The Mine Ventilation Society of South Africa Annual Conference 2017

The ability of process plant ventilation to reduce exposure to harmful airborne pollutants

28 July 2017

prepared by Johan Snyman

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What is a Process Plant?

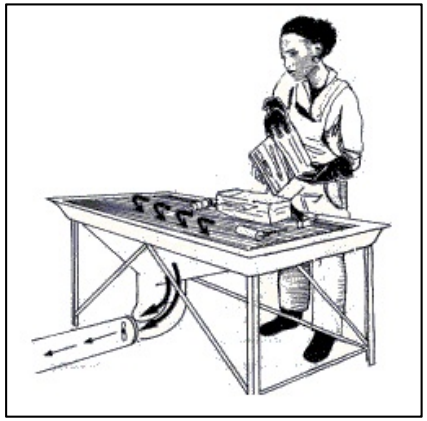
Definition: Plant where raw material are processed into a product

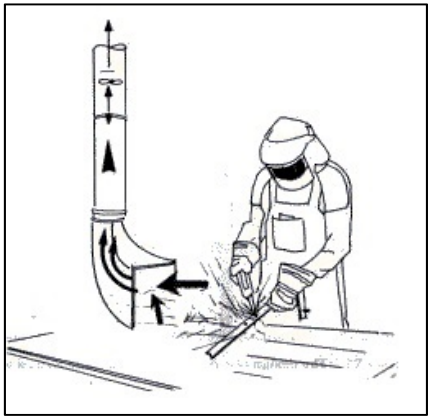
Examples of various types of process plants are:

- ❑ Chemical and Petrochemical
- ❑ Agricultural
- ❑ Mineral processing [refineries]
- ❑ Food and pharmaceutical

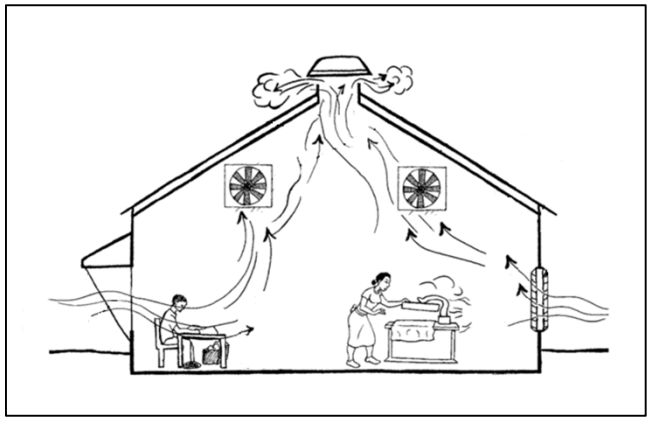
Process Plant Ventilation

Local Exhaust Ventilation [LEV]





General Ventilation

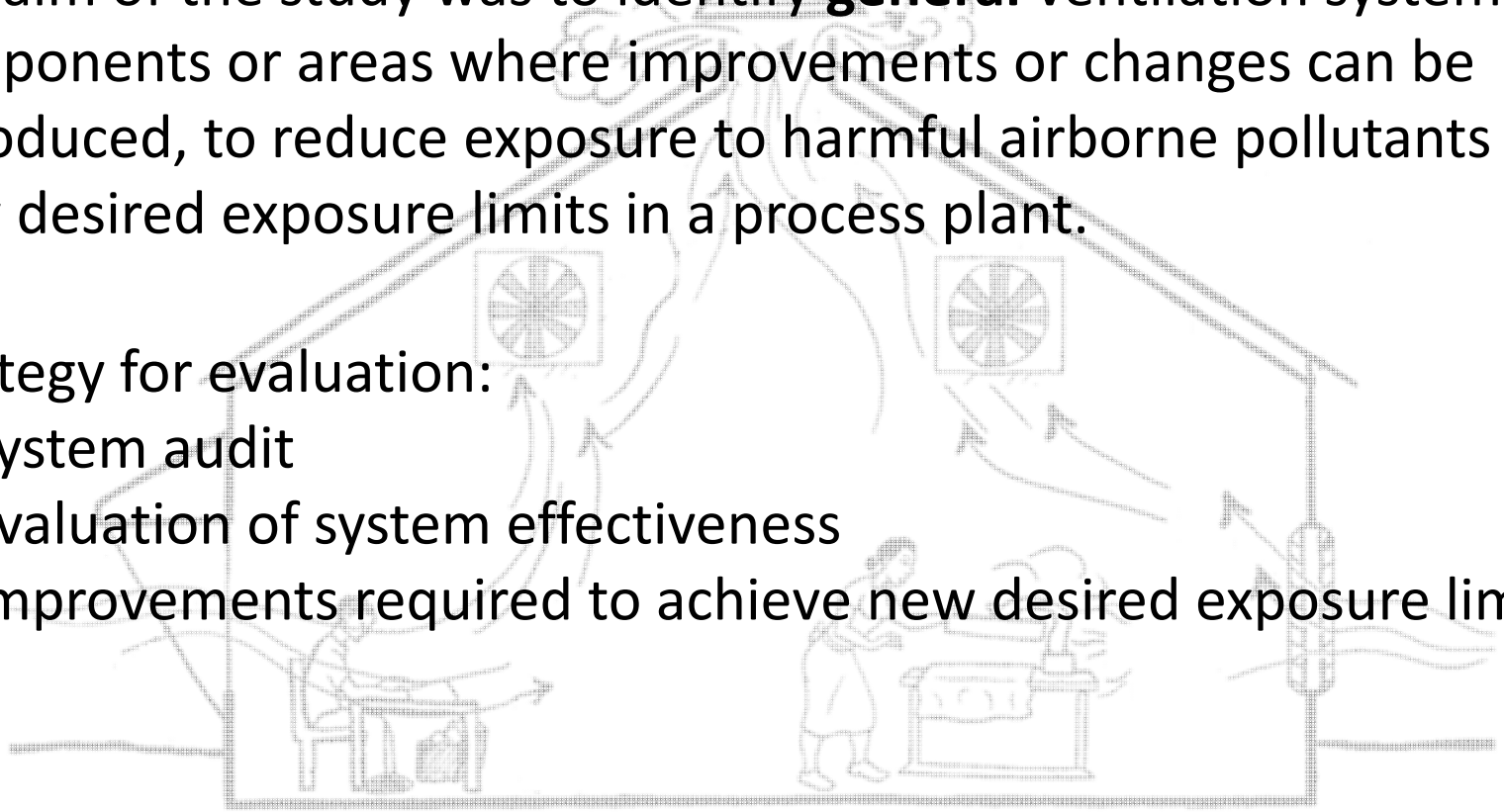


LEV system and general ventilation system are interdependent

- ❑ The LEV system focuses on capturing the air borne pollutants [ABPs] at the source of generation
- ❑ ABPs that do get released into the general air space due to inefficiency of the LEV system are dilute to acceptable levels with the general ventilation system

Case Study - Reduce exposure to harmful airborne pollutants by general ventilation

The aim of the study was to identify **general** ventilation system components or areas where improvements or changes can be introduced, to reduce exposure to harmful airborne pollutants to new desired exposure limits in a process plant.



