Comparison of hard and textile floors

Report RF-97/034

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Scope:

The intention for this preliminary project is to compare textile floors with hard floors in the school of Tranberg in Oppland County. The indoor air climate has been compared with regard to the volatile organic compounds (VOC), particles in the air and reverberation time.

Key-words:

carpet - school - particles - organic compounds - reverberation time

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Summary

The intention for this preliminary project has been to make a comparison of only 3 different parameters from textile floors and hard floors in four classrooms in the school of Tranberg in Oppland Community. The investigation was done only after one years use of the textile floors. The parameters to be compared were the volatile organic compounds (VOC), particles in the air and reverberation time. We have not investigated the accumulation of allergens in textile floors, or the possible health effects of allergens and micro organisms.

The examination was done in four classrooms in the school. The differences between the rooms were the choice of coating at the floor: one room with Nordpfeil Olymp 21, nylon 6/6 (velour carpet), one room with Ege Golf, nylon 6/6 (level loop carpet) and two rooms with Vinyl Tarkett Optima.

The field study took place from March 19th to 22nd 1996, and the investigation included measurements of volatile organic compounds (VOC) in indoor air, air born dust and reverberation time.

The VOCs were sampled using 2 different sorbent tubes; tenax and charcoal, and both "night" and "day" samples were taken. The results show slight differences between the total VOCs at "daytime" for the hard floors and the carpeted rooms both for tenax and for charcoal samples. Samples taken when ventilation system was off showed increased differences between the total VOCs (taken with tenax samples) with about 27 % higher values for the hard floor, compared with the carpeted floor. In day time there was no significant differences between carpeted floors and hard floors.

The outdoors total VOC values differed with about 65 % for the samples taken with tenax compared with the charcoal samples.

The comparison of the tenax analysis performed by two different laboratories shows about 5 to 60 % difference in reported results. It has to be considered the low number of possible comparable samples, and also uncertainties due to the methods of analysis.

The particles in the air were counted by "Air borne particle counter" which has a particle size ranges of 0.3, 0.5, 1 and 5 microns. The counting of air born dust started early in the morning before the pupils arrived, during class lessons and after the school period was finished. We also measured before and after cleaning of the classrooms. The amount of air born dust was measured for two days and there were little differences between the amount of air born dust in the carpeted rooms compared with the hard floors during the measured period. The analysis give statistical significant higher values of dust in carpeted rooms than in hard floor rooms during the cleaning period.

The particle counter also recorded air humidity and air temperature. The relative air humidity was significantly lower for the carpeted rooms than for the class rooms with hard floors. The differences in the indoor temperature conditions were small.

The outdoor temperature range from -11,7 °C to -4,4 °C and the outdoor air humidity range from 75 to 62 % during the field period.

The reverberation time was measured and analysed by Multiconsult AS in Oslo, after the Norwegian Standard 8173. There was just a slight difference between the reverberation time results for the different class rooms, and the results satisfy the current Norwegian standard.

The maintenance is important in all classrooms, and then also in carpeted rooms, and the maintenance has to be done due to specifications from the carpet supplier.

Carpets can be a good alternative to other floor coatings, when maintenance is well taken care of. ***The project can only make this conclusion for new carpets, because the carpets was installed about a year before the investigation****. The intention of the project has been to make a following up study after 3 to 5 years and maybe again after 10 years. Such a following up study has also to include investigation of allergens and micro organisms.*

Preface

The project is performed on behalf of GuT (Gemeinschaft umweltfreundlicher Teppichboden) and TFI (Deutsches Teppich-Forschungsinstitut). And the work has been carried out at RF - Rogaland Research, Stavanger.

The acoustics measurement of reverberation time is performed by Multiconsult Oslo, and the analysis of air born dust by gravimetric examination was done at NILU (Norwegian Institute for Air Research) in Oslo.

The analysis of the tenax and charcoal sampling tubes were done by the German Carpet Research Institute (TFI in Aachen). NMT (in Norway) analysed the control samples of tenax.

At RF-Rogaland Research, research scientist Ernst Olsen has been responsible for the field investigations and the data analysis were performed by senior scientist Olav Christie.

Stavanger, January 1997

Anne Næss Myhrvold

1 Introduction

The use of carpets has been very much discussed for several years, specially due to carpets in kindergartens and schools. One of the main problems concerning use of carpets have been related to allergens from mites in the dust. Several studies have been performed within this area: for example by van Bronswijk (1).

