BELGIAN CENTER
FOR OCCUPATIONAL HYGIENE

Safe Container unloading procedures, an obligation or not important?

Introduction on how to perform risk assessment on inbound cargo – upstream approach – root cause analysis

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INTRODUCTION

- Cf. Session last year
- Downstream risk assessment is possible
- Follow up by selective and nonselective measurements is feasible

→ Not really possible to solve the problem

GOALS

ROOT CAUSE ANALYSIS

1. Which chemicals of concern are present in different parts of the produced goods
2. Identify the high risk chemicals compared with downstream measurements
3. Define action items to reduce or eliminate VOC content in products

PREDECTIVE ANALYTICS

1. Correlate Upstream & Downstream nonselective and -selective measurement Results
2. Set up an upstream limit value → decision chart if cargo can leave the factory

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Root Cause Analysis Procedure

Factory Visit

- Selection of shipped product
- Sampling on Finished Product, Material and Chemical Usage

Lab Testing

- Product Non-selective PID Measurement with Chamber Aging
- Product Selective Measurement with Chamber Aging
- Materials & Chemicals Selective Measurement by Solvent Extraction

Identify Root Causes & Follow Up Actions

- Identify Root Causes of Concerned VOCs
- Define Action Items to Reduce or Eliminate Concerned VOCs Content in Products

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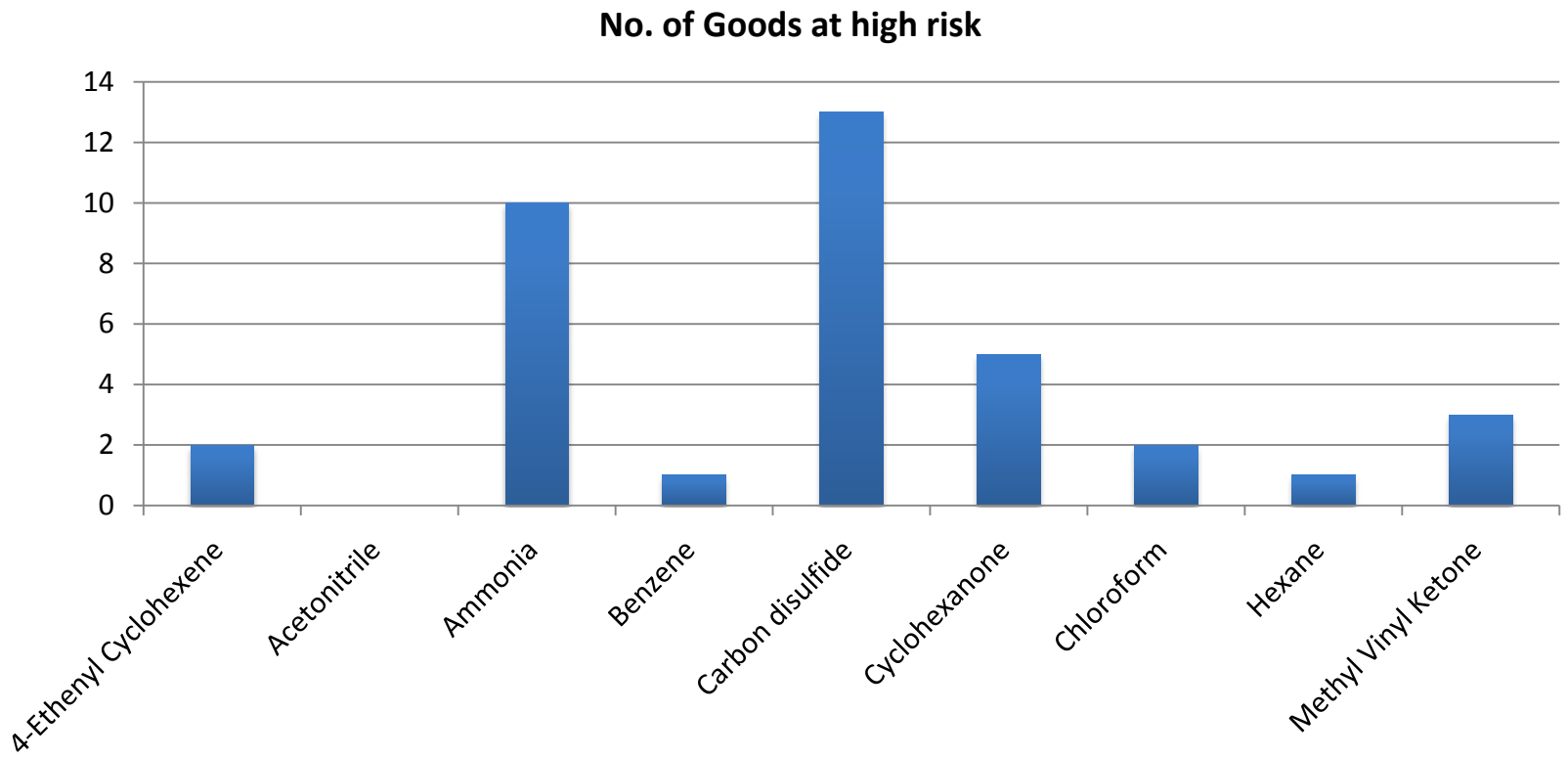
Root Cause Analysis – Upstream Statistics

