Are labelling schemes effective?

Target values for indoor air concentrations ($\mu g/m^3$) given by The Finnish Classification for Indoor Air Climate

CLASS	S1	S2	S3
TVOC (volatile organic comp.):	200	300	600
Ammonia	30	30	40
Formaldehyde	30	50	100

S1 = “individual IAQ”
S2 = “good IAQ”
S3=“satisfactory IAQ”

Requirements for Emission Class M1

- TVOC < 0,2 mg/m²h
- H_2CO < 0,05 mg/m²h
- NH_3 < 0,03 mg/m²h
- Carcinogenic compounds < 0,005 mg/m²h
- Dissatisfaction with odour ≤10 %
- Plasters and tiling products, levelling agents, putty, mastics, fillers, screeds and renders shall not contain casein.

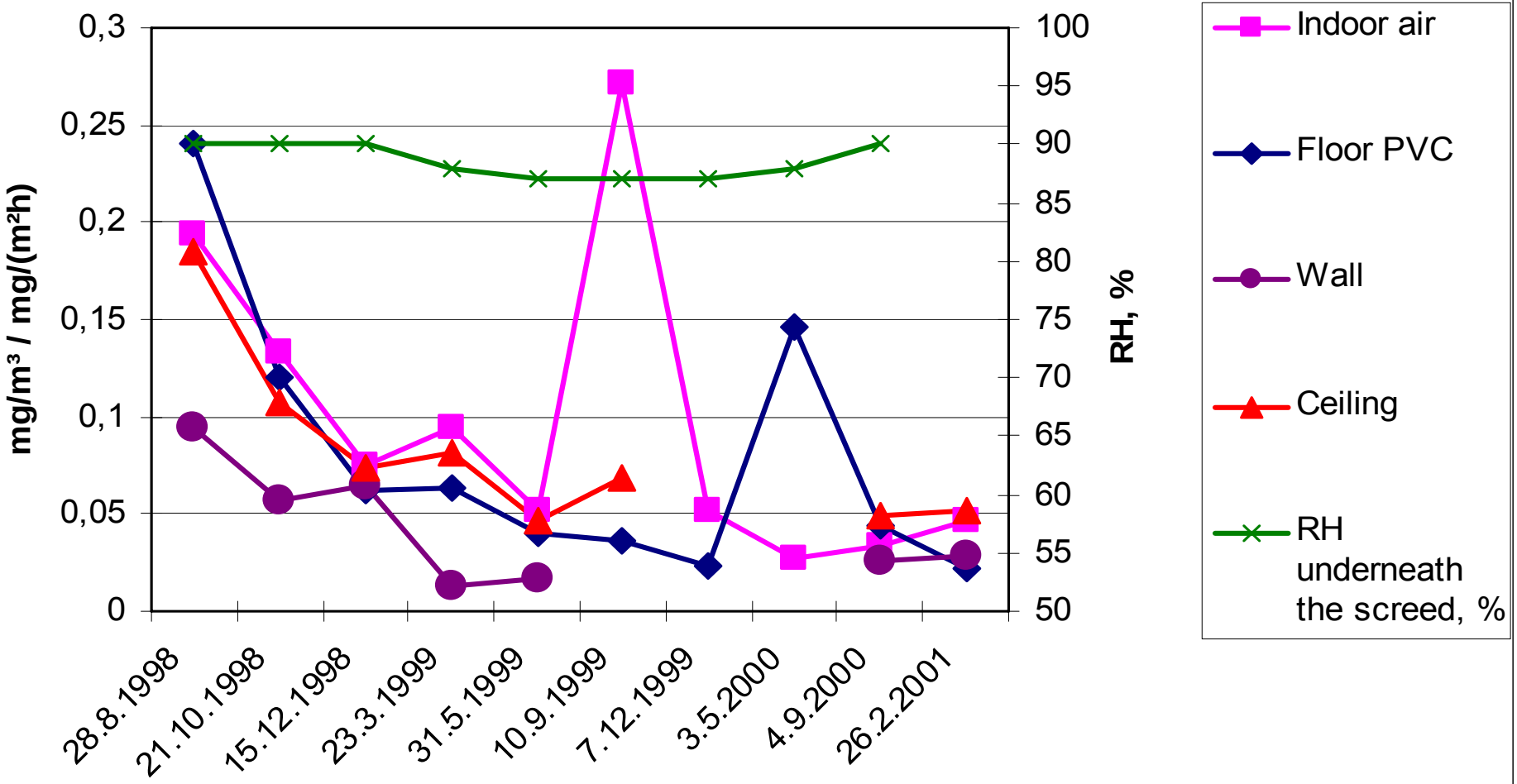
How do the labelled materials perform in real buildings?

Tekes Healthy Building research program:

- Allergy and astma association office building

- Residential buildings

EXAMPLE



Conclusions from the office building

-The emission of the installed flooring material was
in the beginning higher
from both cored concrete slab and structures cast on site than that of single materials
measured in chamber

and

the emission reached again the classification value at the age of
21 weeks, which corresponds to the age of 8 weeks of the
completed building

As a whole this study supports
the estimates, that using M1
class materials S1-class IAQ can be obtained in office buildings. The air quality
has been considered good also
by the occupants.

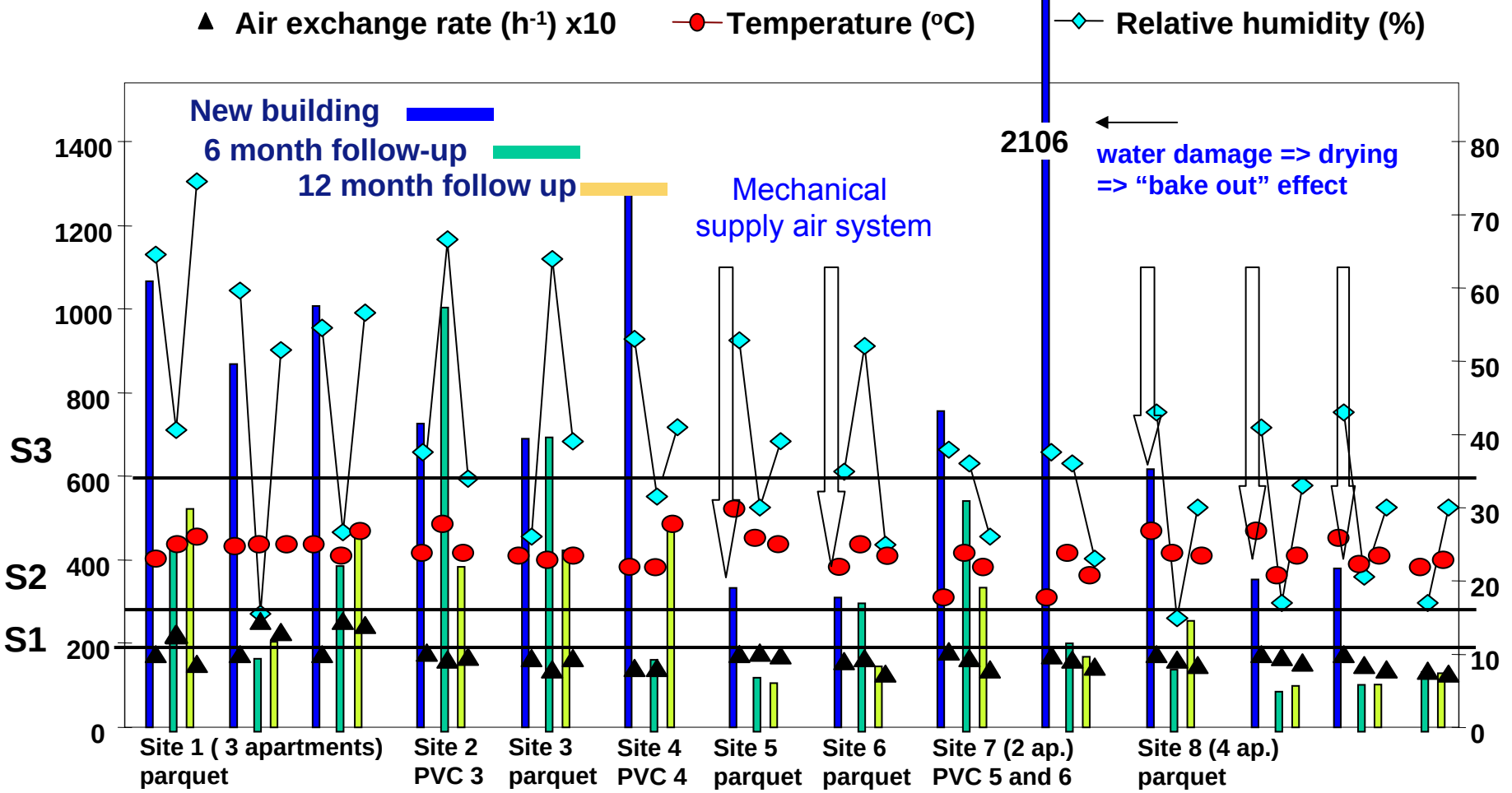
RESEARCH OBJECTIVE "Residential buildings"

- This study investigated how the limits of indoor air concentrations defined in “The Finnish Classification for Indoor Air Climate 2000” (FiSIAQ) can be reached in new residential buildings, which are built with today`s normal building practice, including humidity control of structures, and in which low emitting, classified materials are used.
- In the latter study the objective was to create *reference data* for indoor air quality for newly finished buildings.
- The data collected could be used as a part of the quality control in today´s building practice and in the identification of material/moisture-based problems in suspected cases.

