

Are we Shifting Exposure to Chemical Agents to Warehouse Workers?

Introduction on how to perform risk assessment on
inbound cargo – downstream approach

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INTRODUCTION

- European legislation on hazardous products is very strict (eg. REACH, CLP)
- Imported goods can contain dangerous substances that are off gassing in closed cargo containers
- Research on the impact on workers exposure is lacking



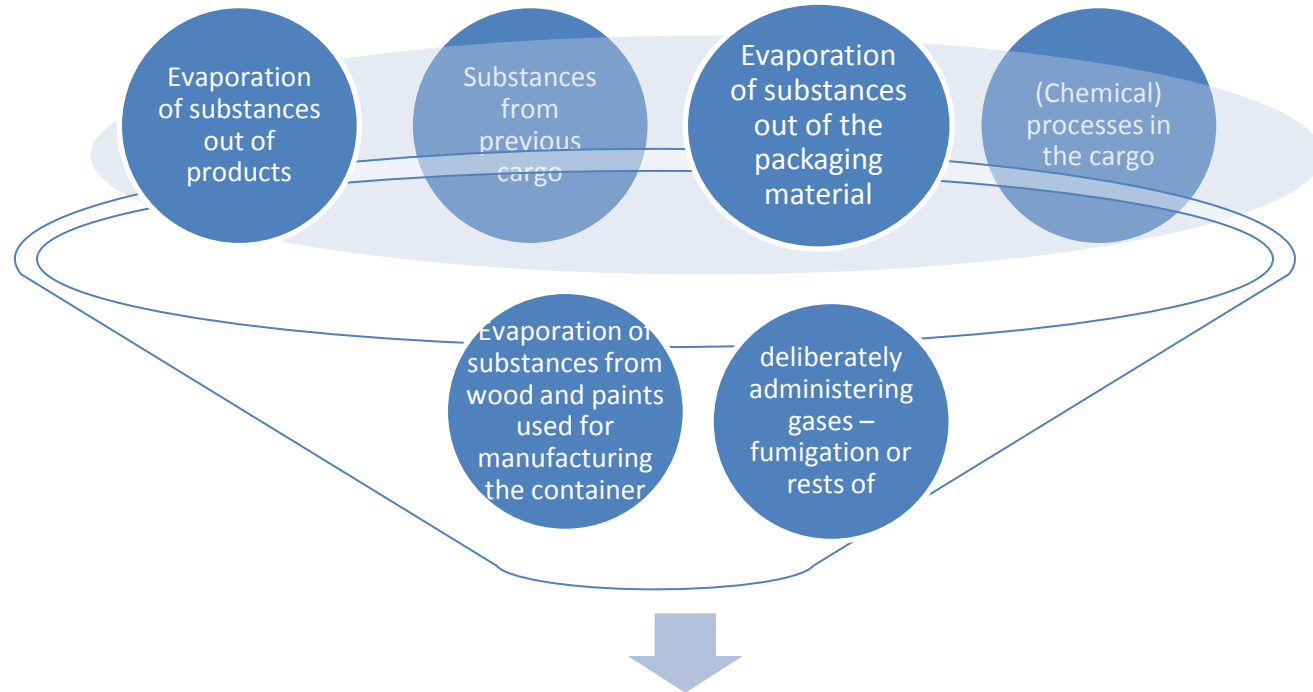
PROBLEM

- Intoxications are reported when unloading cargo containers
 - Fatal accidents caused by acute high exposure to fumigants
 - Headache and other related symptoms by lower exposure to different chemicals
- Occupational hygiene programs are not common in the sector
- Large amount of Containers
 - > 11.000.000 TEU in 2015 – Port of Antwerp & Zeebrugge
- Control programs based on non selective measurements without any proper risk assessment
- Companies and especially the workers are not aware of:
 - the exposure to dangerous substances related to the activities
 - the legislation



INTRODUCTION

- Dangerous gases in containers may result from:



