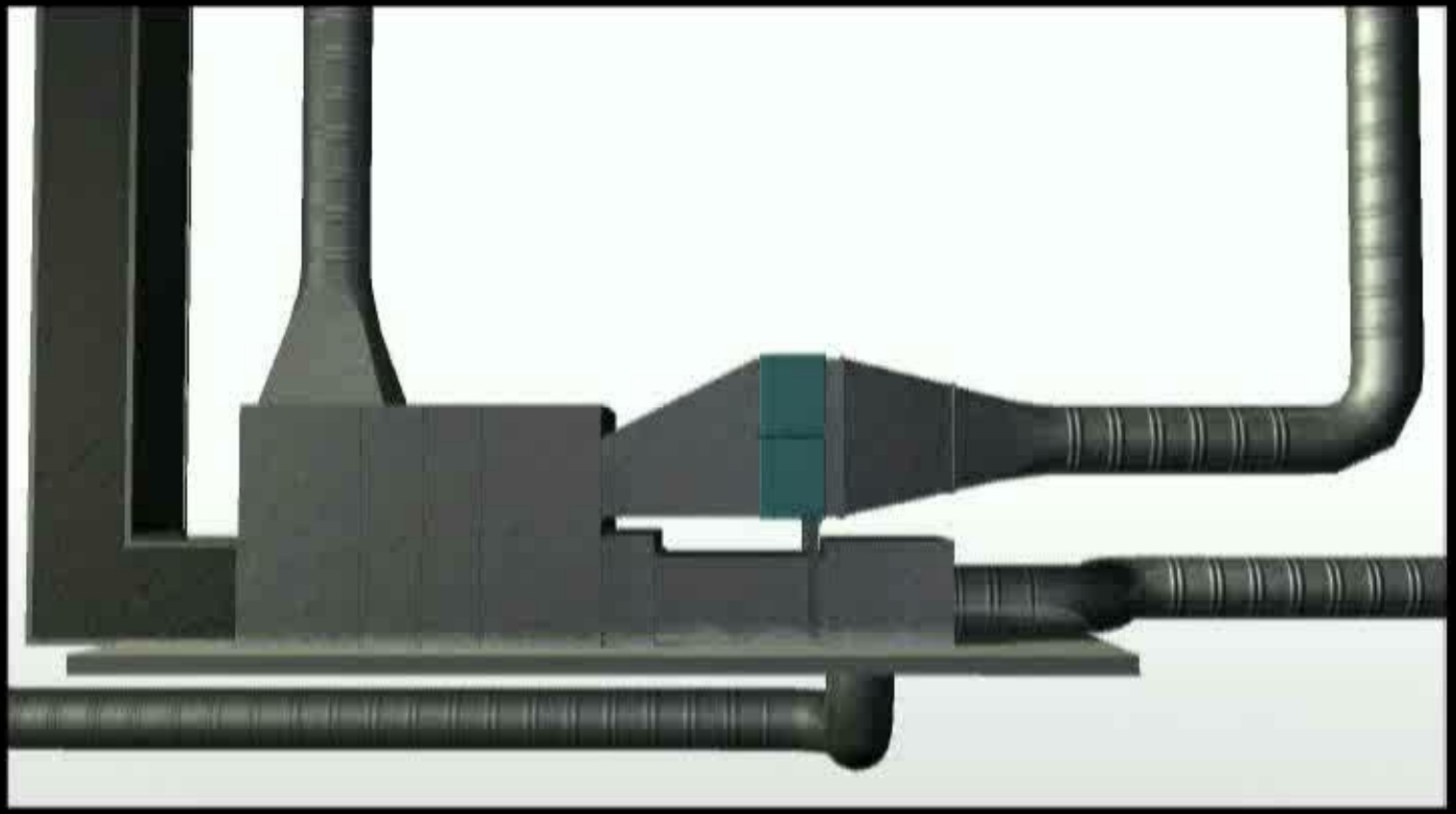
Heat capacity of air, c=1 kJ/kg K

Air flow rate

1 degree C temperature difference means 1.2 kW heating power for an air flow of 1 m^3/s
Average annual temperature difference in Finland is about 14 C
Average heat power is thus 17 kW per 1 m3/s airflow