In Norway the Allergy research group at Haukeland Hospital investigated dust from carpeted and smooth floors (2), and The Norwegian Health Inspection advises against use of carpets in kindergartens and schools (3).

During the Indoor Air conference in Japan summer 1996 some more studies on carpets were presented. A study of Masuda et. al. (4) shows high amount of allergen levels from mites in carpets, and want to pay the attention to the ventilation capacity when installing carpets in classrooms.

Dingle and Whyte (5) found very high amount of heavy metals (such as lead and cadmium) in carpeted rooms near by heavy vehicle traffic and petrol stations. They also found that the air analysis did not contain heavy metals in a classroom with carpets, so maybe the heavy metals were not resuspended into the air.

The intention for this project has been to make a comparison of only 3 different parameters from textile floors and hard floors in the school of Tranberg in Oppland Community. The parameters to be compared were the volatile organic compounds (VOC), particles in the air and reverberation time. The school of Tranberg is a newly renovated school with good indoor climate.

This report gives an introduction to the school of Tranberg due to general information and renovation activities in chapter 2. In the next chapter the procedures for the field investigation are described, and in chapter 4 we report the results for the 3 parameters: volatile organic compounds (VOC), particles in the air and reverberation time.

2 Object

2.1 General information about the school of Tranberg

GENERAL					
Place:	in the municipal of Gjøvik, Oppland county				
Size:	about 650 pupils and 60 teachers. Effective area				
Built in:	1956-1958, renovated in 1994/95.				
CLASS ROOMS					
Construction:	Plastic moulded concrete, framework with brick and concrete surfaces.				
Corridor:	Painted concrete walls, vinyl floors, perforated ceiling without insulation.				
Room	**Area m^2**	**Volume m^3**	**Wall**	**Ceiling**	**Floor**
111 and 112	54,2	162	painted	perf. steel ceiling, dust bounded concrete	PUR coated vinyl
113 and 114	54,2	162	painted	perf. steel ceiling, dust bounded concrete	carpet
Shading device: indoor curtains and outdoors jalousies					
VENTILATION					
Type				**Filter**	**Operating time**
Mechanical balanced displacement ventilation				EU7 and EU8	07:30-14:45 during schooldays.
HEATING SYSTEM					
4 radiators in each class room. Shunting by outdoor sensor. Night set-back 17:00-03:00 Supply air temperature about 17,5 °C.					
CLEANING					
Room	**Method**				
111 and 112	daily dry mop	(Johnson wax)			
113 and 114	daily vacuum cleaning	"IMAGE" with rotary brushes			
Comments					
Yearly main cleaning includes curtains, lamp armature and windows.					

2.2 Information about the renovation

2.2.1 Ventilation

1995: New balanced displacement ventilation with board type thermal exchanger and heating coil with air inlet above roof. Designed air mass was on 1300 m^3/h, this is the same as an amount of outside air like 360 l/s per classroom. The ventilation system has central controlled computer - SD-control, regulated in zones. Sensor for CO_2 and temperature both on air inlet and air outlet. Continuous operating time.

1996: Small adjustments for supply air temperature and operating time. Operating time from 07:30 to 14:45 during the schooldays and closed during weekends.

2.2.2 Heating system

1996: Improved control due to outdoor sensor, and new thermostatic valves.

2.2.3 General

1995: New triple-glazed windows. New PUR coated vinyl floor, new painted and dust bounded concrete surfaces. New perforated ceiling without insulation and removal of old insulation above ceiling. New illuminace in ceiling and near tables, new chairs and desks.

2.3 Floor coating in the selected objects

The examination was done in four classrooms in the school of Tranberg. The differences between the rooms were the choice of coating at the floor:

room 114:	Nordpfeil Olymp 21, nylon 6/6 (velour carpet)
room 113:	Ege Golf, nylon 6/6 (level loop carpet)
room 112:	Vinyl Tarkett Optima 2mm
room 111:	Vinyl Tarkett Optima 2mm

The four classrooms are next to each other at the same side of the building.

3 Experimental arrangement

The field study took place from March 19th to 22nd 1996, and the different activities as set up in the Table 3.1.

Table 3.1 Time schedule

	Tenax	Char-coal	Reverbera-tion time	Particle counting	Gravimet. analyse (air born dust)	Temp. + humidity indoors	Temp. + humidity outdoors
Tuesday 19.		x				x	x
Wednesday 20.	x	x			x	x	
Thursday 21.	x		x	x	x	x	x
Friday 22.	x			x		x	

3.1 Volatile organic compounds (VOC)

3.1.1 Tenax

Equipment and method:

Air pump SKC, model 224 - PCEX7. Tube with adsorbent of organic polymer (Tenax TA).