Strategy for evaluation:

- ❑ System audit
- ❑ Evaluation of system effectiveness
- ❑ Improvements required to achieve new desired exposure limits

General Ventilation System Audit

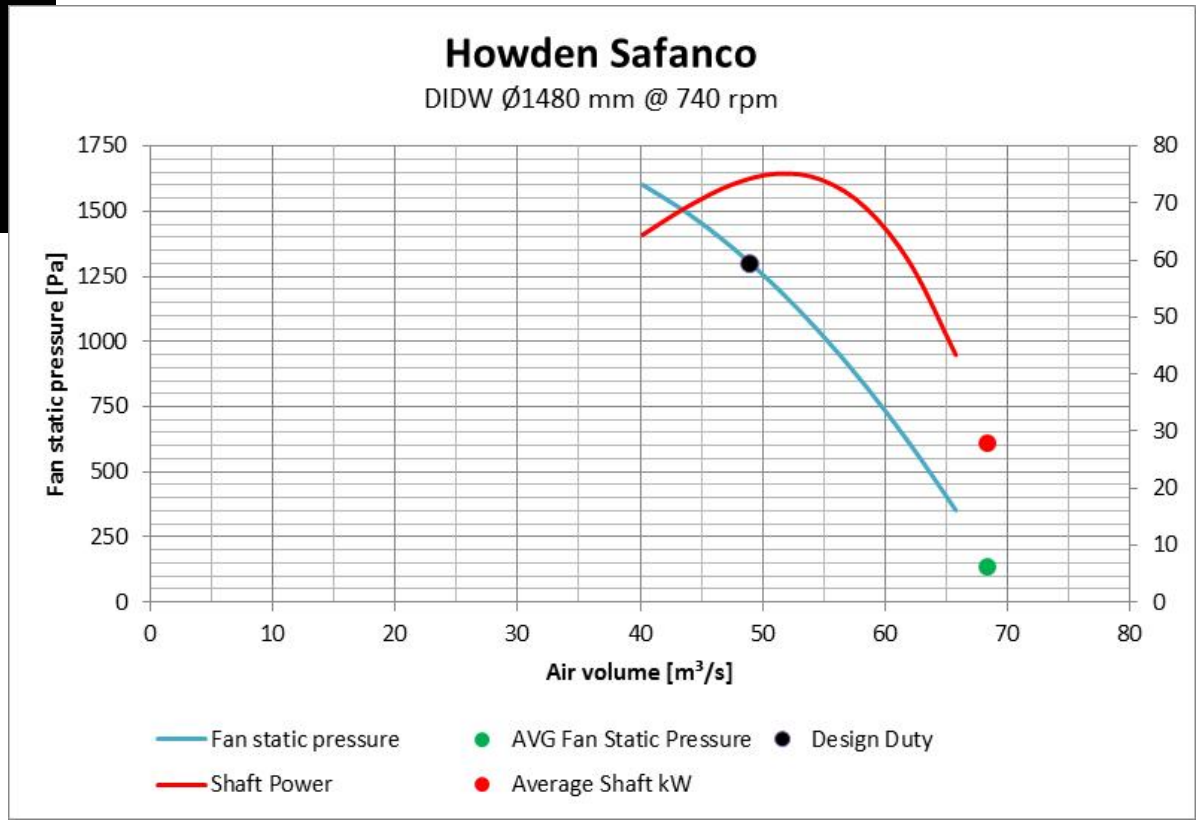
Audit conducted to:

- ❑ Established the condition of the system
- ❑ System fan performance
- ❑ System airflow distribution

General Ventilation System Audit Analysis

Established the condition of the system

Established the performance of the fan



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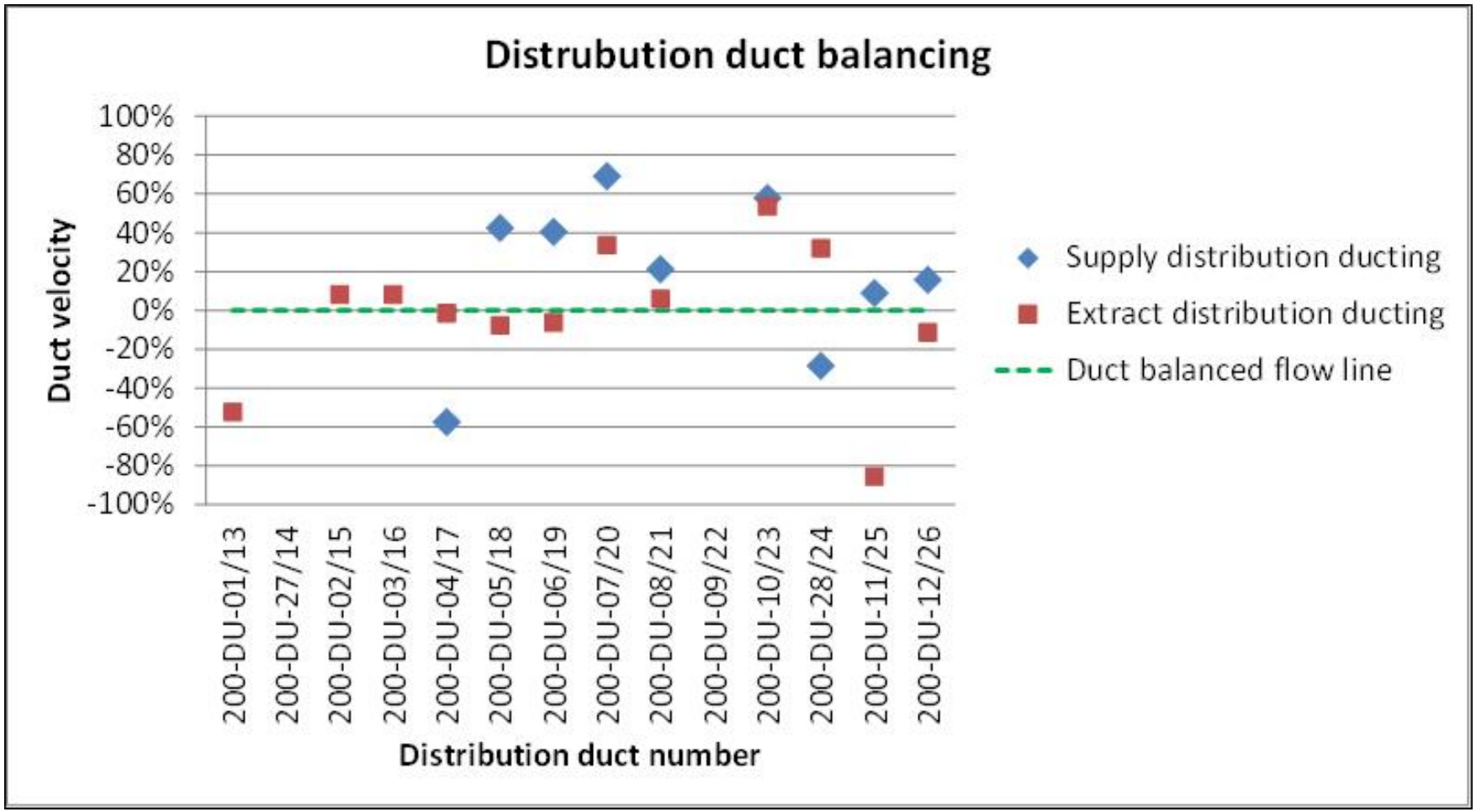
General Ventilation System Audit Analysis