Concerned VOCs	Range (mg/m^3)	No. of Goods at high risk
4-Ethenyl Cyclohexene	0.3864 – 2.7517	2
Acetonitrile	0.282 – 3.61	0
Ammonia	22.83 - 1167	10
Benzene	0.8050	1
Carbon disulfide	1.71 – 23.285	13
Cyclohexanone	11.98 – 30.65	5
Chloroform	7.73 – 18.28	2
Hexane	18.68	1
Methyl Vinyl Ketone	0.15 - 1.68	3

Root Cause Analysis – Upstream Statistics



Root Cause Analysis – components

Components / Chemicals	Identified Concerned VOCs	Concentration (mg/kg)
Component 1	Carbon Disulfide 4-Ethenyl Cyclohexene	5.91 – 35.5 0.88 – 1.01
Component 2	Carbon Disulfide	2.52
Component 3	Chloroform	303 - 1457
Solvent 1	Cyclohexanone	513
Solvent 2	Cyclohexanone	Declared to contain cyclohexanone
Component 4	Ammonia	15 – 112
Component 5	Ammonia	4.91 – 82.5

Upstream & Downstream Predictive Analytics

Upstream Lab Testing

- Product Non-selective PID Measurement with Chamber Aging
- Product Selective Measurement with Chamber Aging

Downstream Container Testing

- Container Non-selective PID Measurement
- Container Selective Measurement

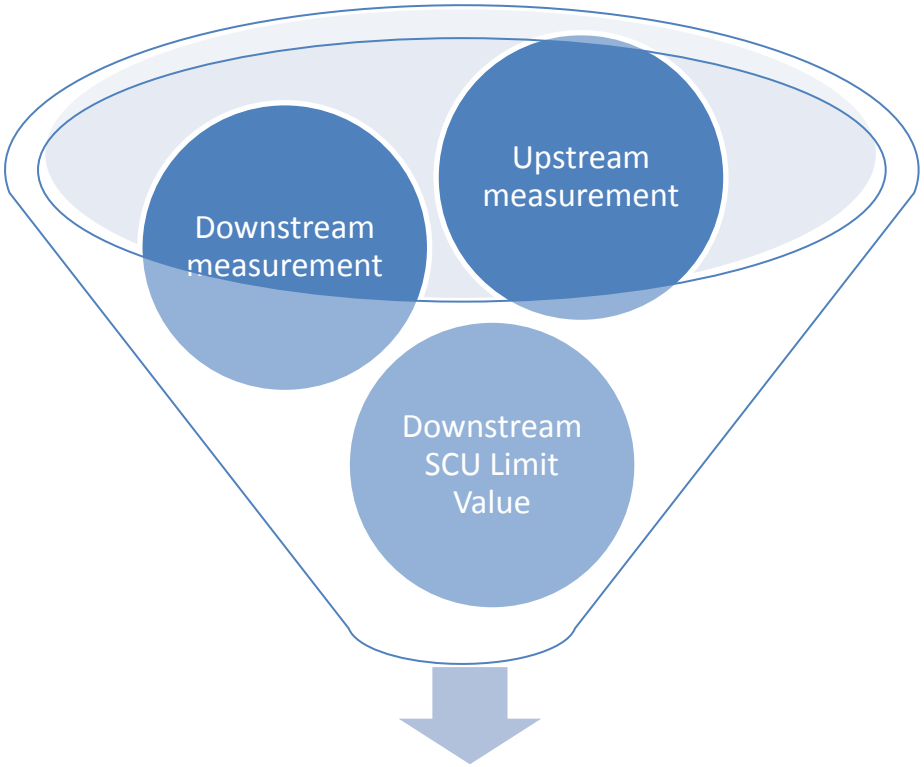
Set Up Factory Upstream Limit Value

- Correlate Upstream & Downstream PID and Selective Measurement Results
- Set Up Upstream Factory Limit Value by Downstream Safe Container Unloading (SCU) Limit Value using Predictive Formula