MEASUREMENT SITES of the residential buildings

- 8 Residential buildings (7 in the city of Helsinki, 1 in the city of Turku), built during the years 1999-2001
- The building structure was built on site, concrete was cast or premanufactured, cored concrete slab
- The floor covering material was parquet (type 1-6) or PVC (type 1-6)
- The ceiling structure was finished with screed (sprayed on the structure)
- Walls were gypsum or concrete structure, finished with screed and painted/ wall paper (site 4)

TVOC concentration and external conditions



TVOC conclusion of IAQ in newly finished buildings

- In general, the TVOC concentration exceeded the S3- class limit of 600 μg/m^3 (FiSIAQ, 2001) in the newly finished residential buildings.
- The parameter that by most affected the TVOC concentration in the newly finished building was the **type of ventilation**: The lowest TVOC concentrations of 310- 620 μg/m^3 were measured at the 5 sites, where a **mechanical supply** and exhaust ventilation system was used.
- The TVOC concentration decreased in 6 months to a <200 - 600 mg/m^3 i.e. S1-S3- class level at all sites except at one site, where the concentration of terpenes a-pinene and d-carene increased. The terpenes were concluded to originate from a newly installed wooden furniture.
- Within one year the TVOC concentration reached S1-class in buildings with supply air ventilation

Formaldehyde conclusion

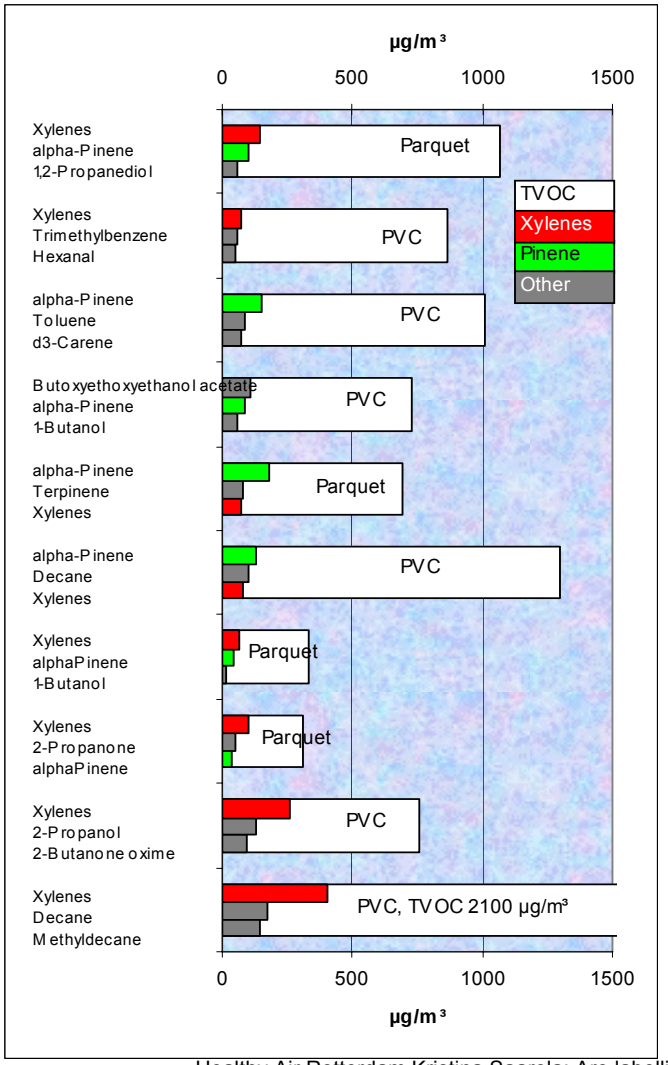
- The indoor air formaldehyde concentration was 13-37 μg/m^3 which correspond to a S1-S2 class in the newly finished buildings.

- Seasonal changes were observed during the follow-up measurements: In general, higher formaldehyde concentrations were measured in summer time when the relative humidity was 50% or higher.

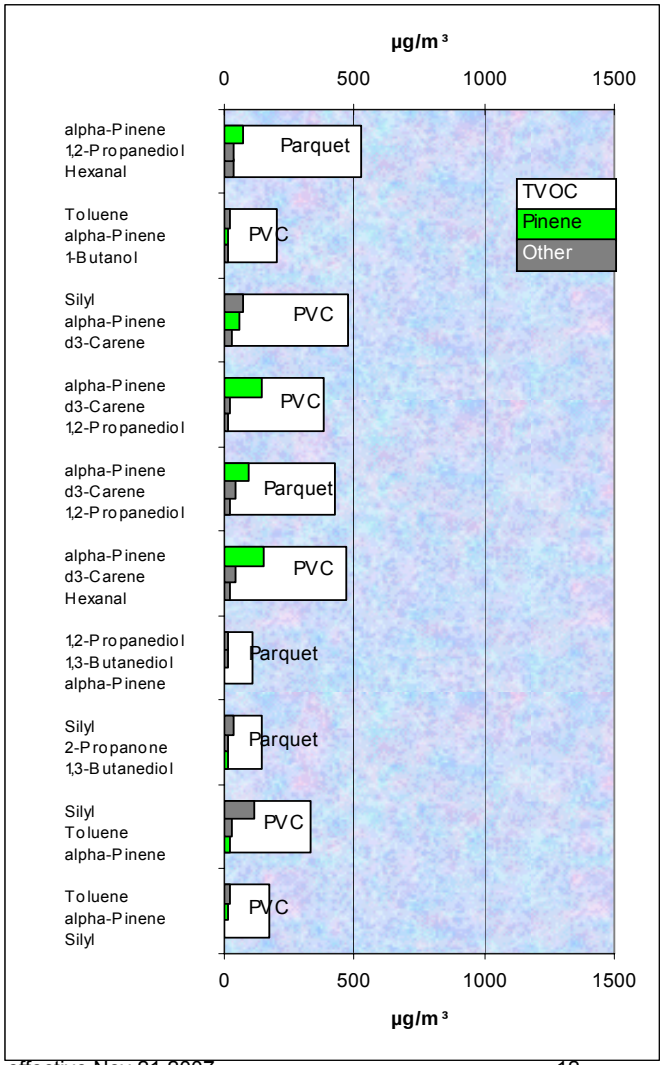
- However, the formaldehyde concentration did not significantly exceed the S2- class level of 50 μg/m^3 during the first year at any measurement site

Example of the most abundant VOCs included in the TVOC-values in the indoor air of new buildings using M1 materials