System airflow distribution



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JS3

Evaluation of system effectiveness

Evaluation of system effectiveness by computational fluid dynamics [CFD] simulation:

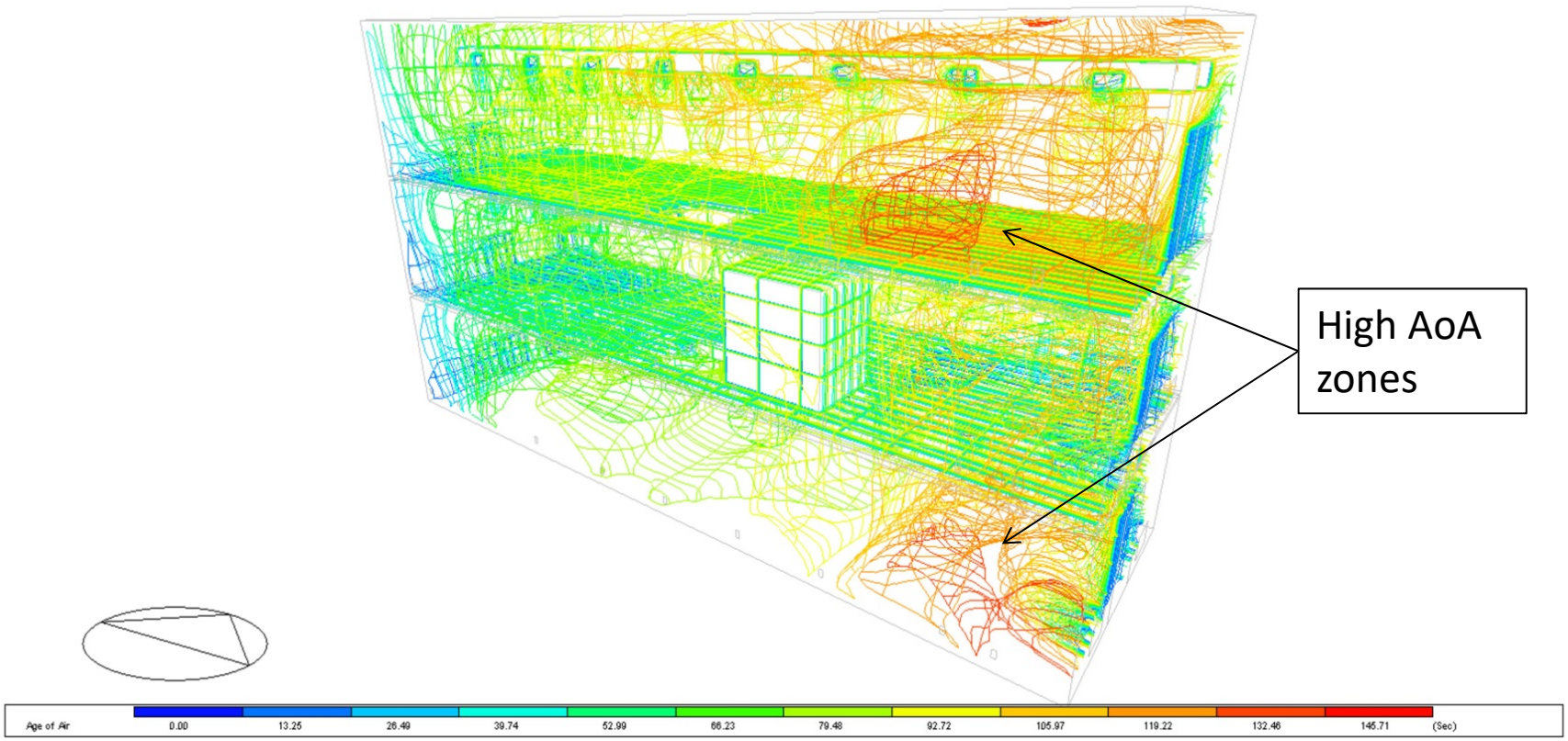
- Identify high age of air [AoA] zones in the general air space
  - AoA is defined as the time [in seconds] that an air particle spends inside the general ventilation space calculated from the time the air particle enters the space until leaving the space.
- Identify non-uniform ventilation profiles
  - This can be determined by studying the velocity profiles of air inside the space
- Ineffective use of general ventilation air
  - Short circuiting air between supply and extract points. This is normally associate supply and return air points located in close proximity in conjunction with low AoA values at return air points