Upstream & Downstream Testing Results

Concerned VOCs	Cas No.	Downstream Container LV (mg/m3)	Upstream Chamber Results, Concentration (mg/m3)	Downstream Container Results, Concentration (mg/m3)
4-Ethenyl cyclohexene	100-40-3	0.45	0.043	ND
Acetonitrile	75-05-8	34.00	ND	ND
Ammonia	7664-41-7	14.00	ND	ND
Benzene	71-43-2	3.25	0.037	ND
CS2	75-15-0	3.16	ND	ND
Cyclohexanone	108-94-1	40.80	**15.7**	**11.4**
Hexane	110-54-3	72.00	0.683	0.015
Methyl vinyl ketone	78-94-4	0.58	ND	ND
Trichloromethane	67-66-3	10.00	0.205	ND
PID Results			**TVOC: 40**	**TVOC: 0.9**

Predictive analytics

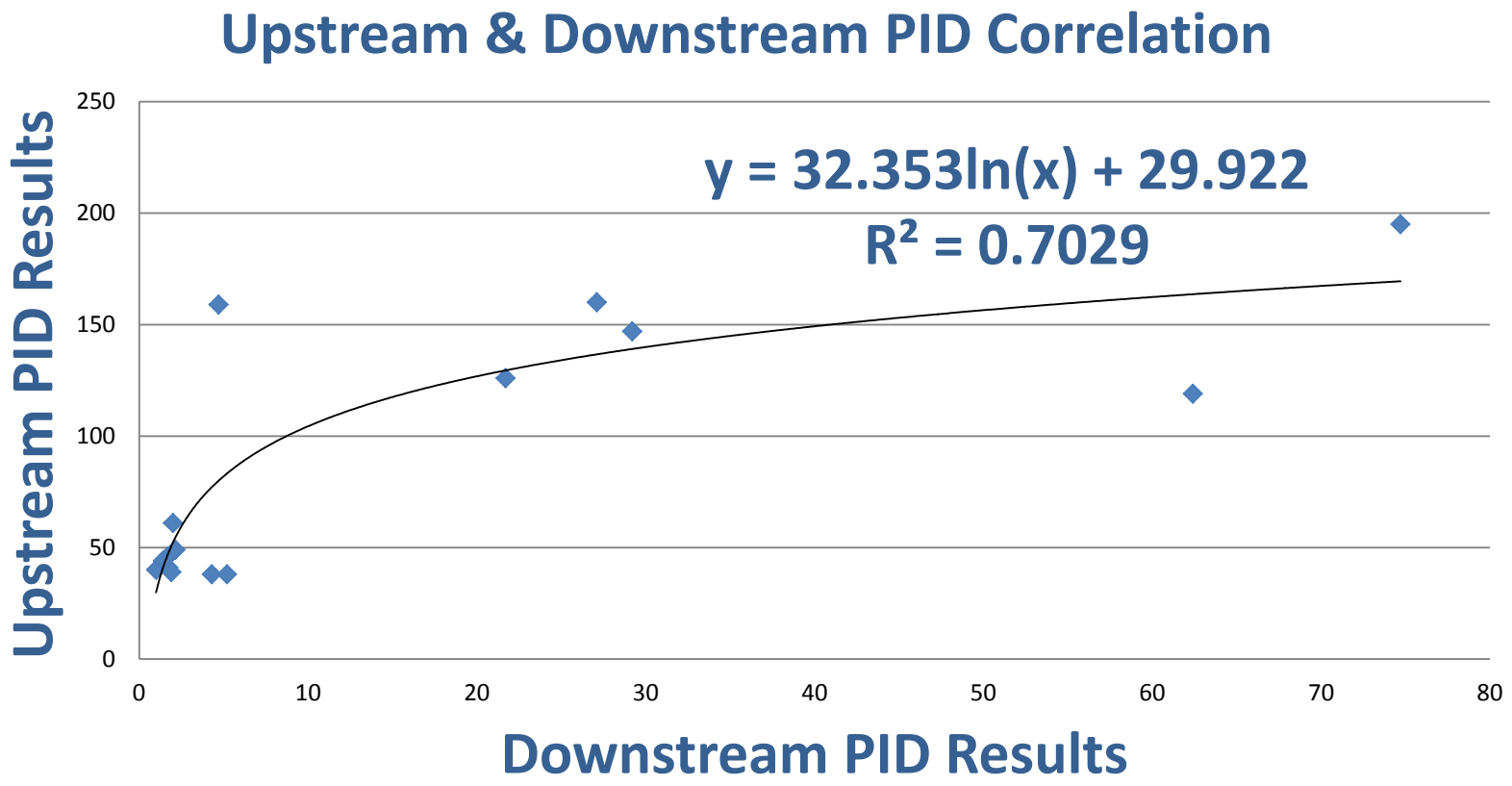


Upstream – Downstream predective analytics

Upstream PRODUCT PID limit value