Age 0 Month

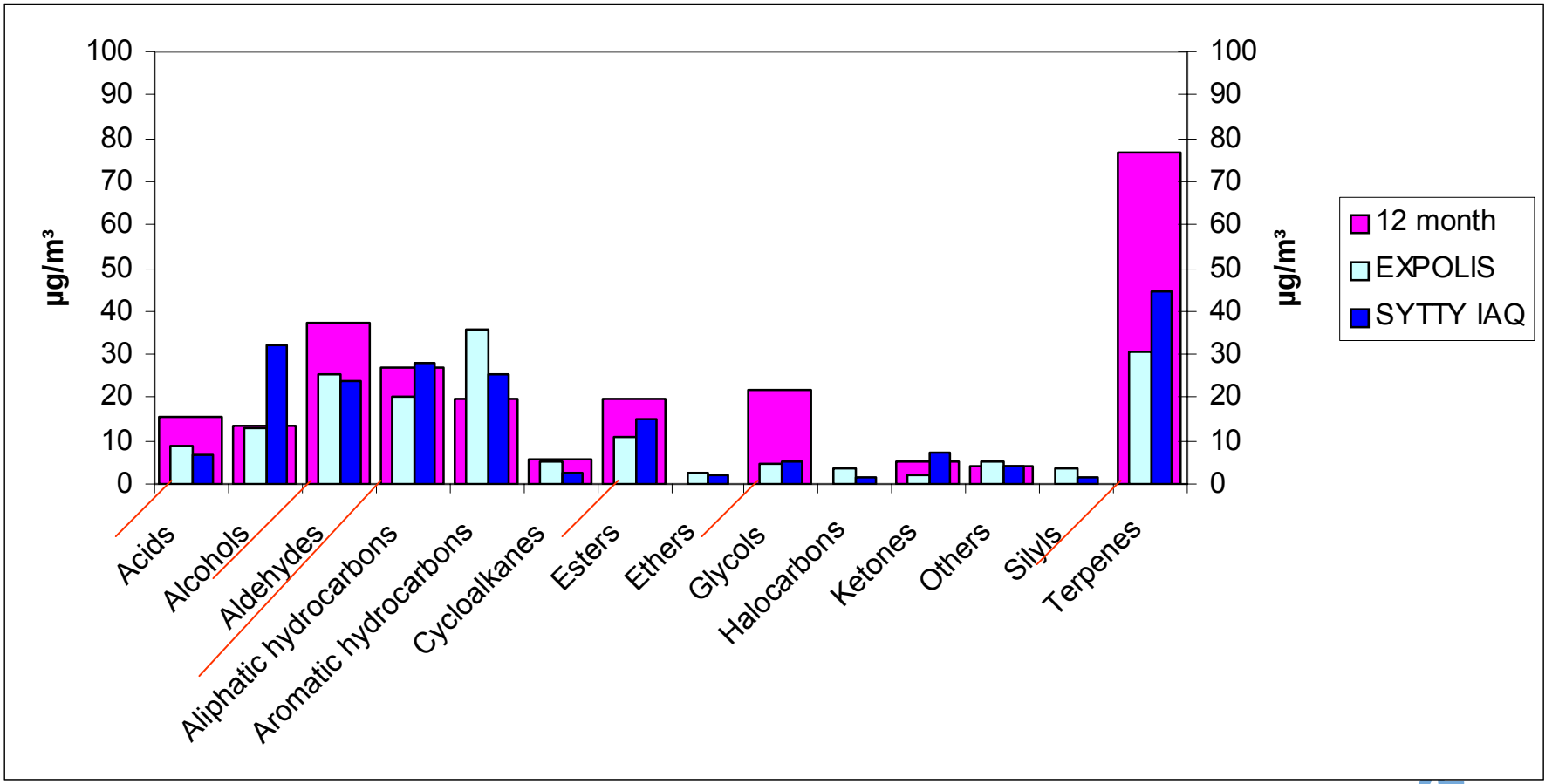


Age 12 Months

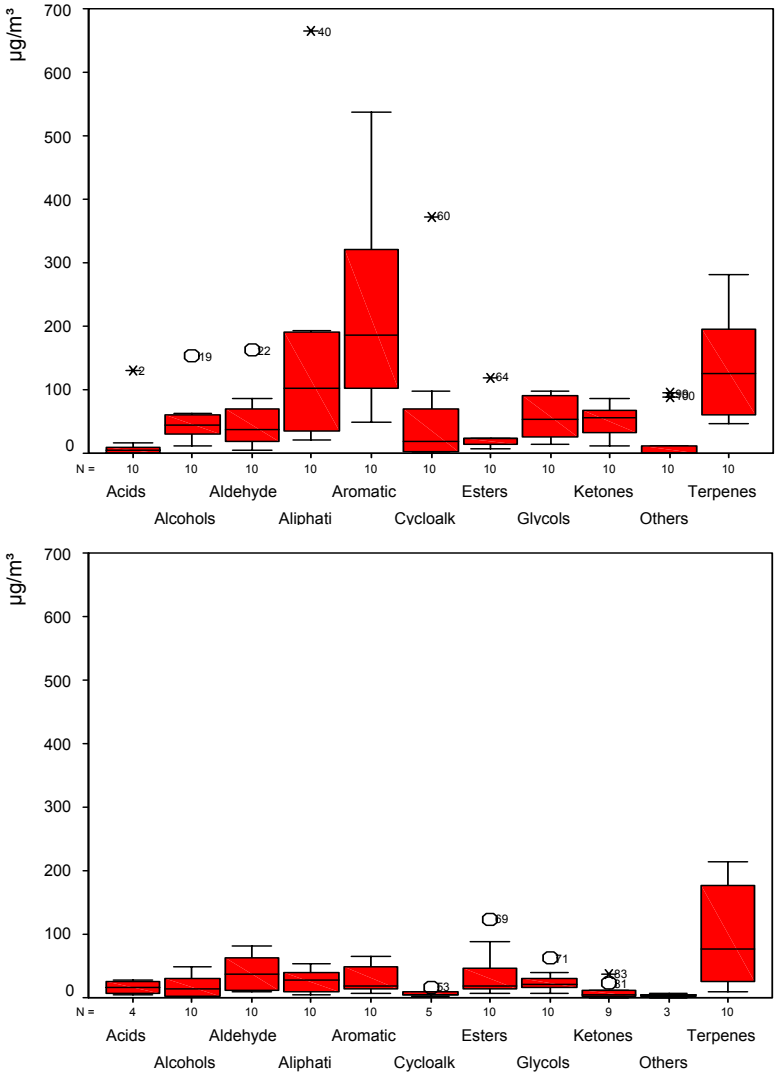


Comparison of chemical compound groups of 12 month old apartments to random choice, old apartmens investigated in the EU Expolis study and a Finnish IAQ study

(http://www.vtt.fi/inf/pdf/publications/2004/P540.pdf).