The test was carried out with a sampling volume of 6.4 litre, sampled with a air supply flows at 80 ml/min.

The analysis of the sampling tubes were done by the German Carpet Research Institute (TFI in Aachen).

A total of 9 control samples were analysed by another laboratory (NMT). The samples were thermically desorbed directly into a gas chromatography/mass spectrometer, GC-MSD (gas chromatography column and detectable by a flame ionisation detector).

Location site:

Classroom: The samplings were carried out contemporary in the same locations for all the four classrooms for a period of 2 days. The samplings were accomplished in a height of 0,1 m and 1,1 m in the middle of the room, at daytime. Finally we accomplished evening/night measurements in all the class room.

Corridor: One sampling was accomplished each day over a period at 2 days close to the floor (height of 0,1 m).

Outdoor: Samples of outdoor levels were accomplished two days near air intake.

Number of Tenax -VOC-sampling:

class room:	19 (+ 8 controls)
corridor:	1
outside:	1 (+ 1 control)
Total number:	21 (+ 9 controls)

3.1.2 Charcoal

Equipment and method:

Air pump SKC, model 224-PCEX7. Tube with adsorbent of organic polymer (Charcoal).

The test was carried out with a sampling volume of 160 litre, sampled with a air supply flows at 2 l/min.

The analysis of the sampling tubes were done by the German Carpet Research Institute (TFI in Aachen).

Location site:

Classroom: The samplings were carried out contemporary in the same locations for all the four classrooms for a period of 2 days. The samplings were accomplished in a height of 1,1 m in the middle of the room, at daytime. In addition we measured some samples from the height of 0,1 m over the floor. Finally we accomplished evening/night measurements in the class rooms 112, 113 and 114.

Corridor: One sampling was accomplished each day over a period at 2 days close to the floor (height of 0,1 m).

Outdoor: Sample of outdoor levels was accomplished one day near air intake.

Number of Charcoal -VOC-sampling:

class room:	15
corridor:	2
outside:	1
Total number:	18

3.2 Air born dust/particles in the air

The main measurements were carried out in the classrooms 112 and 113, with particle counting. Measurements were done in regard to registration of the development and activity through out the day. Classrooms 111 and 114 have been examined as controls for the other 2 classrooms. Number of particles in each fraction are compared, for all the rooms.

Equipment: Air borne particle counter, Met one Model 237 B, which has a particle size ranges of 0.3, 0.5, 1 and 5 microns (4 channel). The instrument also record air humidity and air temperature.

Procedure: Samplings were carried out in the centre of the classrooms 112 and 113, in the height of 0.3, 1.1 and 2.1 m. Some control measurements were taken in the rooms 111 and 114.

Table 3.2 shows a survey over measuring time. The sampling started before the pupils arrived, during class lessons and after the school period was finished. We also measured before and after cleaning of the classrooms.

Table 3.2 Survey over measuring time by particle counting

Day 1		Day 2	
Room 113	Room 111*	Room 112	Room 114*
Time	Time	Time	Time
0640-0710	0715-0750	0640-0700	0705-0730
0800-0910	0930-1005	0805-0910	0935-1005
1030-1300	1305-1335	1030-1300	1305-1335
1355-1515	1520-1700	1355-1515	1520-1605
1705-1830	1835-1910	1750-1810	1815-1835

* Classroom for control.

Start time for ventilation system at 07:30, and the stop time was about 14:45. Cleaning period was from about 14:30 to about 16:00. The time for cleaning each classroom was about 15 to 25 minutes.

The samplings were taken every 4 minute (for a period of 21 sec.). Within about 32 minutes we measured 3 counting in each height.

3.3 Gravimetric examination of air born dust

Equipment and method:

Filter system with 2 fraction (coarse-fraction diameter < 10 and > 2,5 and fine-fraction < 2,5 dm) assembled an impactor which exclude particles > 10 dm. The air supply flow was 10 l/min.

The analysis of the filters were done by NILU in Oslo.

Location site: The samplings were carried out in the classrooms 111 and 113, at a height of 1,1 m in the back of the rooms, at daytime and at night. A total of 4 samples were taken and sampling time for each samples was 8 hours.

3.4 Acoustics measurement of reverberation time

Measurements, analysis and calculation were performed by Multiconsult AS in Oslo for all 4 classrooms, after the Norwegian Standard 8173.