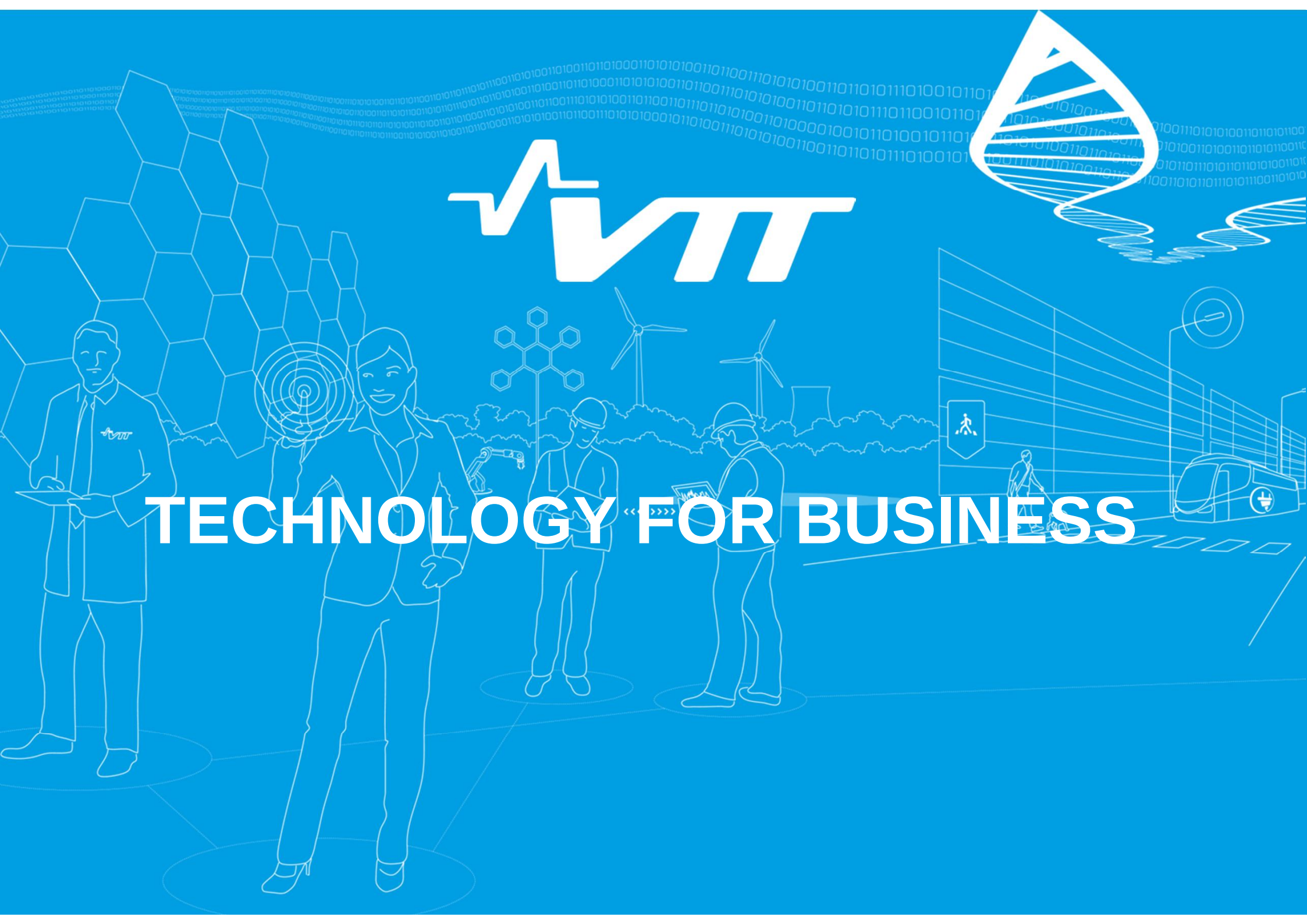
Heat recovery from exhaust air could provide savings from 50 % up to 80 %

Heat recovery – energy savings



Summary

- Welding operations need control measures to keep welders contaminant exposure below occupational limit values
- Local extraction can be the most performance-effective and cost-effective control method
- Efficient control requires the proper use of the system (e.g. frequent replacement of the exhaust hood)
- General ventilation is needed to dilute contaminants that are not captured.
- Hybrid ventilation distribution offers advantages over conventional air supply methods, in that it provides clean air to the breathing zone
- To avoid the clogging of the heat exchanger and maintain high efficiency levels, cleaning of the exhaust air is needed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