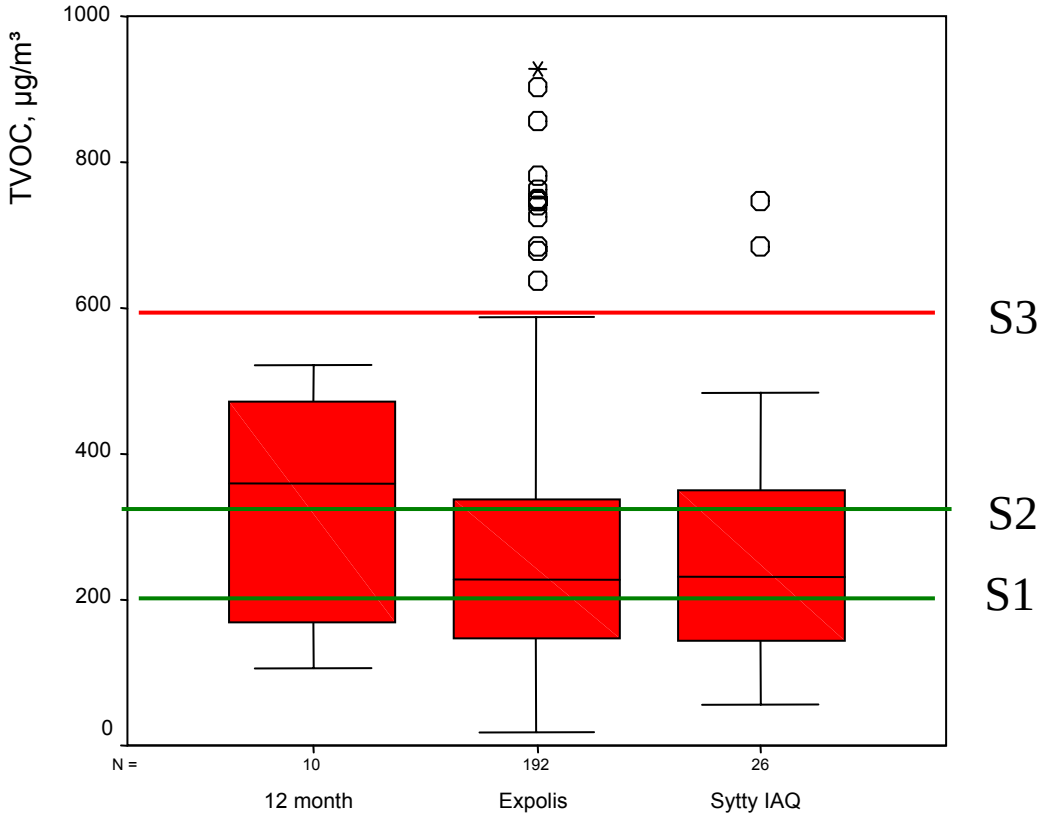


Summary of changes of VOC-groups in the indoor air during the first 12 months



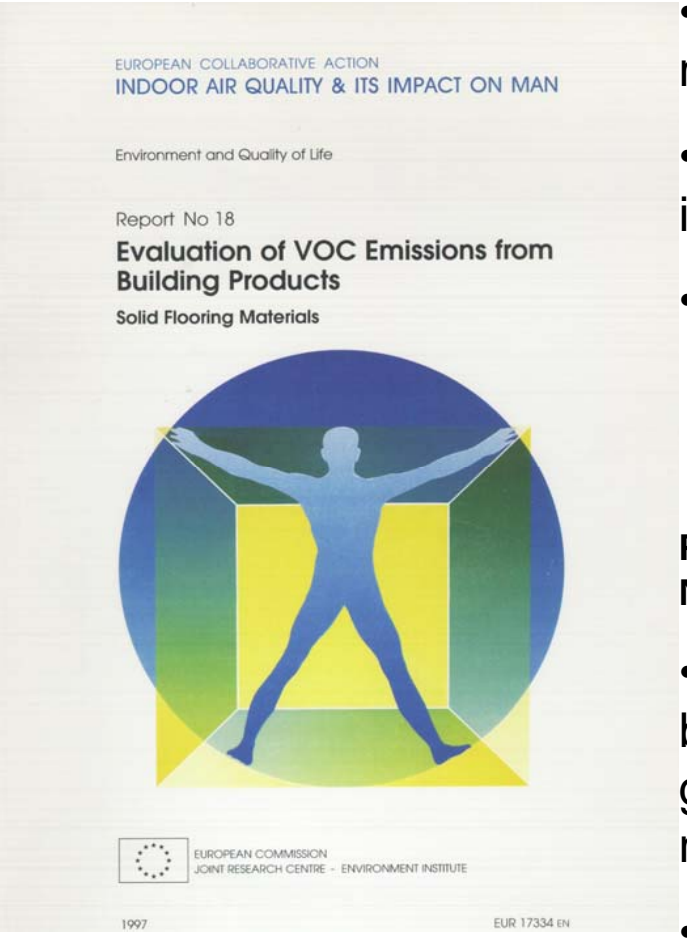
- Within twelve months the median concentrations of aromatic compounds and ketones decayed by 90% and the decay of terpene- median concentration is 39%.
- The concentration of acids rose in half of the apartments and the aldehydes remained in all apartments on the same level as in the beginning.
- The concentration of the rest of the compounds decayed considerably.
- On the other hand new compounds as silyls appear

Indoor air quality variations in new residences compared to the target values Classes S1, S2 and S3 and their comparison to "old" randomly chosen buildings



- The median TVOC-value in 12 month old apartments was of class S2 to S3 on the Finnish Indoor Climate 2000 IAQ-target value scale.
- The TVOC median in the new buildings after 12 months is about 50 % higher than in the old building stock of **Expolis** and **Sytty IAQ-studies** .
- With high TVOC-values there is a risk that in extreme cases a single emitting VOC can give rise to concentrations that exceed the LCI-value.

Calculation and comparison of the risk index calculated from the LCI values



- ECA Report 18 presents a guideline for evaluation of material emissions.
- It is based on using LCI-values (lowest concentration of interest) for chemical compounds emitting from materials.
- From the LCI values a risk index is calculated:

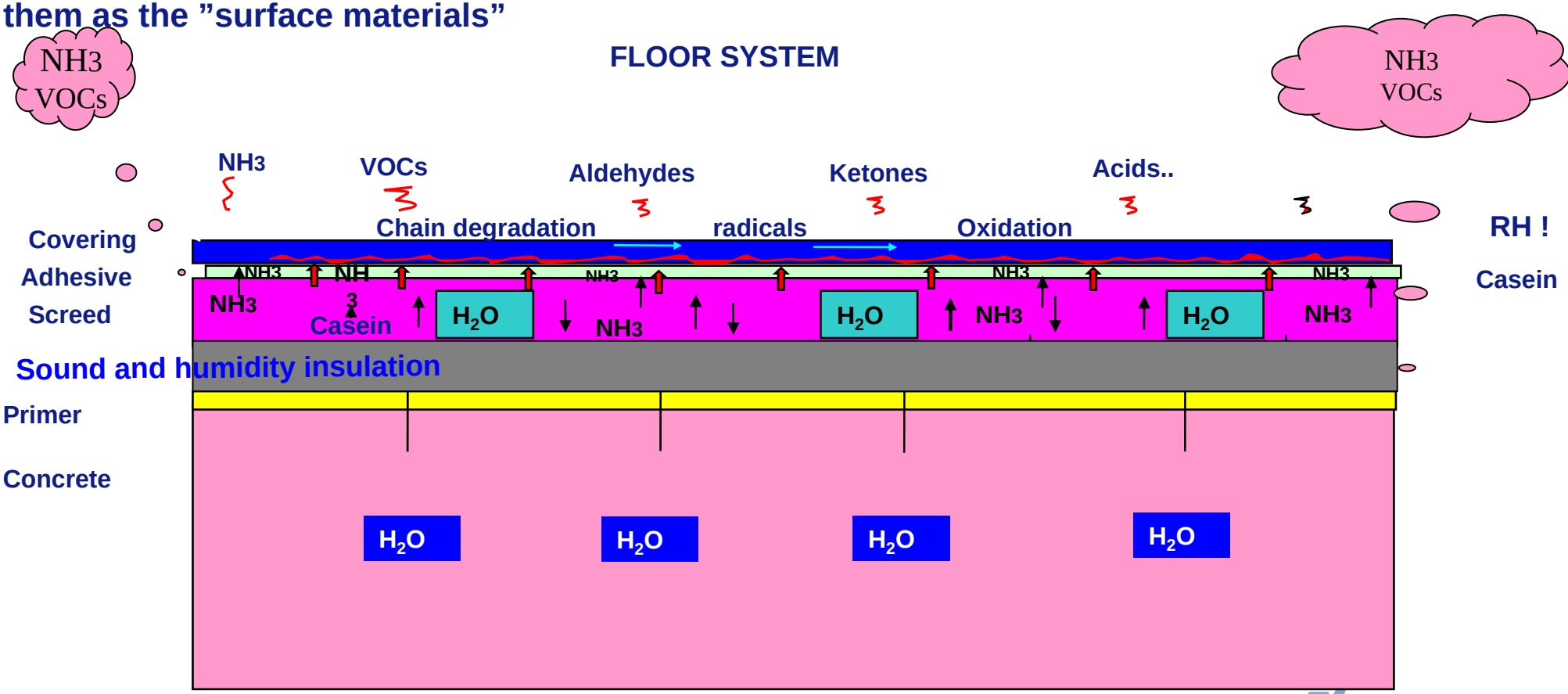
$$R = \sum \frac{c_{i,g}}{LCI_{i,g}}$$

RESULTS OF THE IAQ ATTAINED IN NEW BUILDINGS BUILT USING NORMAL BUILDING PRACTISE AND M1 CLASSIED MATERIALS:

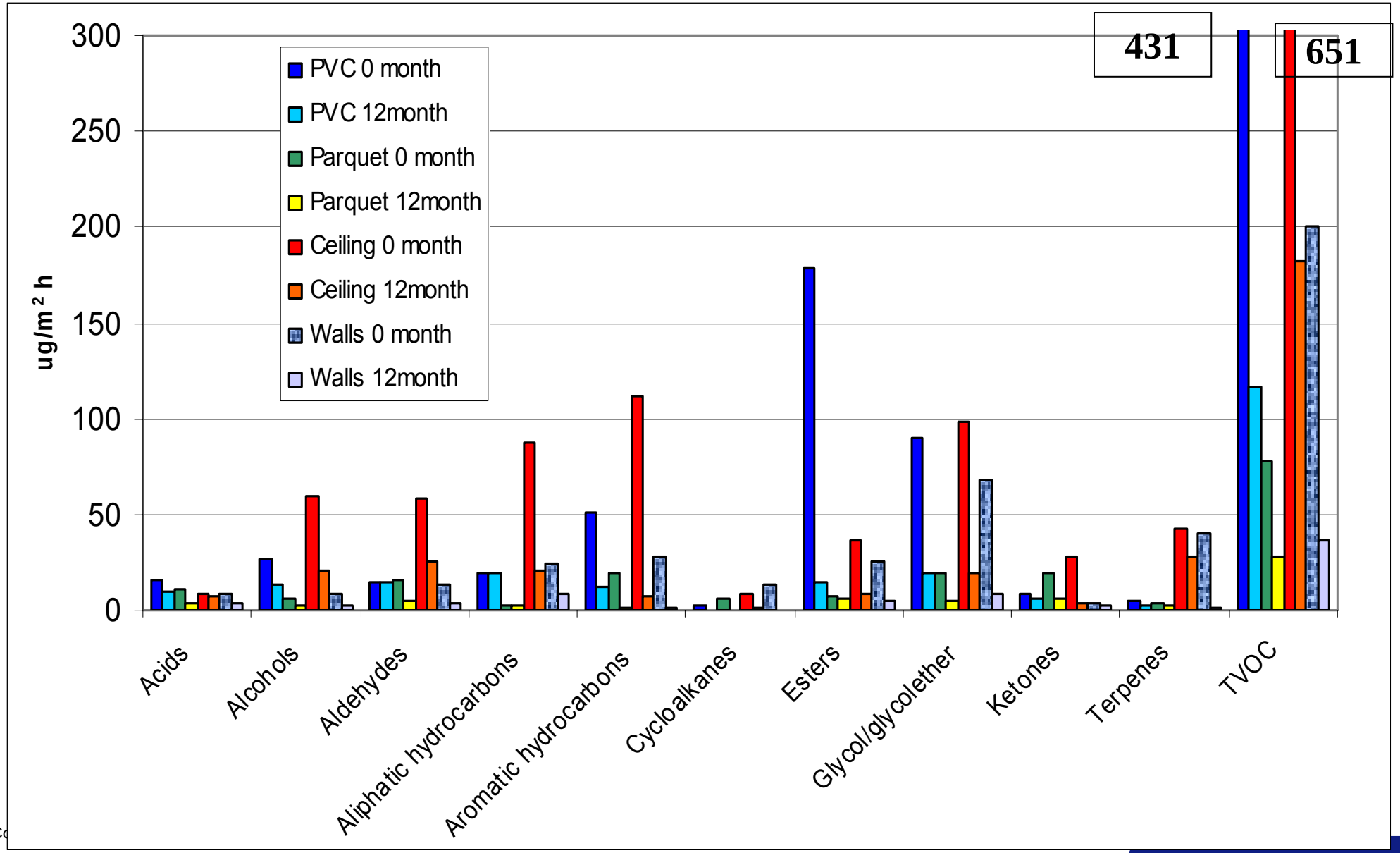
- None of the single chemical group median values in new buildings exceeded the LCI-value used for the respective group, but the R = Σ(group median/LCI) exceeded 1 in the new apartments still after twelve moths of occupancy.
- No material emission related complaints of IAQ were reported in the inhabitant survey