Equipment: Norsonic 840 with microphones and loud-speaker.

3.5 Statistics

The data analysis are performed with SIRIUS multi-variant data analysis for Windows.

Multi-variant data analysis or principle component analysis (PCA) will show correlation's in a data set.

The first principle component (PC1) describes the largest and often most important fraction of variants in the data, but PC1 will seldom explain all of the variants. If the data contains more information it is possible to withdraw another principle component (PC2).

4 Results

4.1 Volatile organic compounds (VOC)

4.1.1 Tenax

Many of the compounds were found in sufficient low concentrations, the measured VOC-values are presented in Figure 4.1.1.1 (with ventilation system on) and Figure 4.1.1.2 (with ventilation system off). The numbers in the figures refer to Table 4.1.1. with name of the measured compounds. VOCs measured at day time with ventilation system on show small differences when comparing the hard floors with the carpeted floors. The compounds number 3 "sum of xylole" has the highest concentration measured both for carpeted and hard floors. When the ventilation system is closed the concentrations of both "sum of xylole" and "sum of trimethyl-benzole and ethylbenzole" have increased, specially for the hard floors. The outdoor concentrations of VOCs are show in Figure 4.1.1.3.

Table 4.1.1 Name of the compounds

1 Toluol	2 Ethylbenzol	3 Sum of Xylole
4 Sum Trimethyl-benzole and Ethylbenzole	5 Styrol	6 Benzaldehyd
7 Acetophenon	8 Phenol	9 Naphtalin
10 Dodecen A	11 Dodecen B	12 alpha pinen
13 beta phinen	14 3-Caren	15 I-Limonen
16 Isopropanol	17 Butanol	18 Ethylhexanol
19 Furanmethanol	20 Sum Butylacetat and Tetrachlorethen	21 Butanon-2
22 Methyl-methoxi-pentanon	23 Methyl-pyrrolidionon	24 Methyl-dihydro-furanon
25 Cyclohexanon	26 Propylenglycol	27 Methoxiethanol
28 Phenoxiethanol	29 Butoxiethanol	30 Ethoxiethoxiethanol
31 Pentanal	32 Hexanal	33 Nonalnal
34 Dekanal	35 Ethylhexansäure	36 Diethylphtalat
35 Ethylhexansäure	36 Diethylphtalat	37 Hexamethyl-cyclotrisiloxan
38 Octamethyl-cyclotrisiloxan	39 Decamethyl-cyclotrisiloxan	40 Heptan
41 Octan	42 Nonan	43 Dekan
44 Undekan	45 Dodekan	46 Tridekan
47 Tetradekan	48 Sum of the aromats	49 Sum of all components