Predictive analytics

- Formula – algorithm to set SITE/PRODUCT limit value

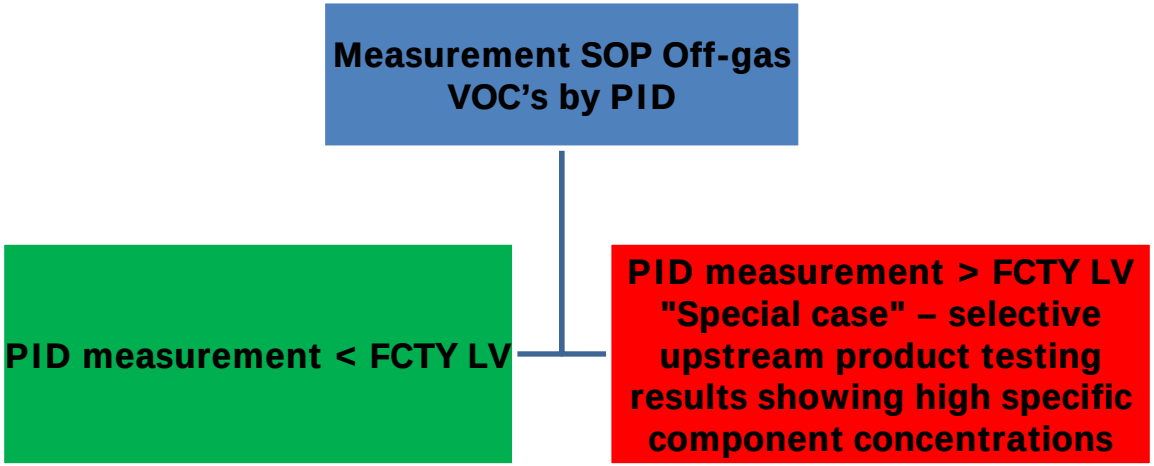


Predictive analytics

- Formula – algorithm to set SITE/PRODUCT limit value

  Upstream PID LV = 32,353ln(Downstream PID LV) + 29,922

- A clear procedure



Safe for shipment

Not safe for shipment – actions required

Predictive analytics – results (1)

PRODUCT	Downstream PID Limit value (ppm)	Measured PID	Conclusion	Upstream PID Limit value (ppm)	Measured PID	Conclusion
1	43,3	5,2		151,8	38	
2	23,0	1,4		131,6	49	
3	23,0	1,4		131,6	44	
4	23,0	1,9		131,6	39	
5	6,8	1,73		91,9	41	
6	6,8	1,1		91,9	40	
7	24,8	2,00		134,0	61	
8	39,8	21,7		149,0	126	