Material emissions from structures

NOTE: In M1 system materials are tested as single building products taken from the production. In buildings several products are used inside of the structures. VTT's experience shows, that emissions from materials even deep inside the structures are transported to indoor air due to diffusion processes and leakages and subsequently we test and evaluate them as the "surface materials"



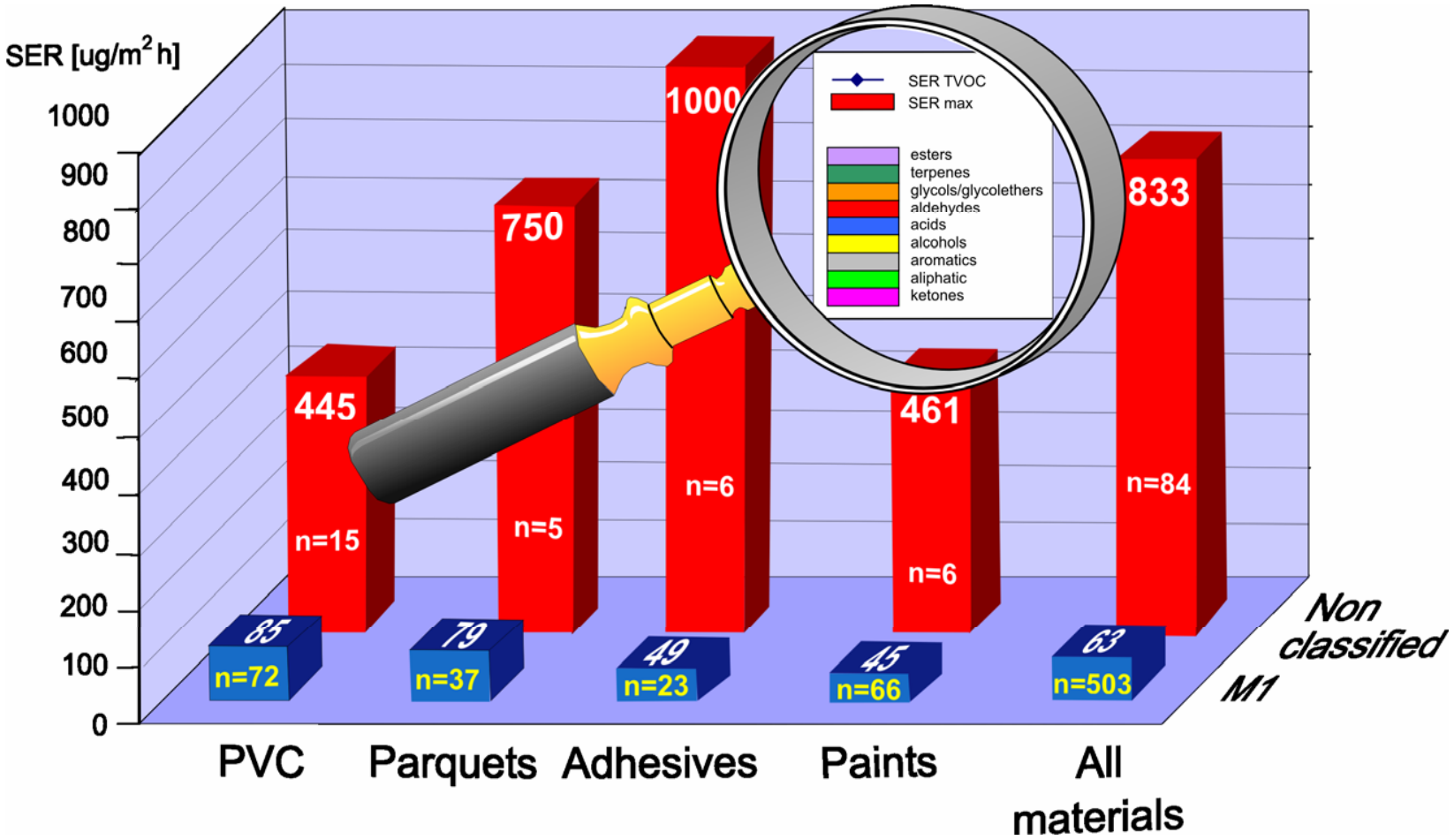
VOC emission from the surfaces of structures in residential buildings



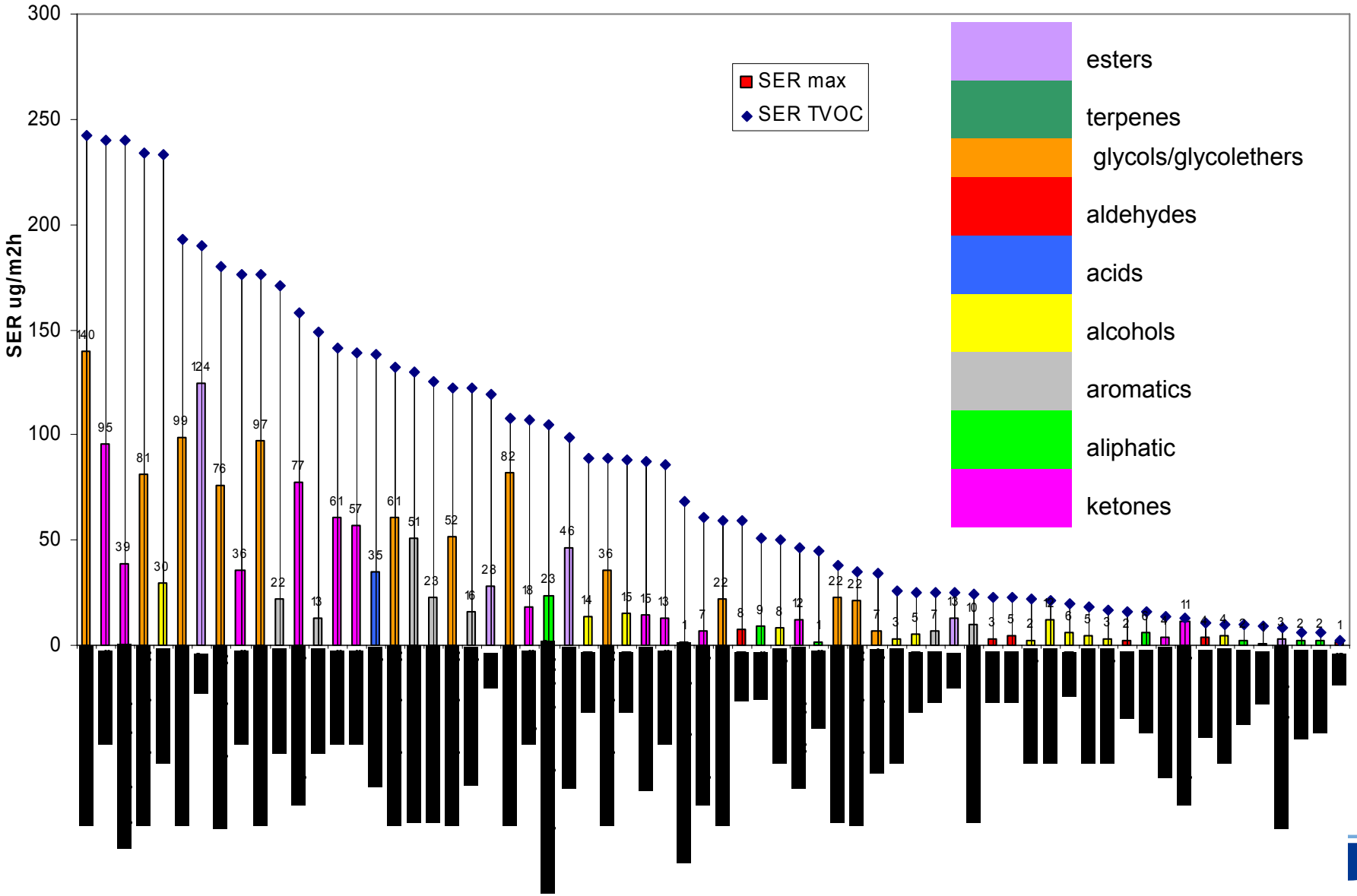
Emission from single materials

- Material emissions have decreased significanty after implementation of labeling systems
- Examples from VTT:s material emission database of materials before and after implementing the M1 classification system:

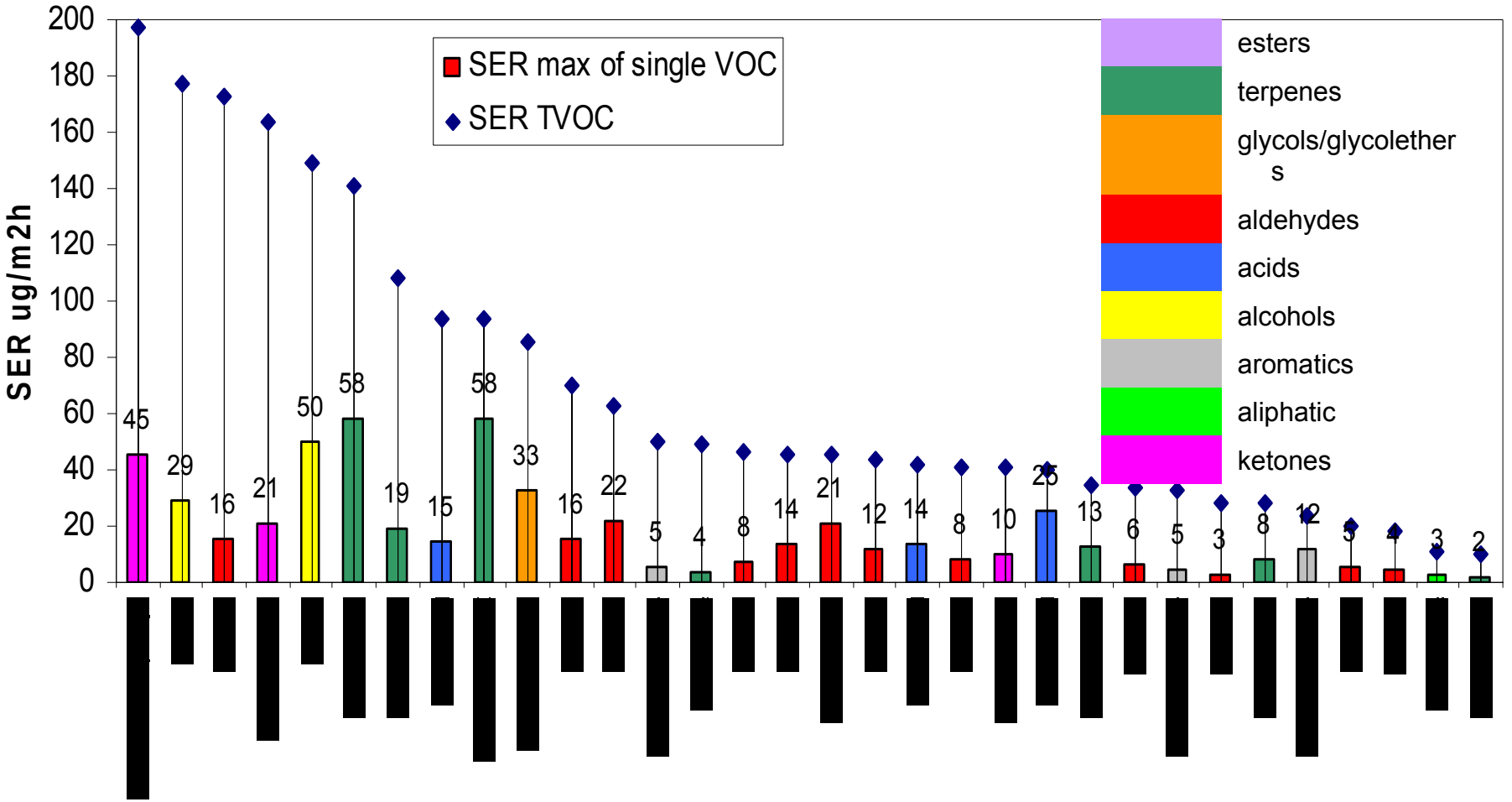
TVOC emission from M1 materials compared to conventional materials before the classification



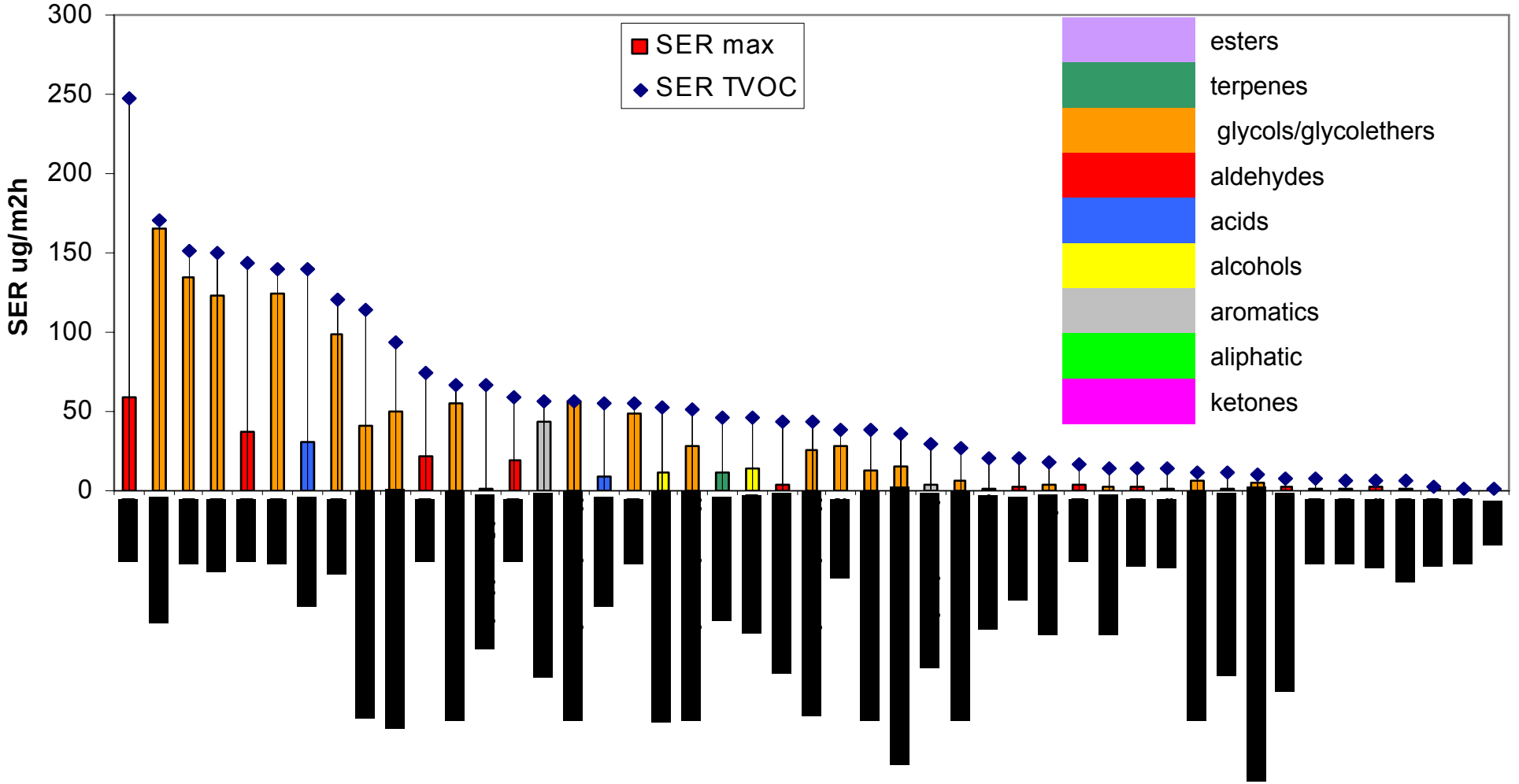
TVOC value and its highest single VOC emission of 65 PVC flooring materials