Difficult mix to control



GOALS

RISK ASSESSMENT

1. Which chemicals of concern are present in container air
2. Find out if there is follow-up needed for inbound containers
3. Identify if additional personal monitoring is required
4. Establishing safe unloading procedures

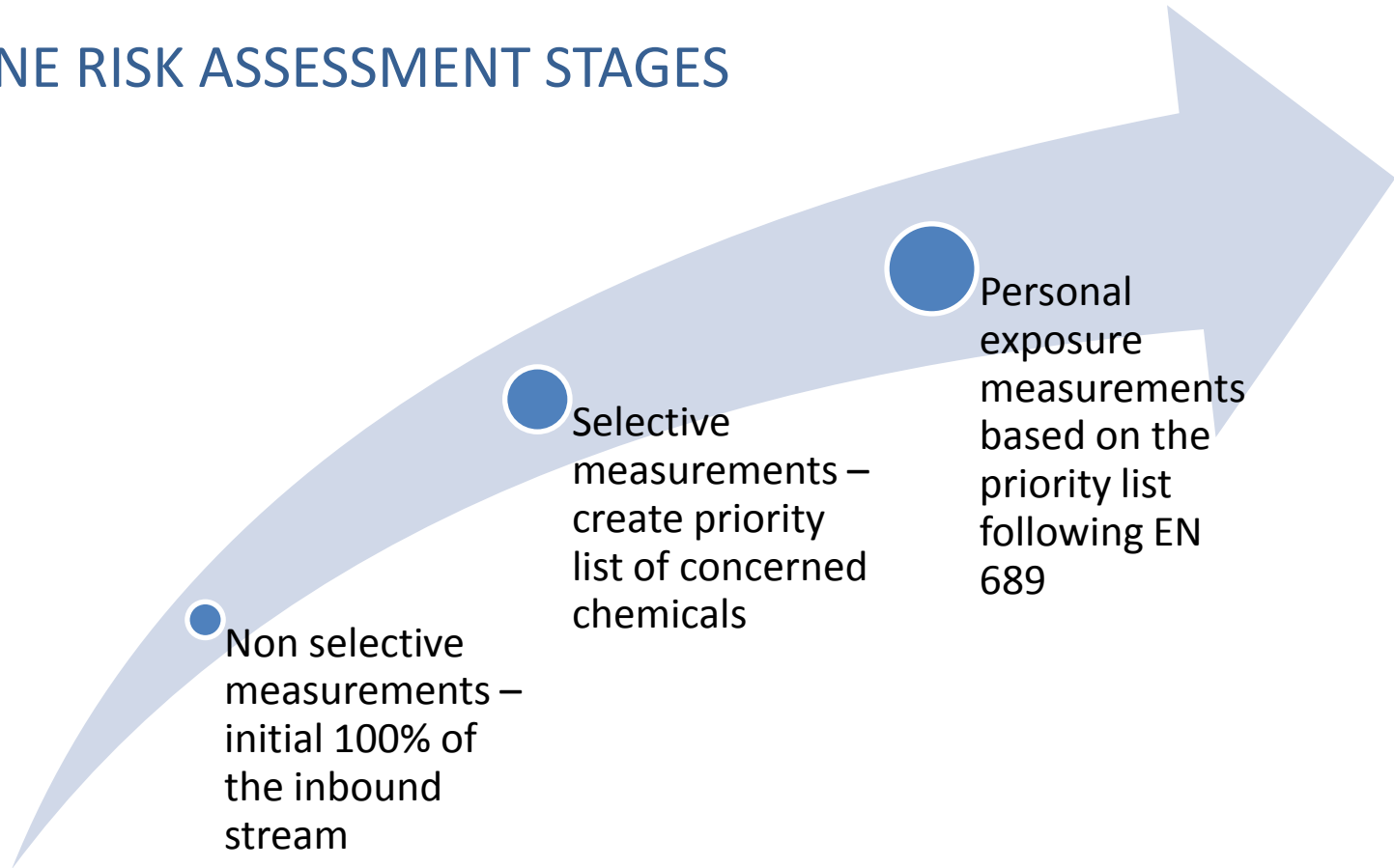
SAFE UNLOADING PROCEDURE (SCU)

1. Are non selective limit values adequate to follow up inbound streams and ensure safe unloading
2. Establish clear limit values for safe unloading (red= unsafe or green= safe)



DOWNSTREAM APPROACH

DEFINE RISK ASSESSMENT STAGES



DOWNSTREAM APPROACH

Why first non selective measurements?