Slide 8

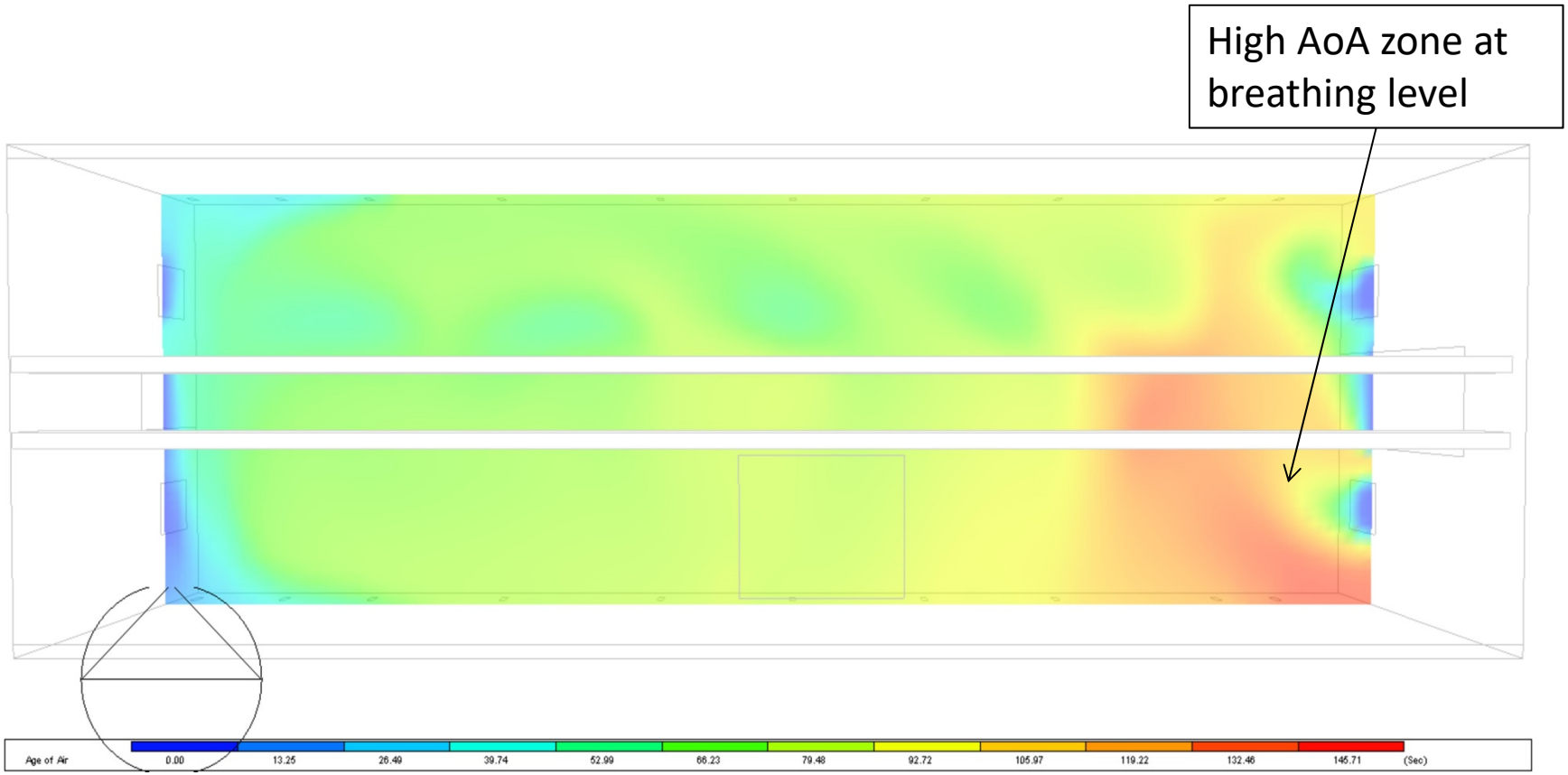
JS3 Define AoA and use this stead of stale air. use AoA continiously

Johan Snyman, 14/Jul/2017

Evaluation of system effectiveness



Evaluation of system effectiveness



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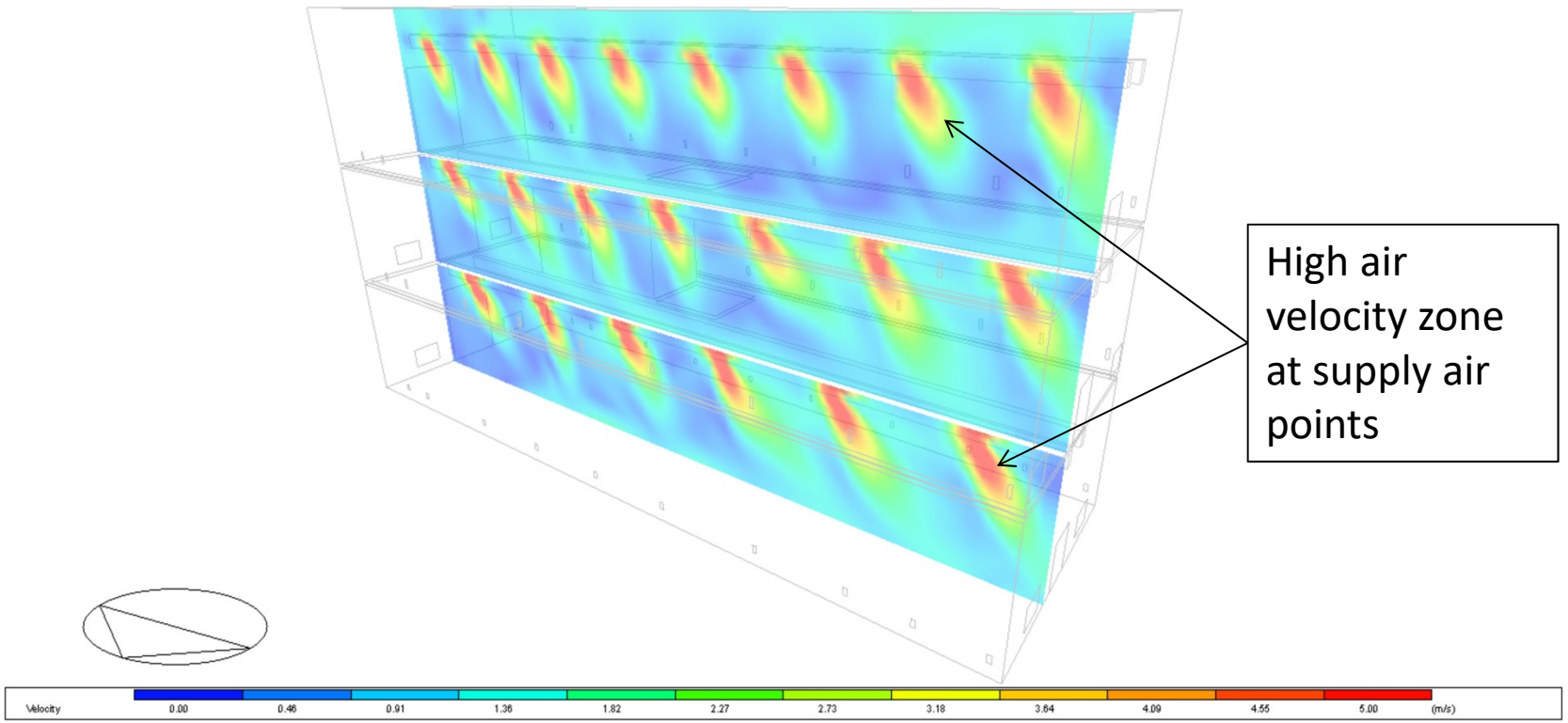
JS4