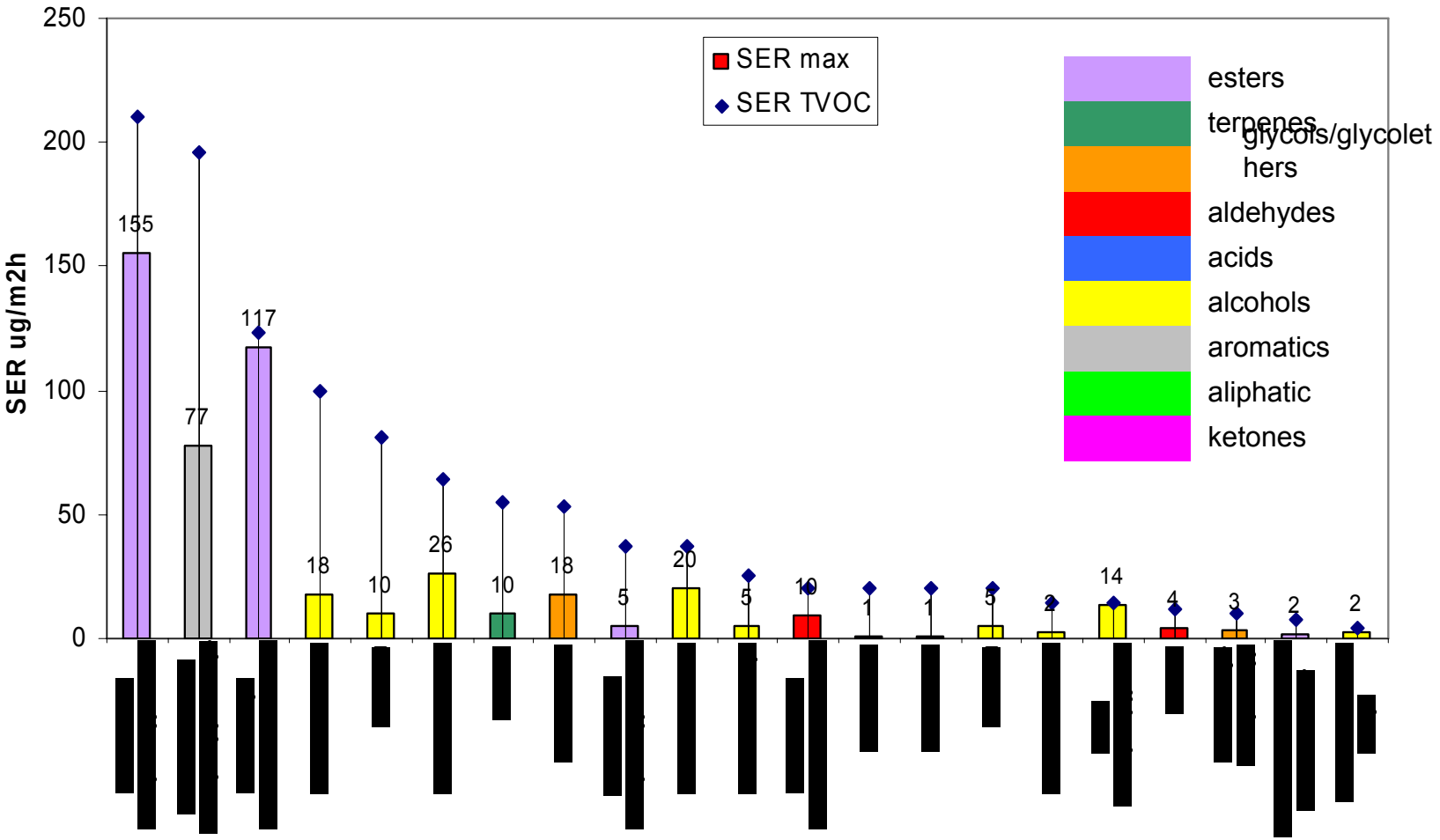
TVOC value and its highest single VOC emission of 32 parquets



TVOC value of 46 paints and the highest single VOC of each



TVOC emission from 21 adhesives and the highest VOC- emission of each

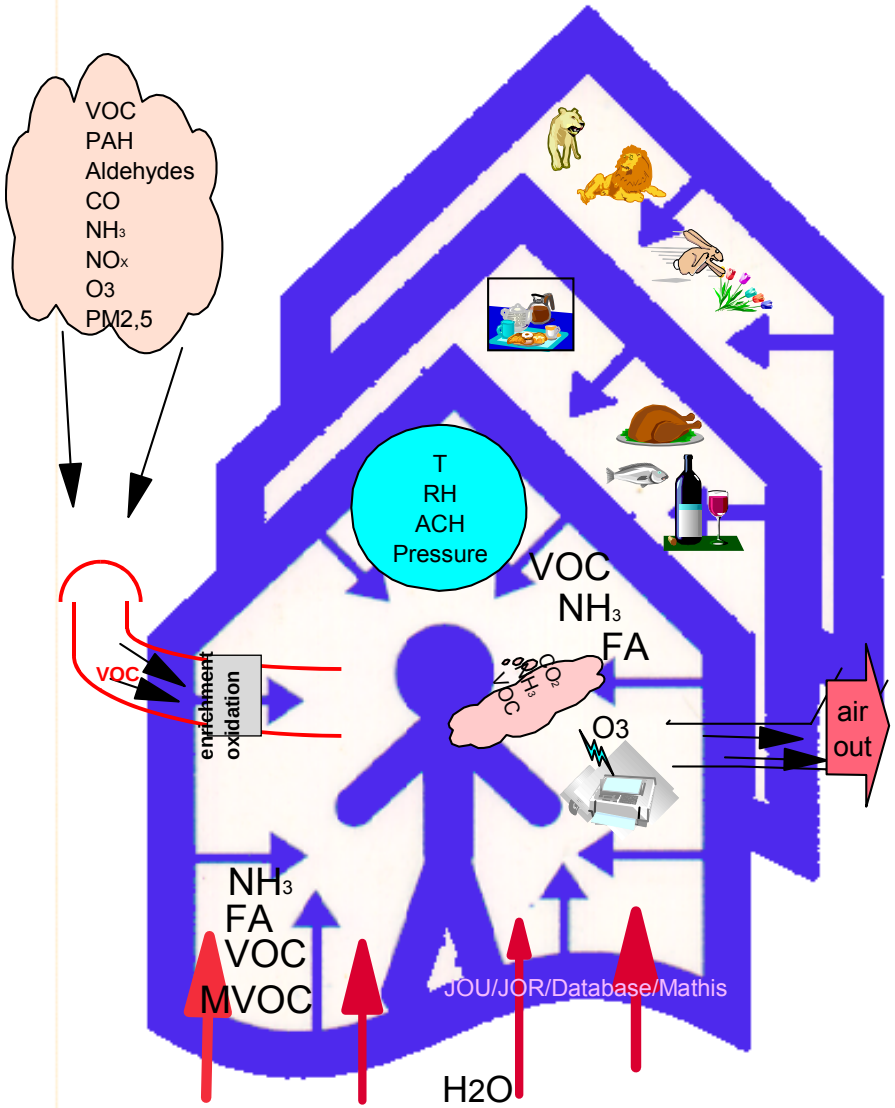


Conclusions regarding material emissions from stucture surfaces compared to single materials emissions and the attained indoor air quality in new buildings

- Emission from the surface materials installed on structures is for months higher than the emissions from sigle materials measured in chambers.
- However, S1 Indoor air quality is reached in offices and residences equipped with supply air ventilation within a couple of months.
- It is evident that the labelling systems have improved the indoor air quality by reducing emissions building products.
- The use of low emitting materials is especially advantageos for IAQ in residential buildings with less effective ventilation system.