- Type of measurement can be chosen:
 - Measurement cells and tubes (eg Dräger tubes, PID,...)
 - Advantage: fast analysis → fast first evaluation
 - Disadvantage:
 - Not usable for exact concentration measurements
 - Cross sensitivity – not for risk assessment (not sure about the compounds)
 - Selected ion flow tube (SIFT)-MS
 - Advantage : fast analysis and reliable results (concentration)
 - Disadvantage : only the pre-defined components are determined in concentration (can be costly for the first screening if it appears that there are subsequently GC / LC-MS measurements needed for component detection)



DOWNSTREAM APPROACH

Why first non selective measurements?

- Type of measurement can be chosen:
 - FT-IR
 - Advantage: fast analysis
 - Disadvantage :
 - Cross sensitivity - peak overlap (expert is needed to analyze IR spectra)
 - Only the pre-defined components are determined in concentration (can be costly for the first screening if it appears that there are subsequently GC / LC-MS measurements needed for component detection)
- Gives a significant picture of the container flow - every response is a NO GO
- Targeted implementation of the more expensive selective measurements



MATERIALS & METHODS

Types of measurements:

- Container air sampling of a closed container using a probe connected with adsorption media connected with an air sampling pump
- Personal air sampling where the adsorption media connected with an air sampling pump was carried by the operator during the whole work shift.

Selective measurements

- ISO 16000-6.2 - Indoor air - Part 6 – total VOC analysis - samples where taken on TENAX and CARBOTRAP and analyzed using TD-GC-MS
- NIOSH method 2018 – Determination of aldehydes – samples where taken on cartridges containing silica gel coated with acidified 2,4-DNPH and analyzed using HPLC-UV



MATERIALS & METHODS

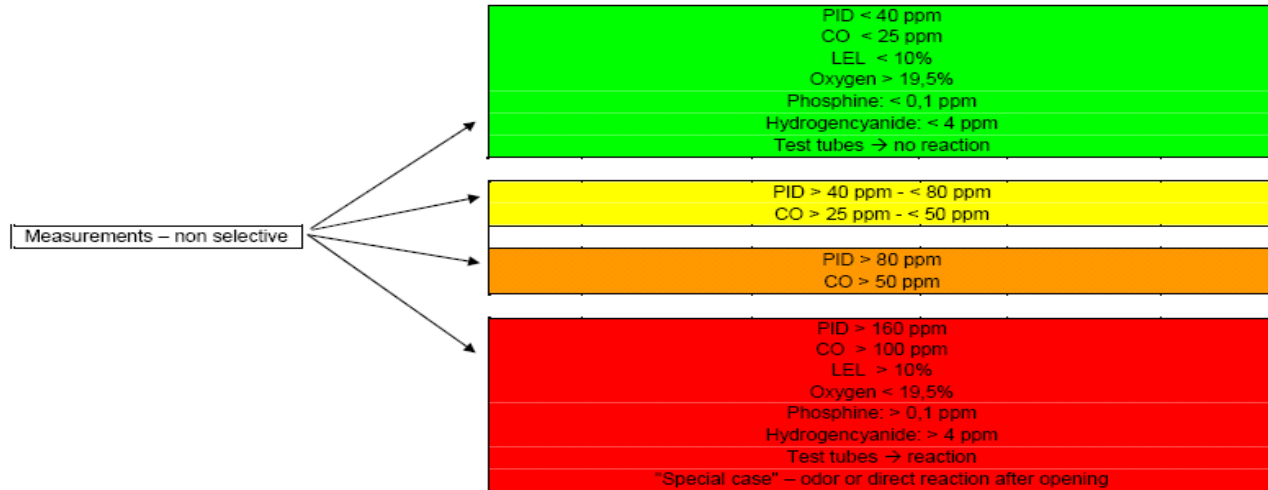
Non selective measurements:

- Photo-ionization detector (PID) - MiniRAE 3000 portable VOC monitor 10.6 EV
- MultiRAE with following sensors:
 - Phosphine (0-20 ppm) – resolution 0,1 ppm
 - Carbon dioxide (0-50.000 ppm) – resolution 100 ppm – NDIR sensor
 - Ammonia – (0-100 ppm) – resolution 1 ppm
 - Hydrogen sulfide– (0-100 ppm) – resolution 0,1 ppm
- QRAE+ detector with following sensors:
 - Oxygen (0-30%) – resolution 0,1%
 - Carbon monoxide (0-500 ppm) – resolution 1 ppm
 - Explosion sensor – (0-100% LEL) – resolution 1% LEL
 - Hydrogen cyanide – (0-100 ppm) – resolution 1 ppm



MATERIALS & METHODS

During risk assessment following procedure was followed

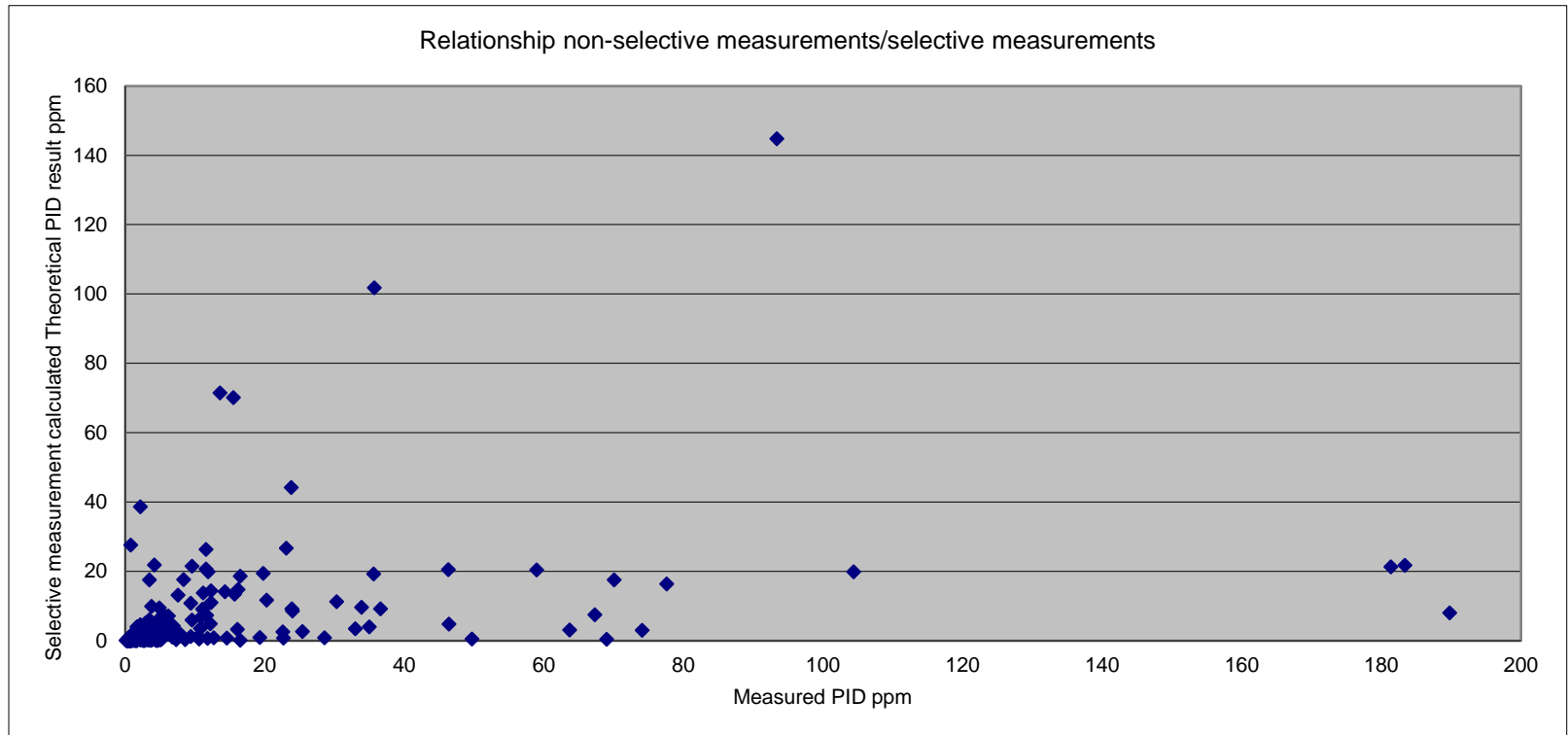


	safe to unload without any action
	Safe to unload after ± 1 hour standing with doors open. Also safe to unload directly when using PPE. Caution!! Always remeasure before entering.
	Safe to unload after ± 4 hours standing with doors open. Also safe to unload directly when using PPE. Caution!! Always remeasure before entering.
	Not safe to unload - special degassing needs to take place Caution!! Always remeasure before entering. "Special case" - If there's a special odor or direct effects when opening the container - close the container immediately - measurements needs to be done by active sampling.