Evaluation of system effectiveness

General ventilation air velocity profile



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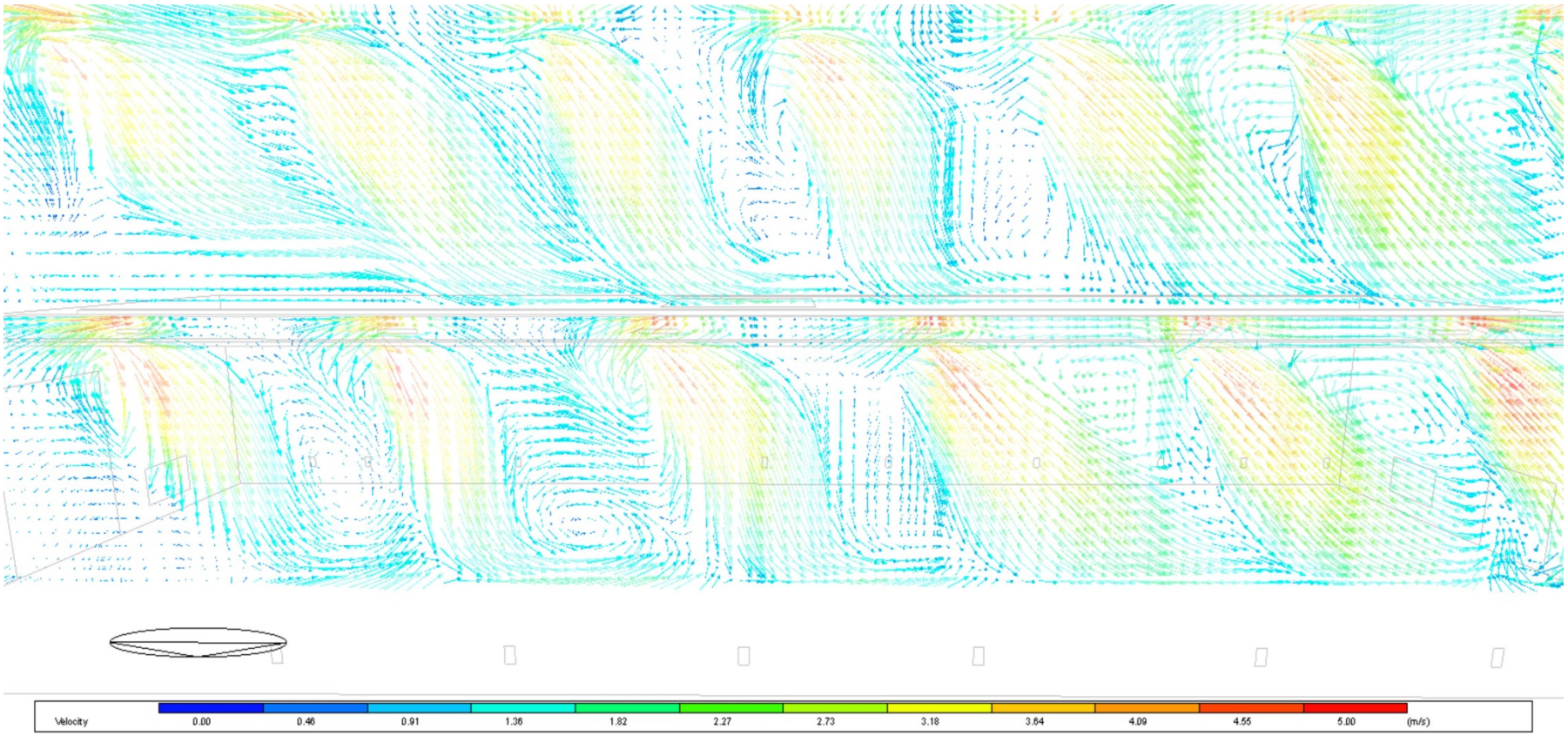
Slide 11

JS4 Say why this is relavent.
Say more to explain
"show that supply are is adequate or effecetive
Johan Snyman, 14/Jul/2017

Evaluation of system effectiveness

General ventilation airflow pattern



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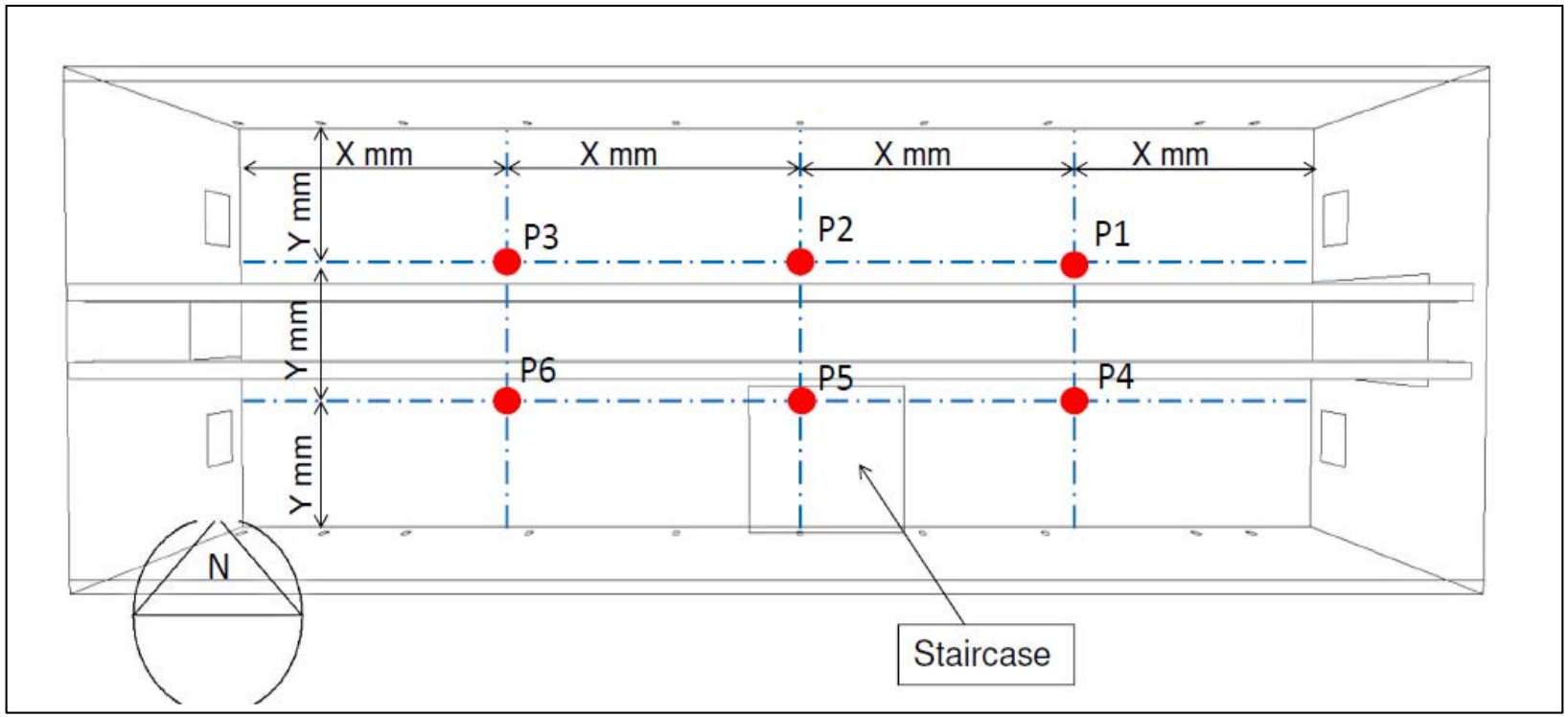
Improvements required to achieve new desired exposure limits