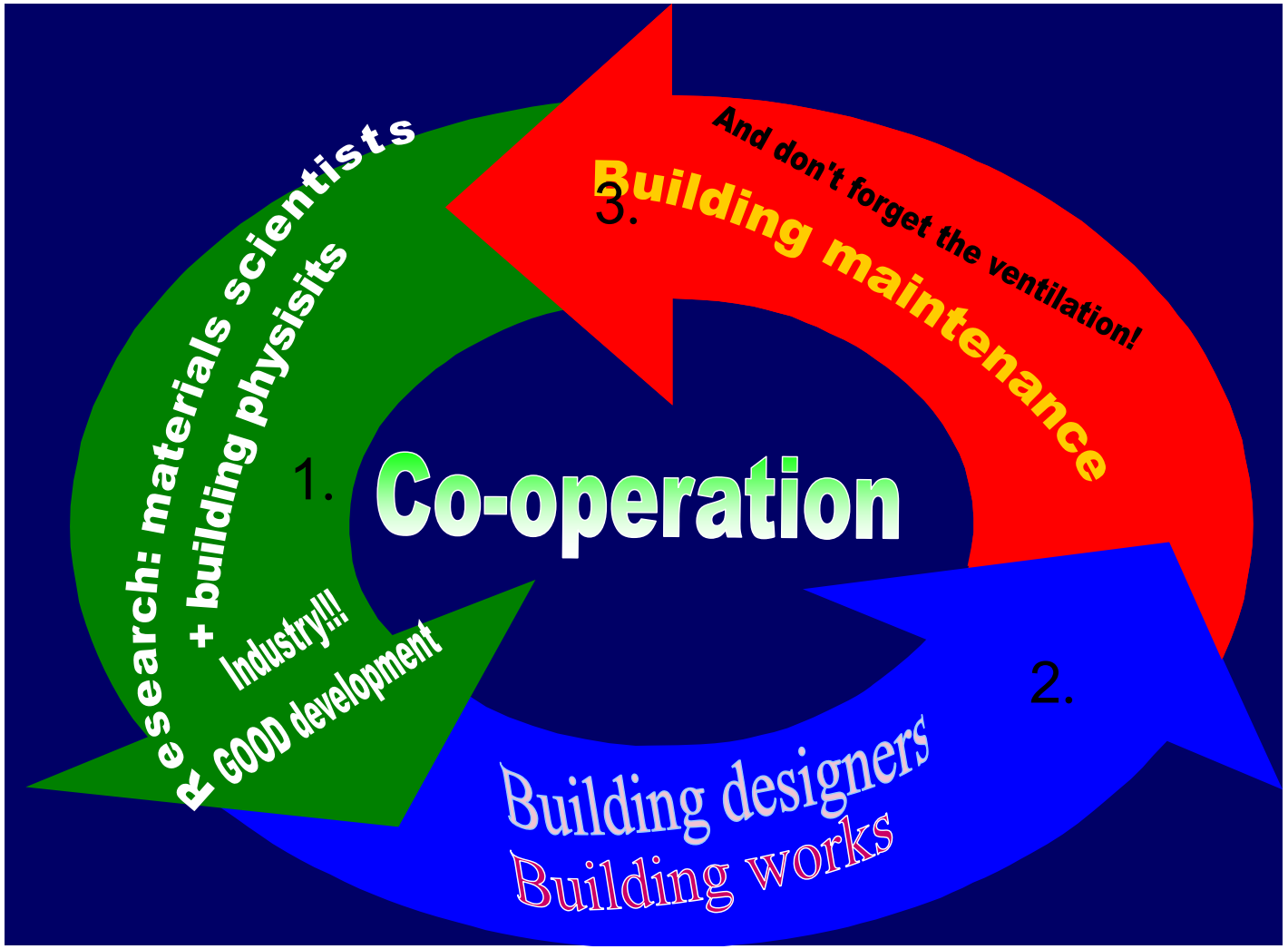
INDOOR AIR QUALITY

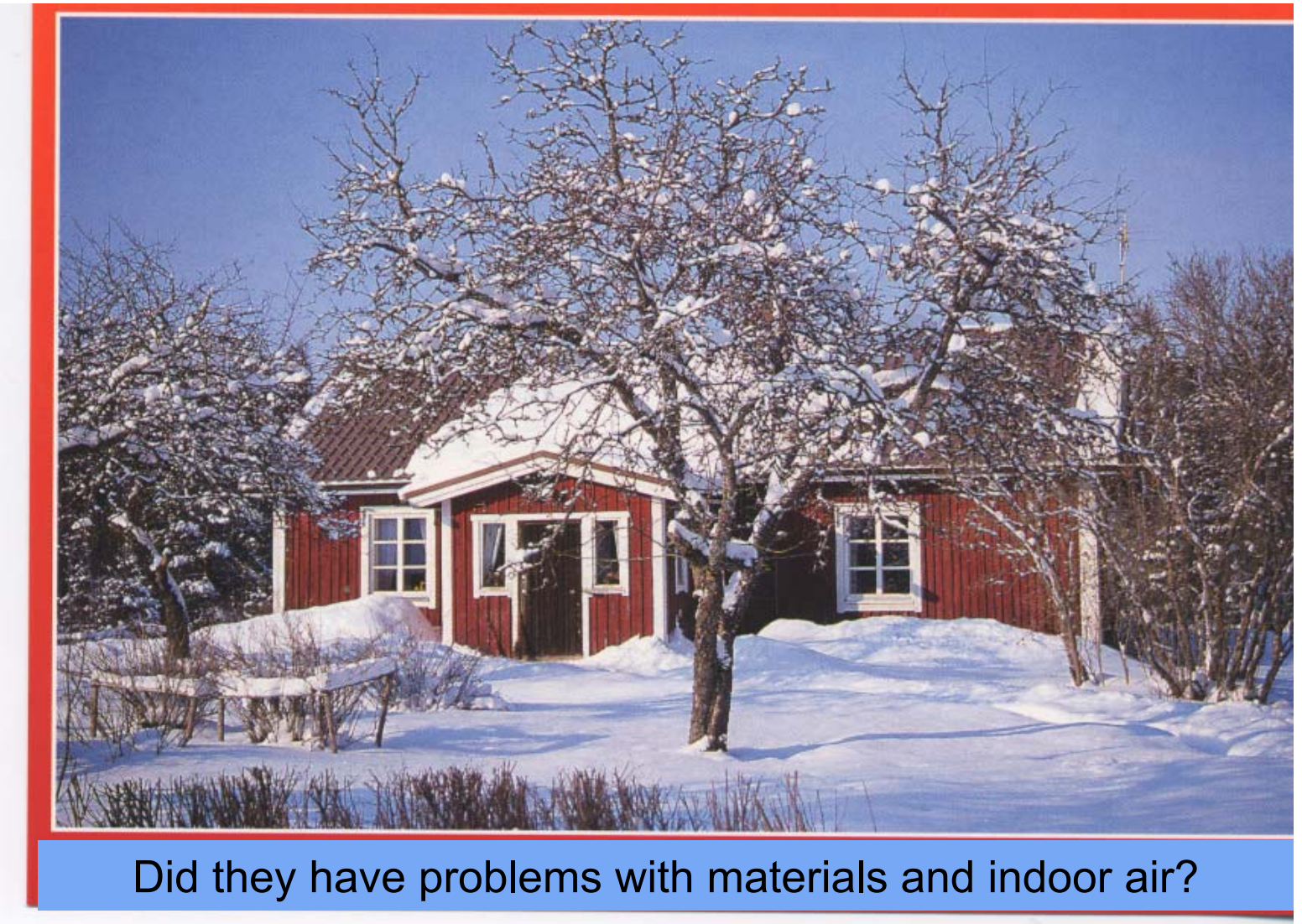
SOURCES+SINKS+VENTILATION = IAQ



Indoor air quality depends on several chemical sources and processes and physical factors all having an impact on the final air quality in the building. Ventilation efficiency has a major role in "adjusting" the final IAQ level in the space

It is also important design, build and maintain the building in such a manner that emissions are not generated by exposing materials to detrimental circumstances e.g. excess humidity





Did they have problems with materials and indoor air?

Thank you

References to material used in compiling this presentation

- **Reference values for structure emissions measured on site in new residential buildings in Finland**
  Järnström, Helena; **Saarela**, **Kristina**; Kalliokoski, P.; Pasanen, A.-L.
  Atmospheric Environment . Vol. 41 (2007) No: 11, 2290 - 2302

- **Reference values for indoor air pollutant concentrations in new, residential buildings in Finland**
  Järnström, Helena; **Saarela**, **Kristina**; Kalliokoski, Pentti; Pasanen, Anna-Liisa
  Atmospheric Environment . Vol. 40 (2006) No: 37, 7178 - 7191

- **What is behind TVOC in new buildings**
  Saarela, **Kristina**; Järnström, Helena; Tirkkonen, Tiina; Villberg, Kirsi
  Healthy Buildings 2003, Vol. 1, Singapore 7-11 Dec. 2003. National University of
- Singapore (NUS), ISIAQ. Singapore (2003), 325 - 330

- **Exposure of population and microenvironmental distributions of volatile organic compound concentrations in the EXPOLIS study**
  Saarela, **Kristina**; Tirkkonen, Tiina; Laine-Ylijoki, Jutta; Jurvelin, J.; Jantunen, M.
  Atmospheric Environment. Vol. 37 (2003) No: 39-40, 5563 - 5575

- **What is behind TVOC in M1 -classified construction and finishing materials - VTT's experience**
  Saarela, **Kristina**; Villberg, Kirsi; Tirkkonen, Tiina
  Indoor Air 2002, 9th International Conference on Indoor Air Quality and Climate. Monterey, CA, 30 June - 5 July 2002. Vol. 3 (2002), 619 - 624

- **Emissions of floor structures during building phase and the indoor air quality of a new office building**
  Saarela, **Kristina**; Laine-Ylijoki, Jutta; Lukkarinen, Timo; Kettunen, A.; Ruotsalainen, R.
  The 8th International Conference on Indoor Air Quality & Climate, Indoor Air 99. Edinburgh, Scotland, 8 - 13 August 1999. Vol. 1. BRE; Garston; Watford; WD2 7JR. Edinburgh (1999), 564 - 569