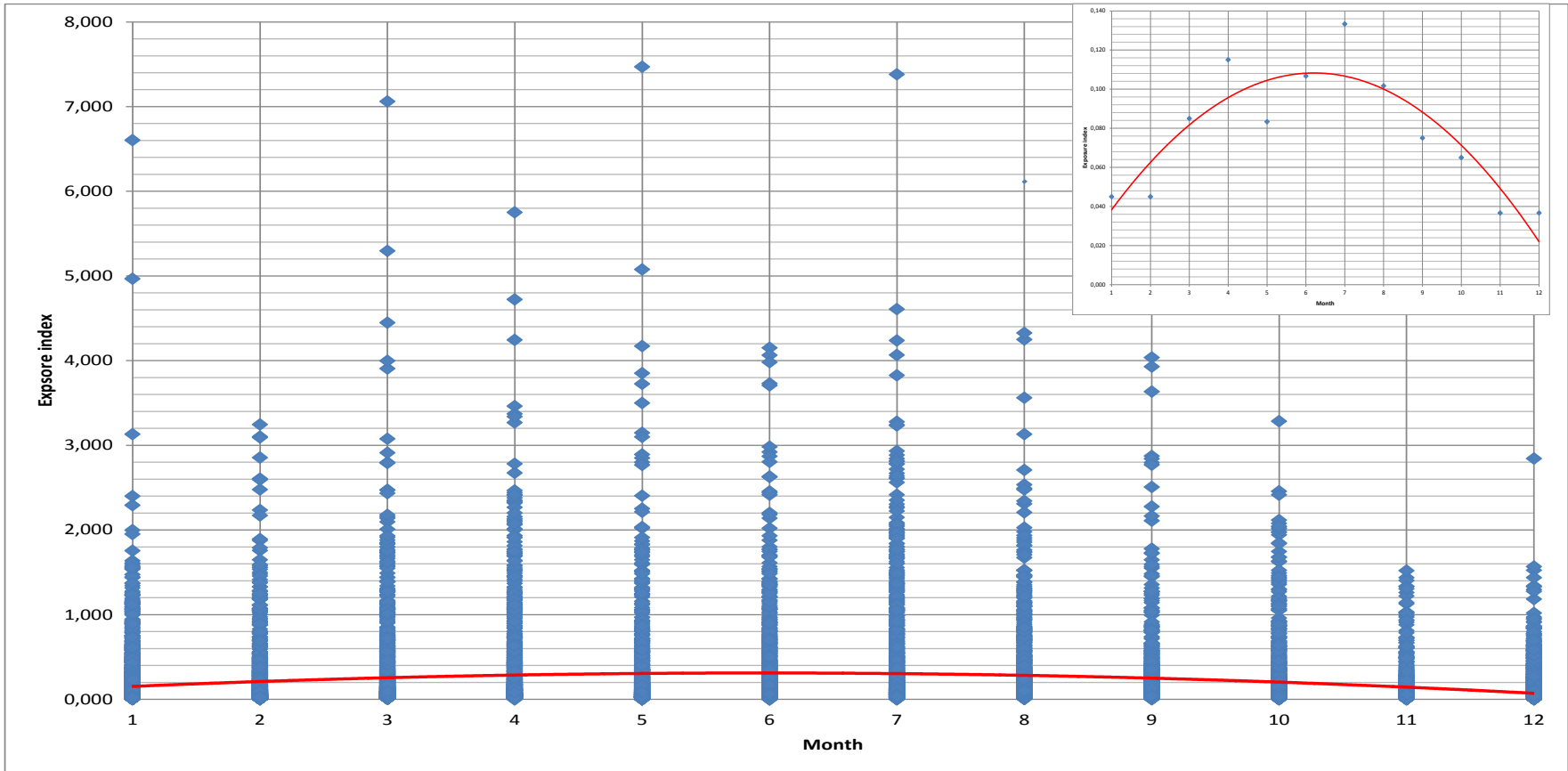
RESULTS

- Relationship between non selective and selective measurements



RESULTS

- Seasonable impact on exposure – container air data



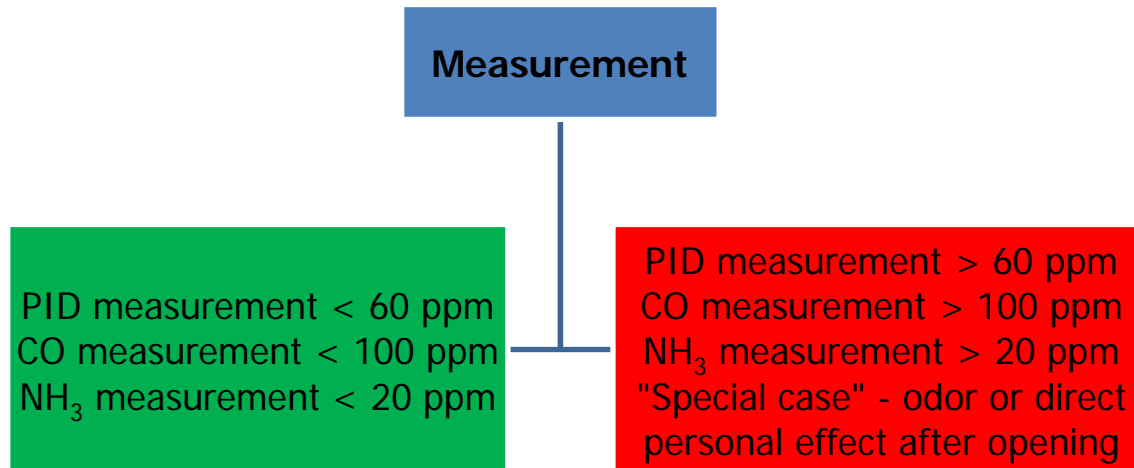
RESULTS

- Seasonable impact on exposure – personal measurements
 - Problem: very difficult to convince warehouse directions to perform personal measurements → number of results is very small
 - Personal measurement receiving before intervention n=6 (range exposure index 0,001 – 0,287) – Lognormal parametric statistics 95% 1,19 → according to EN 689 – red situation
 - Personal measurement background before intervention n=18 (range exposure index 0,001 – 0,232) – Lognormal parametric statistics 95% 0,885 → according to EN 689 – orange situation
 - Important to notice is that personal exposure is higher in summer when unloading and higher in winter as for background tasks



RESULTS

- Out of all the results an algorithm has been created to define the SCU process
 - See example below for a specific selected stream



Safe to unload without any action

Not safe to unload – natural ventilation needs to take place for 70 minutes (the average ventilation time in the SCU process was 70 minutes) – after that direct unloading

"Special case" - If there is a special odor or a direct personal effect when opening the container, close the container immediately – selective and non selective measurement needs to be done.