Methodology for establishing the improvements required:

- ❑ Calibrate the CFD model with static ABP samples
- ❑ Estimate the extend of improvement required
- ❑ Simulate the improvements required in the calibrated model

Calibrate the CFD model with static ABP samples

Static ABP sampling at predefined points in the plant breathing zone



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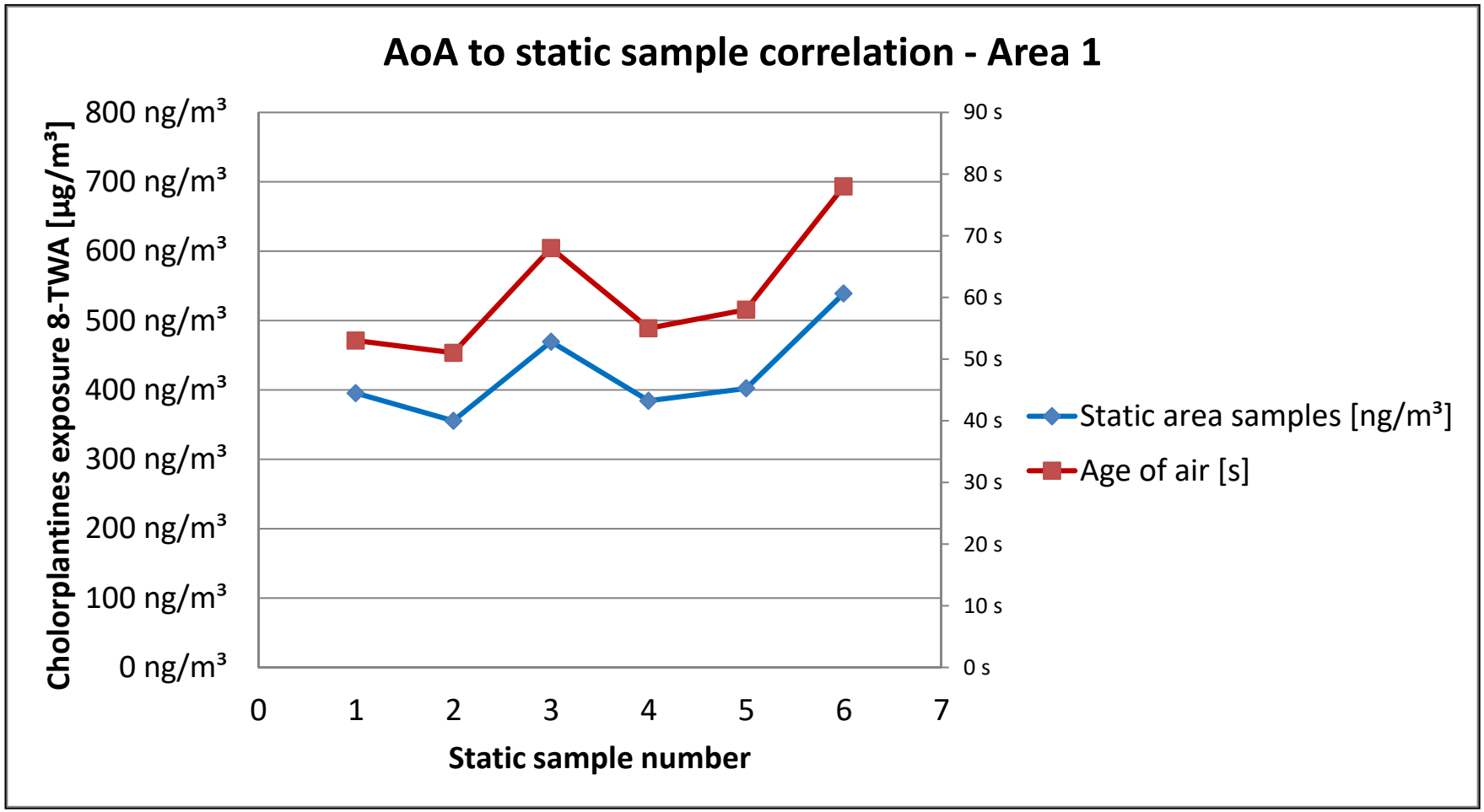
Calibrate the CFD model with static ABP samples