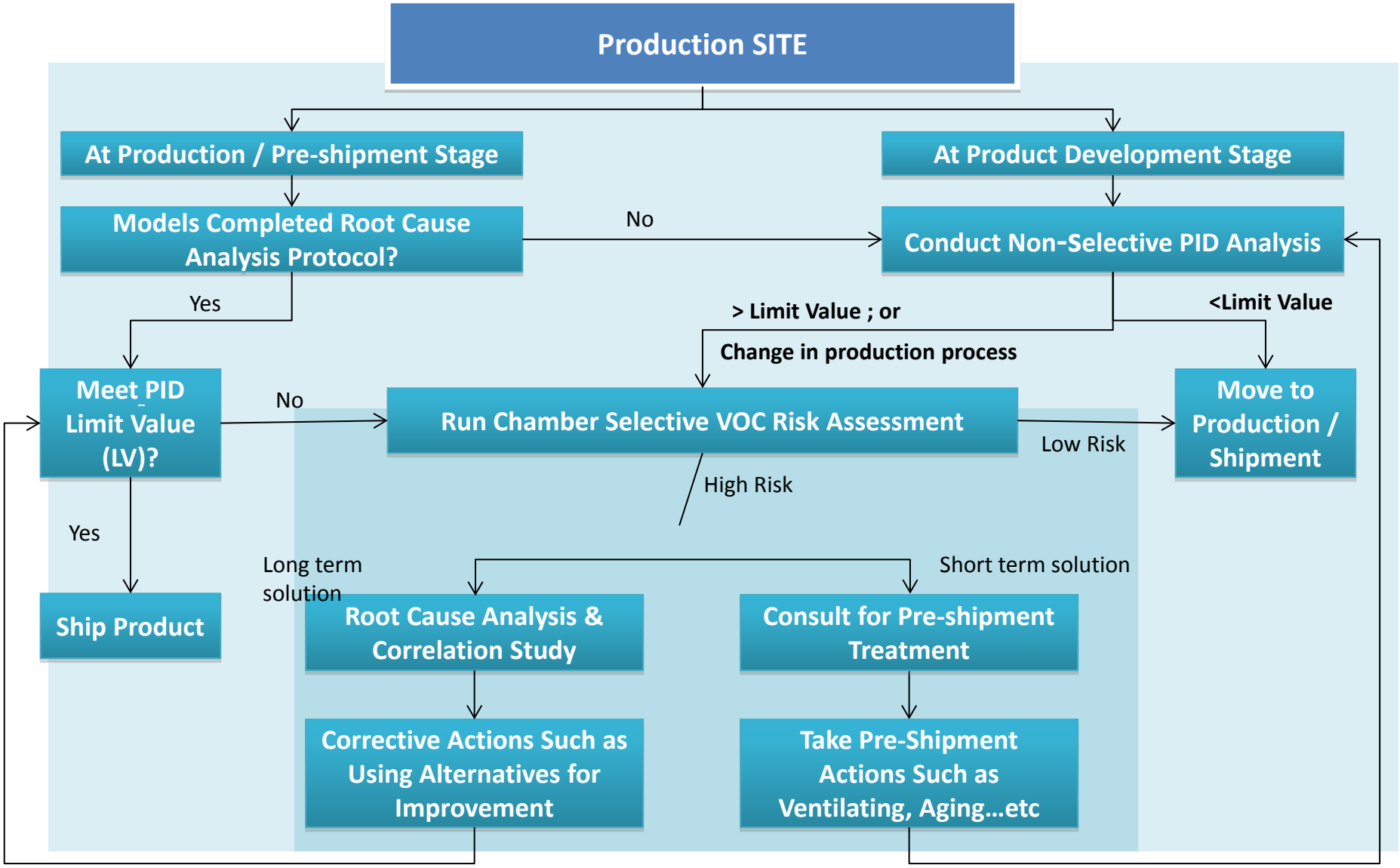
Predictive analytics – results (2)

FCTY/ STYLE	Down-stream PID Limit value (ppm)	Measured PID	Conclusion	Upstream PID Limit value (ppm)	Measured PID	Conclusion
9	84,5	29,2		173,0	147	
10	84,5	62,4		173,0	119	
11	17,3	27,1		122,0	160,0	
12	17,3	4,7		122,0	159,0	
13	22,7	1,7		131,0	46,0	
14	22,7	4,3		131,0	38,0	
15	39,8	74,7		149,0	195,0	

False positive → conservative

CONCLUSION

- Root cause analysis can identify chemicals of concern → replacement advice can be given at R&D level → workers exposure at production site will decrease
- Predictive analytics can provide clear upstream limit values and can be used prior to shipment → less problems at unloading site


Production SITE
At Production / Pre-shipment Stage
At Product Development Stage
Models Completed Root Cause Analysis Protocol?
No
Conduct Non-Selective PID Analysis
Yes
> Limit Value ; or
Change in production process
<Limit Value
Meet PID Limit Value (LV)?
No
Run Chamber Selective VOC Risk Assessment
Move to Production / Shipment
Low Risk
High Risk
Yes
Long term solution
Short term solution
Ship Product
Root Cause Analysis & Correlation Study
Consult for Pre-shipment Treatment
Corrective Actions Such as Using Alternatives for Improvement
Take Pre-Shipment Actions Such as Ventilating, Aging…etc

DISCUSION & NEXT STEPS

- Information necessary to improve the predictive analytics:
  - Product chamber test results
  - Downstream related product results
- Changes of chemicals/products used need to be identified in the development stage NOT in the production stage.
- Information needed from the production sites:
  - Dates and shipment detail of upstream tested products
  - Communicate results of the upstream measurement results

DISCUSION & NEXT STEPS

- Information needed from the suppliers
  - Technical and Safety data sheet to perform a modelled SCU risk assessment → conclusion: good for improvement or not good enough as an improvement
- What are the production sites receiving
  - Updated limit values for container air prior to shipment
  - Updated Risk Assessment files

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Thank you for your attention

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