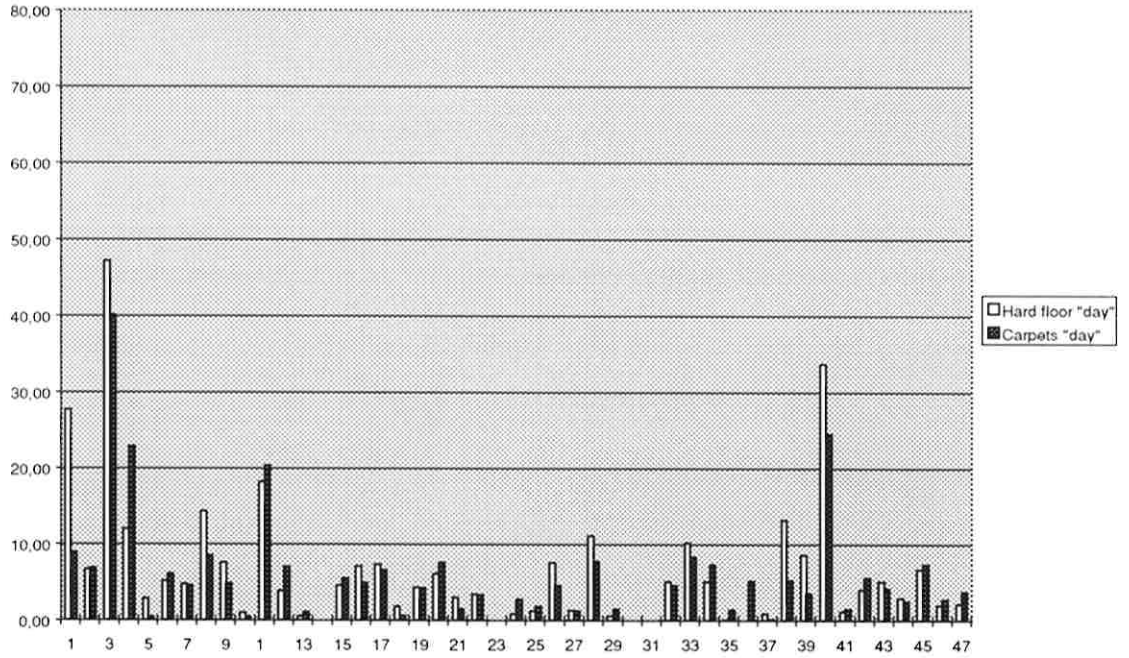

Figure 4.1.1•1 Comparison of the compounds (µg/m³) from the tenax analysis of hard floor and textile floor during the schooldays, with ventilation system on.

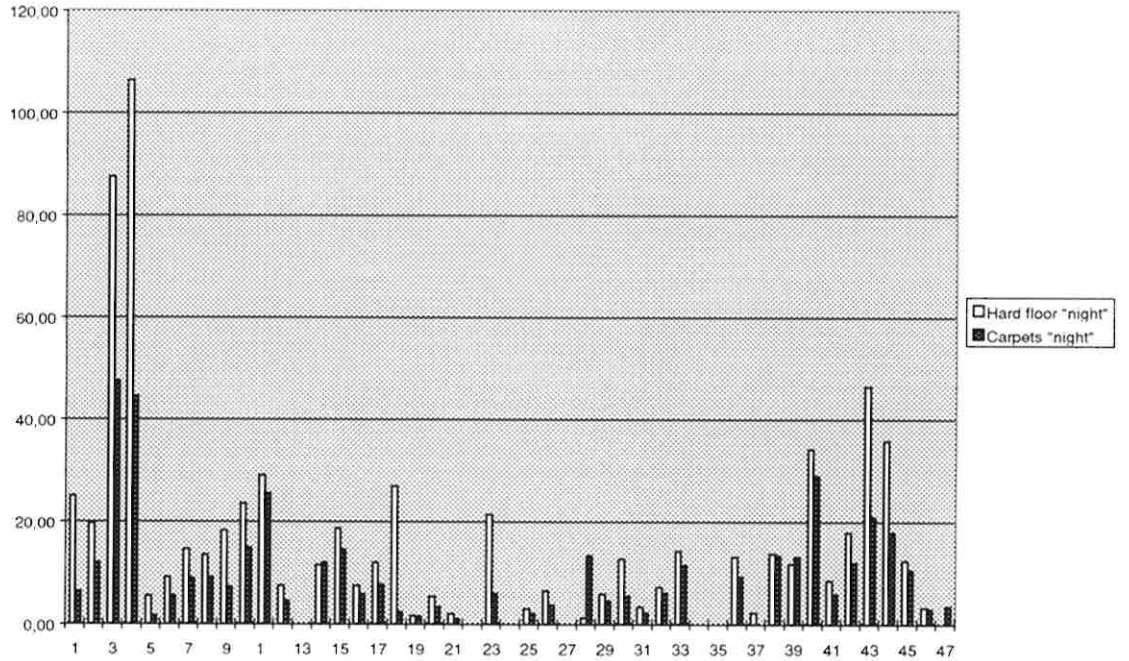

Figure 4.1.1.•2 Comparison of the VOC compounds (µg/m³) from the tenax analysis of hard floor and textile floor with ventilation system off.