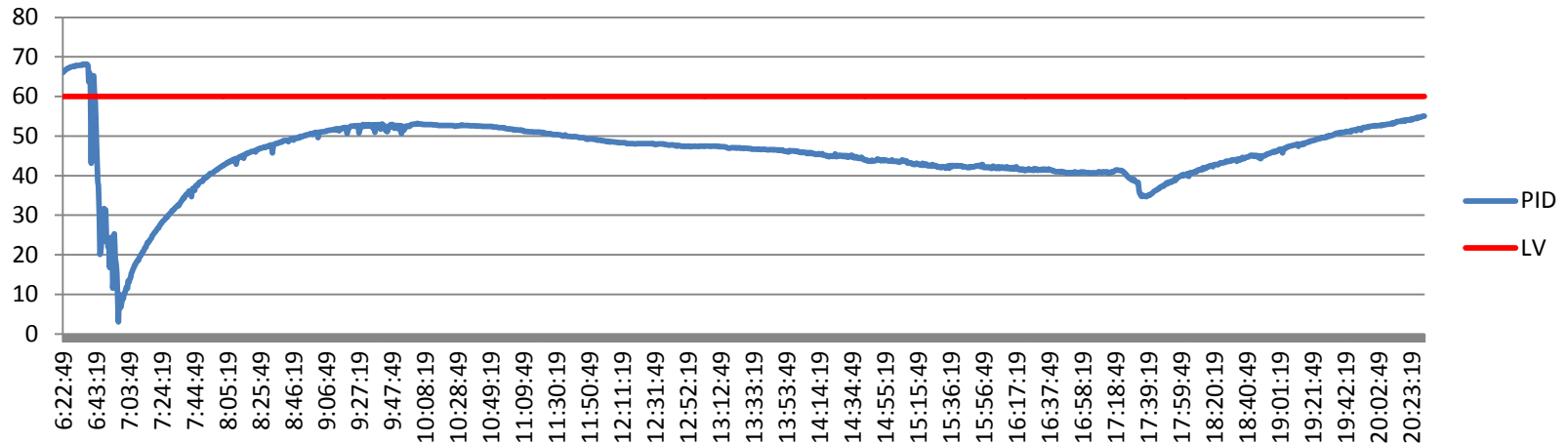
RESULTS

- Based on all the measurements an SCU process is introduced
 - After introducing SCU process personal measurements were more accepted by directions and workers
 - Personal measurement receiving after intervention n=13 (range exposure index < 0,001 – 0,087) – Lognormal parametric statistics 95% 0,169 → according to EN 689 – green situation – exposure drop by factor 7
 - Personal measurement background after intervention n=14 (range exposure index < 0,001 – 0,07) – Lognormal parametric statistics 95% 0,109 → according to EN 689 – green situation – exposure drop by factor 8
 - No difference in personal exposure in summer and winter



RESULTS

- Reason why natural ventilation works



- Direct huge concentration drop when doors are opened
- Offgassing of material is still going on but stays lower than the established limit value



CONCLUSION

- Warehouse workers are exposed to a complex mixture of volatile substances
- By performing a proper risk assessment this exposure can become negligible
- Natural ventilation with direct unloading is working properly
- Follow up can be done by direct reading instruments



DISCUSSION

- Next project is root cause analysis → upstream risk assessment
 - Better knowledge of the chemicals used in the production processes
 - Identify a solution preventing to send high VOC content containers to the downstream chain
 - Programs to prevent workers exposure at upstream side



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- Direct huge concentration drop when door is opened

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Thank you for your attention



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