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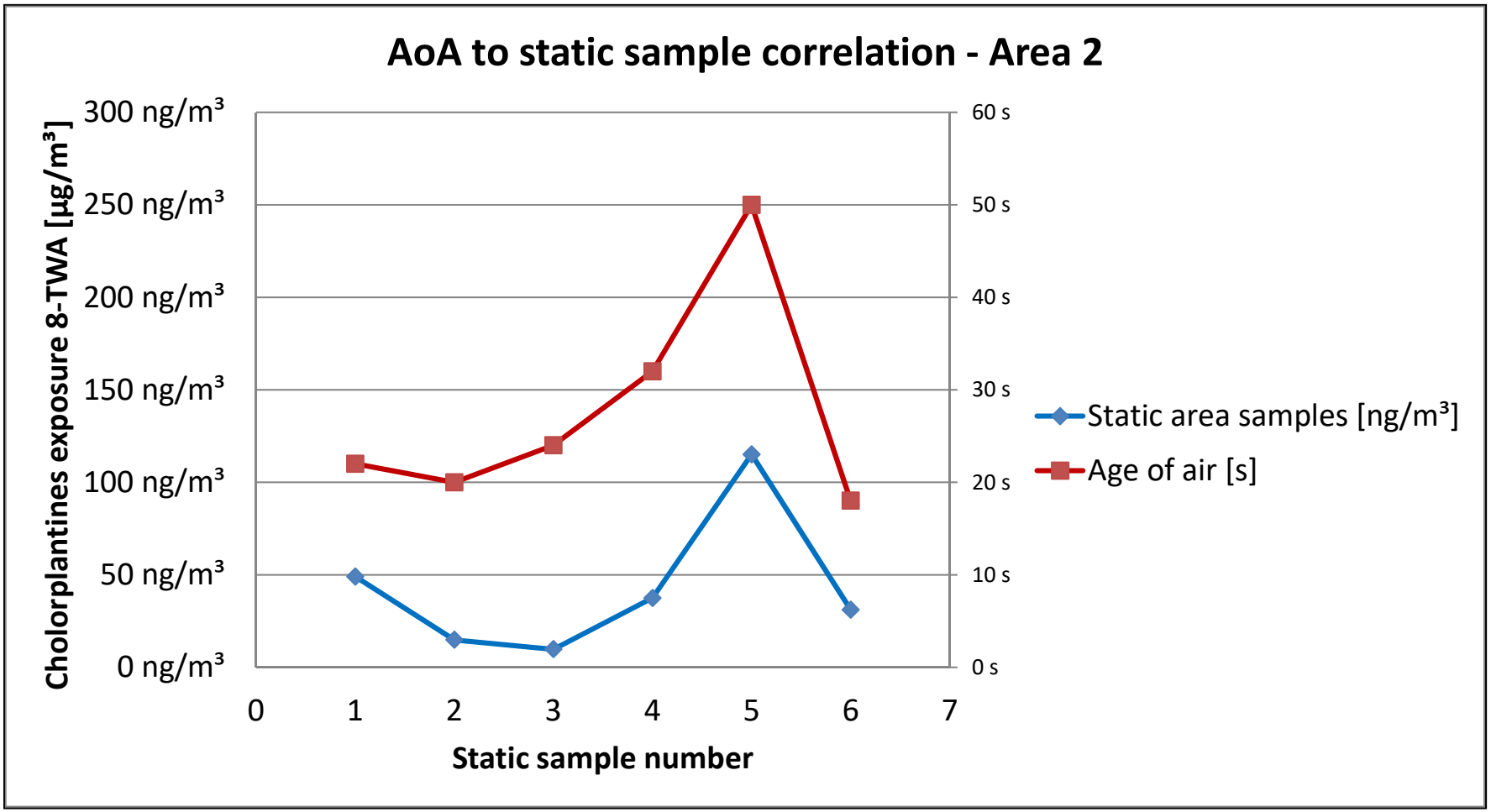
Calibrate the CFD model with static ABP samples



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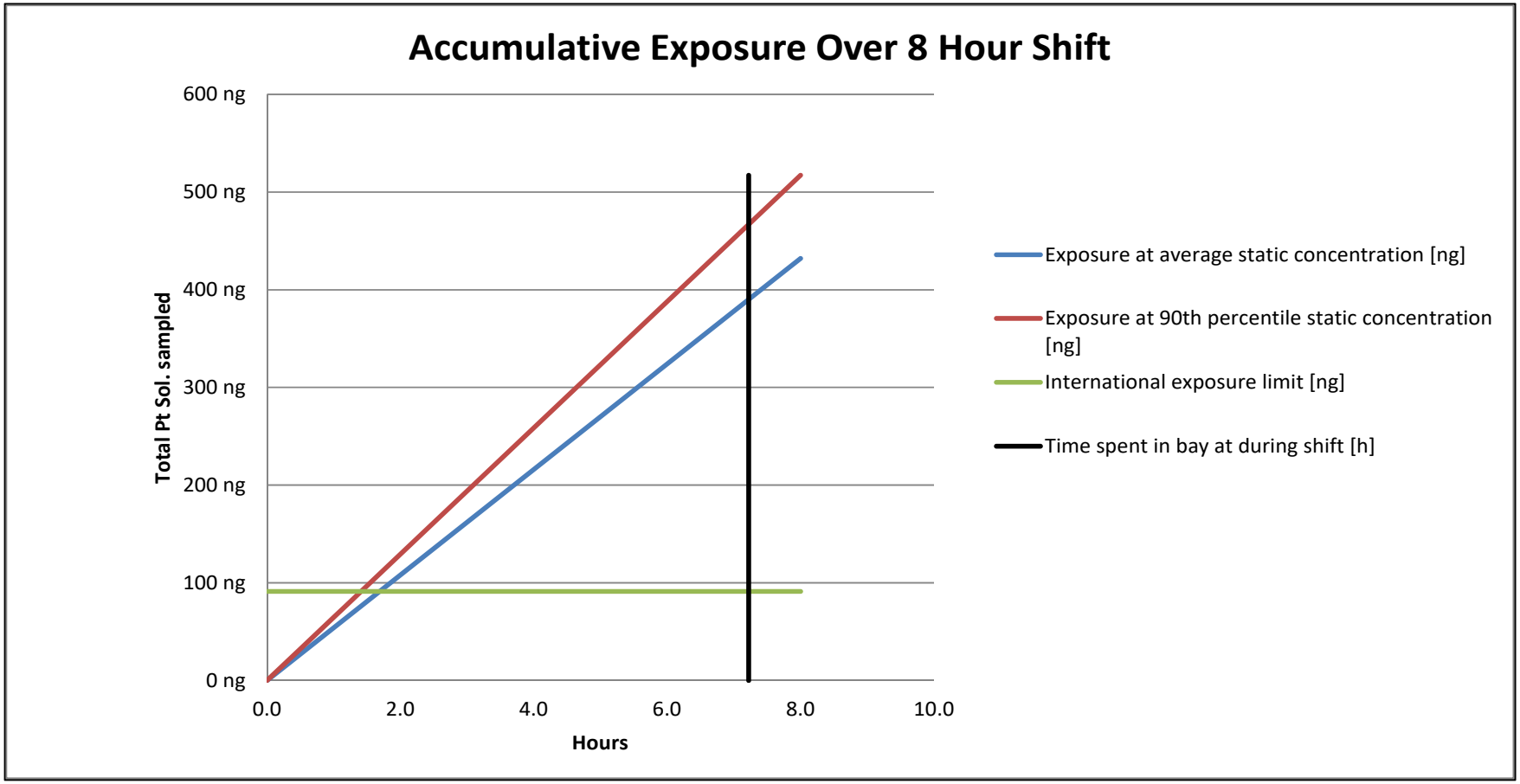
Estimate the extent of improvement required