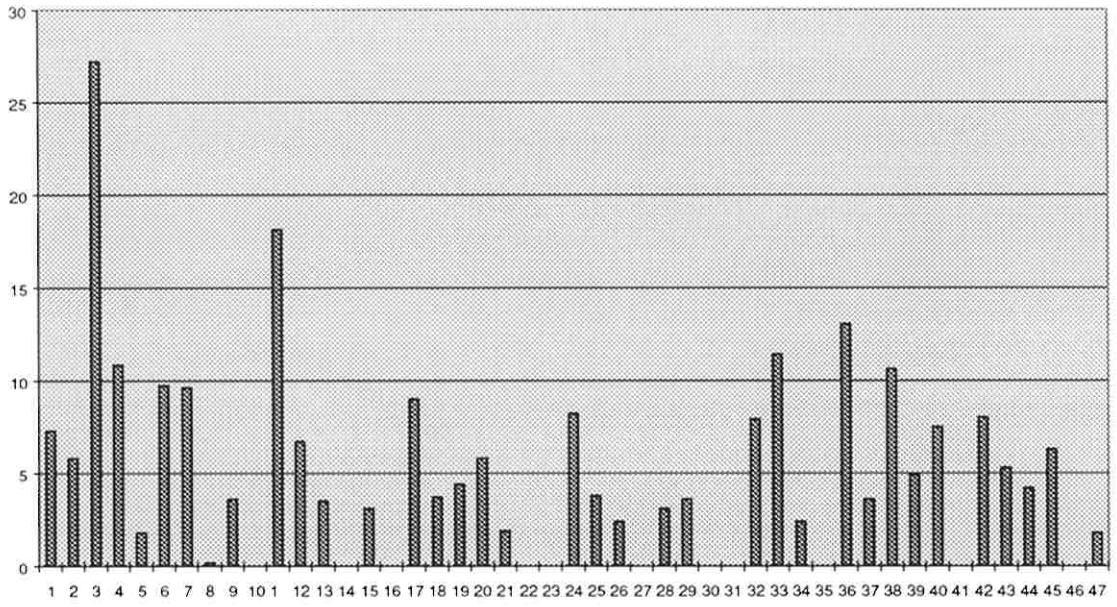

Figure 4.1.1.•3 VOCs outdoor values (µg/m³) from the tenax analysis.

There are small differences between the total VOCs at "daytime" for the hard floors (320 µg/m³) and the carpeted floors (306 µg/m³). The concentrations are given as mean values for the measured period. Samples taken when ventilation system was off showed greater differences between the total VOCs for the hard floor (651 µg/m³) compared with the carpeted floor (471 µg/m³) (Figure 4.1.1.4).

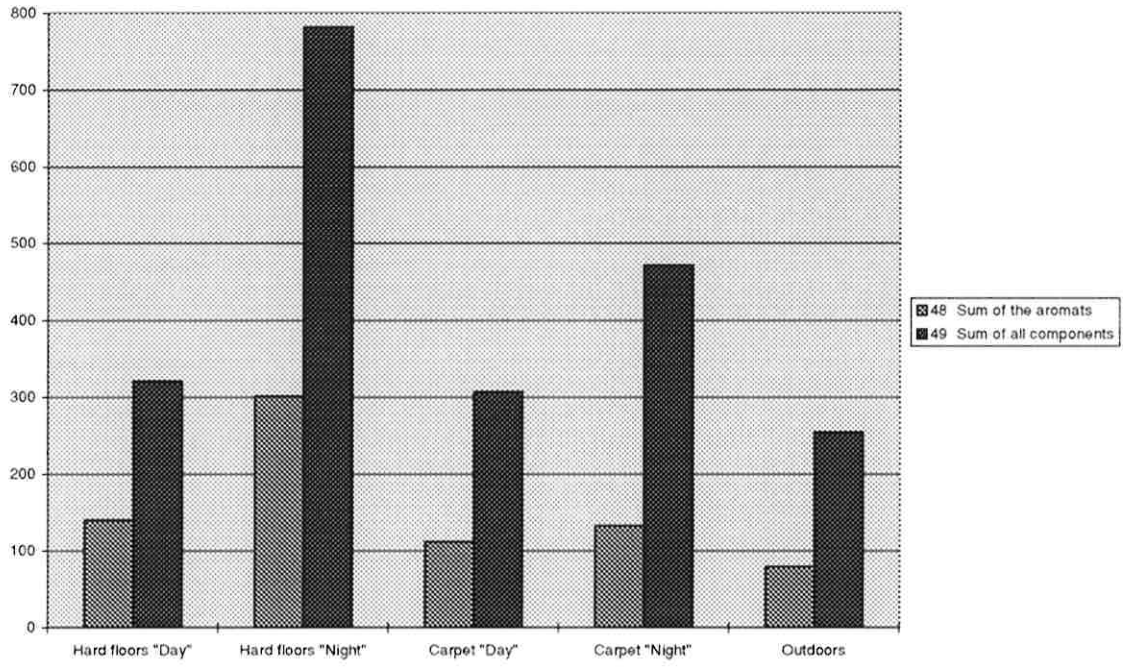

Figure 4.1.1.•4 Comparison of the total VOCs (µg/m³) for carpeted rooms and hard floors.

The first principle component shows the correlation of the amount of compounds. There is a positive correlation between the compounds. The variation during the period are shown, and the hard floors show high amount at "night" values (without ventilation) compared with the carpeted floors (Figure 4.1.1.5).

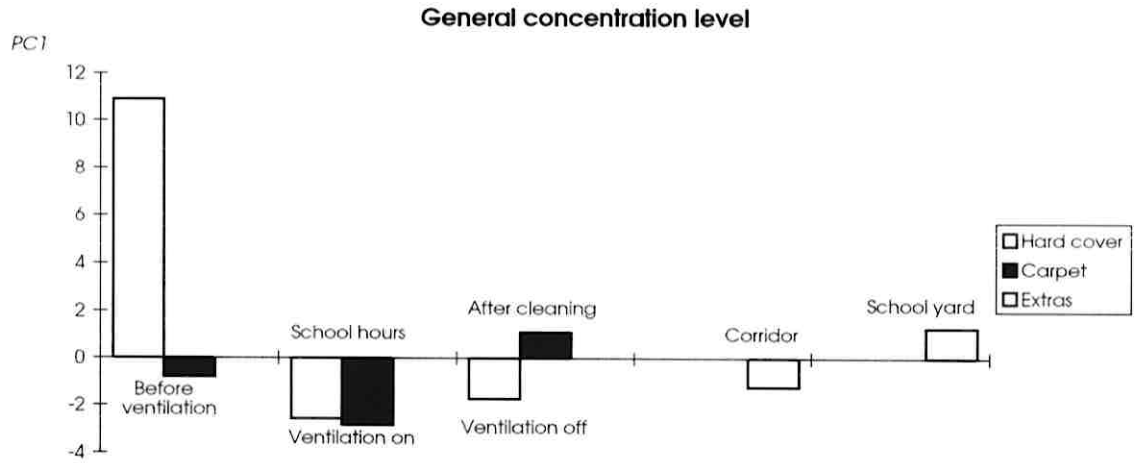

Figure 4.1.1.•5 Correlation between the total VOCs in hard floors and in carpeted floors. Positive values at the y-axe correspond with high amount of VOCs and negative values with low amount of VOCs.

4.1.2 Tenax results from two laboratories

Analysis of the 21 sampling tubes were done by the German Carpet Research Institute (TFI in Aachen), and a total of 9 control samples were analysed by another laboratory (NMT in Norway). The total VOC-values analysed by the two laboratories are set up in Table 4.1.2.

The comparison of the 1,1 m results from samples taken in the school hours give about 30 to 60 % lower values for NMT than for TFI. The results from samples taken at 0,1 m when ventilation system was closed show from 5 to 60 % higher values for NMT than for TFI. It has to be considered the low number of samples in this comparison.

Table 4.1.2
Comparison of the tenax results; total VOCs (µg/m³) from the two laboratories

	TFI	NMT	TFI	TFI	NMT	TFI
	0.1m	1.1m	1.1m	0.1m	0.1m	0.1m
	Before ventilation	School hours	School hours	School hours	Ventilation off	Ventilation off
room 111	1031	180	358	395	919	710
room 112	1106	183	270		736	277
room 113	404	140	356 (single)	368	514	467
room 114	274		232	288	785	740
corridor		226	514			
outdoors		165	254			

4.1.3 Charcoal

There are small differences between the total VOCs of the "daytime" results for the hard floors (454 µg/m³) compared with the carpeted floors (502 µg/m³). We can see the same variation for the "night" values with 272 µg/m³ for the hard floor and 363 µg/m³ for the carpeted floor. The concentration values are given as mean values for the measured period. The numbers in the figures refer to Table 4.1.1. with name of the measured compounds.

The outdoors total VOC value is high (Figure 4.1.3.1), and it is about 65 % higher than the total VOC outdoors level taken with tenax samples.

First principle component shows the correlation of the amount of compounds and the variation during the measured period are shown in Figure 4.1.3.2 There is a positive correlation between the compounds.

The data analysis did not give significant results for the other principle components, due to low number of compounds and samples.