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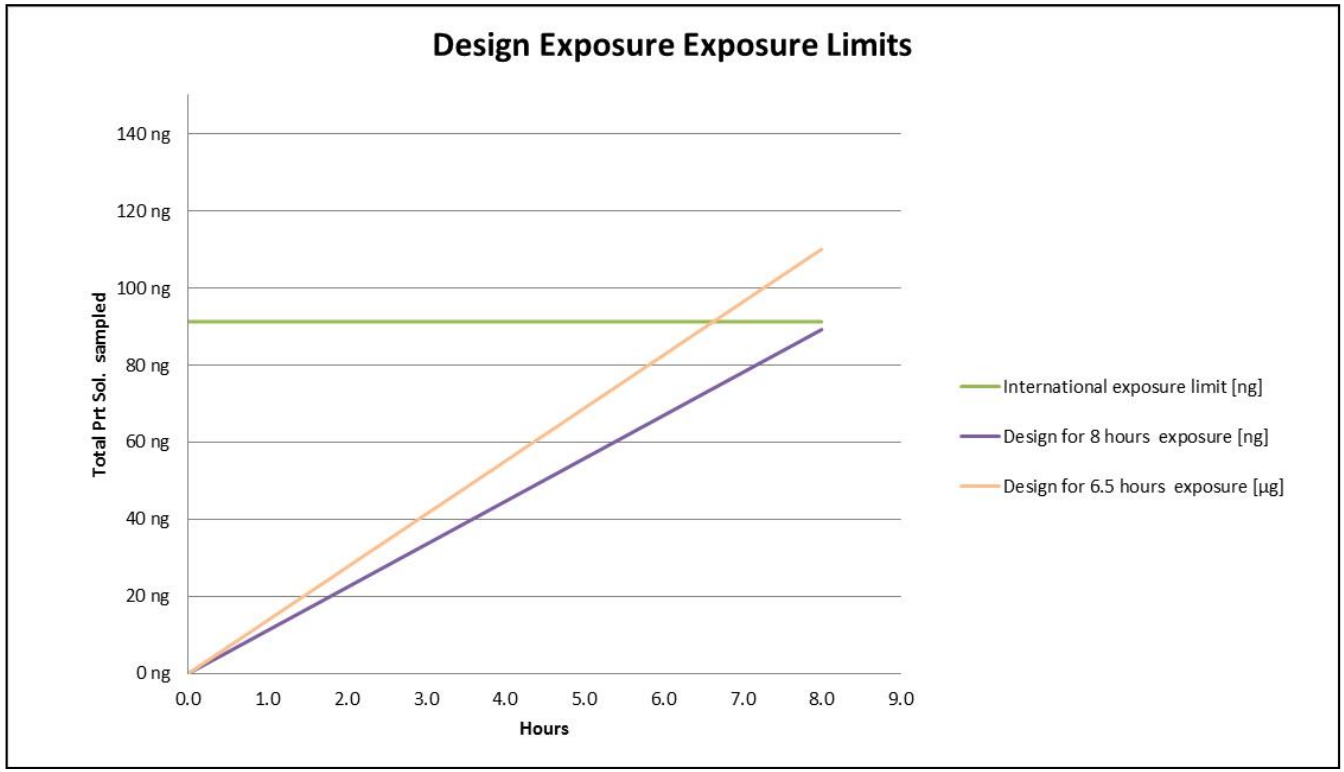
JS5

Estimate the extent of improvement required



Brown line 7.2 hours design

Design for hours under exposed	7.2 hours
Maximum accumulative personal exposure	91 ng
Allowed static concentration [90th %]	121 ng/m³
AOA [90th %]	76.4 s
Design AOA	16.3 s
Air volume required per bay	130 m³/s

Purple line 8.0 hours design

Design for hours under exposed	8 hours
Maximum accumulative personal exposure	91 ng
Allowed static concentration [90th %]	98 ng/m³
AOA [90th %]	76.4 s
Design AOA	13.2 s
Air volume required per bay	160 m³/s

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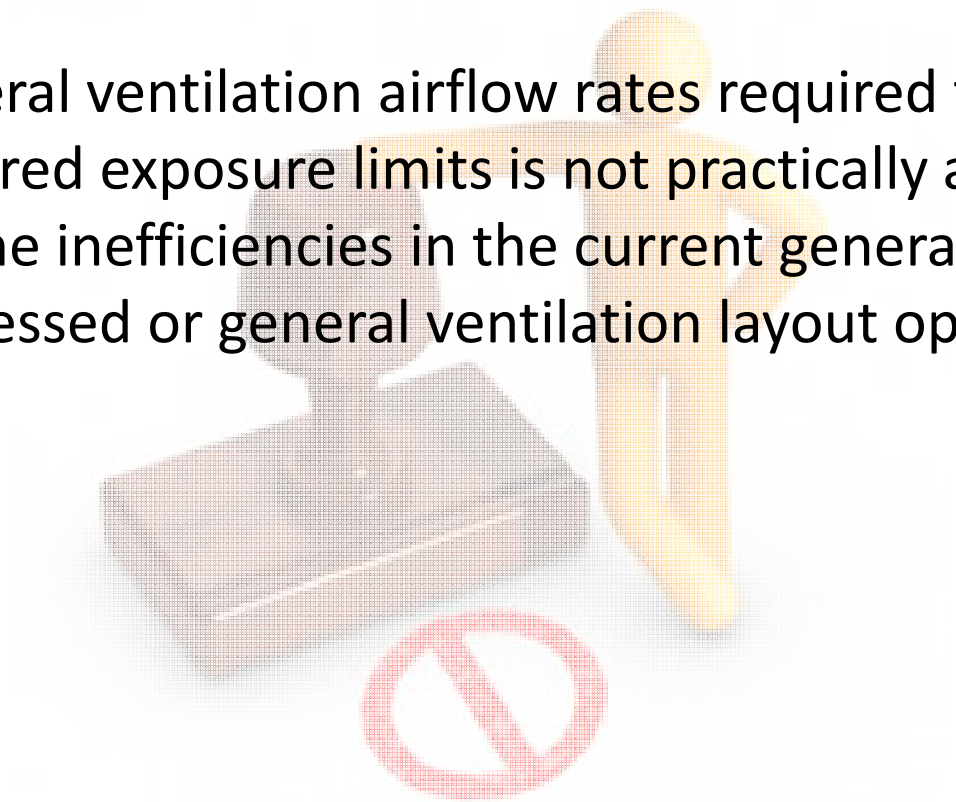
Slide 18

JS5 Make two sides
Maybe shorter legends
Johan Snyman, 14/Jul/2017

Simulate the improvements required in the calibrated model

The general ventilation airflow rates required to obtain the new desired exposure limits is not practically achievable. Even if the inefficiencies in the current general ventilation are addressed or general ventilation layout optimized



Typical recommendations on how to achieve obtain the new desired exposure limits

- Review the effectiveness of LEV or draught system extraction elements at capturing the airborne pollutants at the source.
- Evaluate the ability of the LEV or draught system to provide sufficient extraction rates to the extraction elements.
- Consider automation of process directly exposing occupants to airborne pollutants.
- Training of occupants to avoid unnecessary generation of airborne pollutants in the plant general air space during operations.

Questions and Answers

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