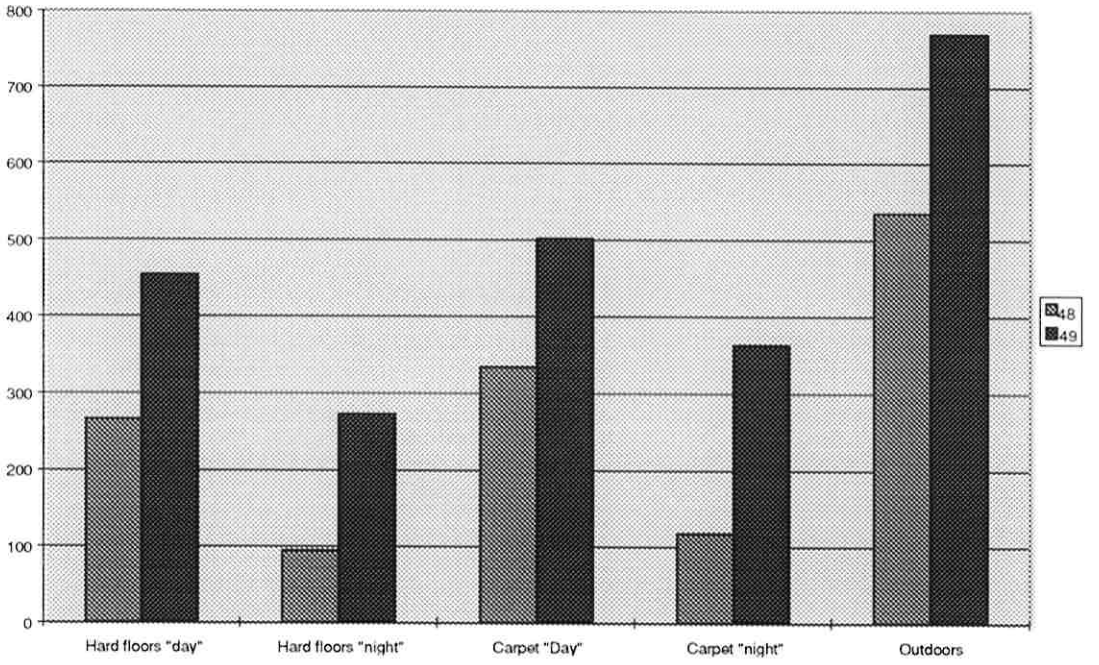

Figure 4.1.3.•1 Comparison of the total VOCs (µg/m³) for carpeted rooms and hard floors. The number 48 refers to sum of aromats and number 49 to sums of all compounds.

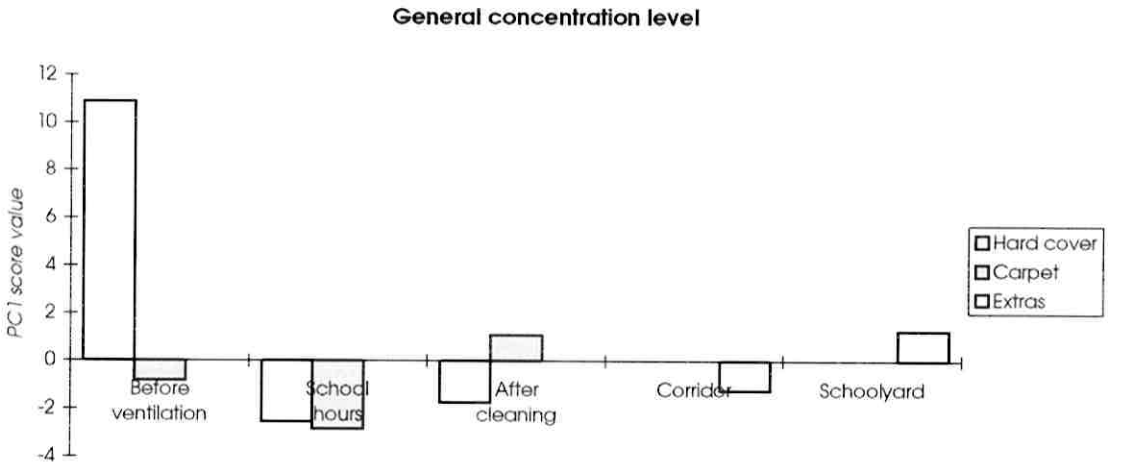

Figure 4.1.3.•2 First principal component shows the amount of VOC. Positive value at the y- axe correlates to high amount of VOC, and negative value with low amount of VOC. Comparison of hard floor and textile floor with regard to total VOC during the test period.

4.2 Relative air humidity and room temperature

The air borne particle counter did also record air humidity and air temperature. The relative air humidity are significantly lower for the carpeted rooms than for the classrooms with hard floors (Figure 4.2.1). The temperature ranges from 19,8 to 23,2 °C and the differences between the rooms during this period were small (Figure 4.2.2).

The outdoor temperature range from -11,7 °C to -4,4 °C and the outdoor air humidity range from 75 to 62 % during the field period.

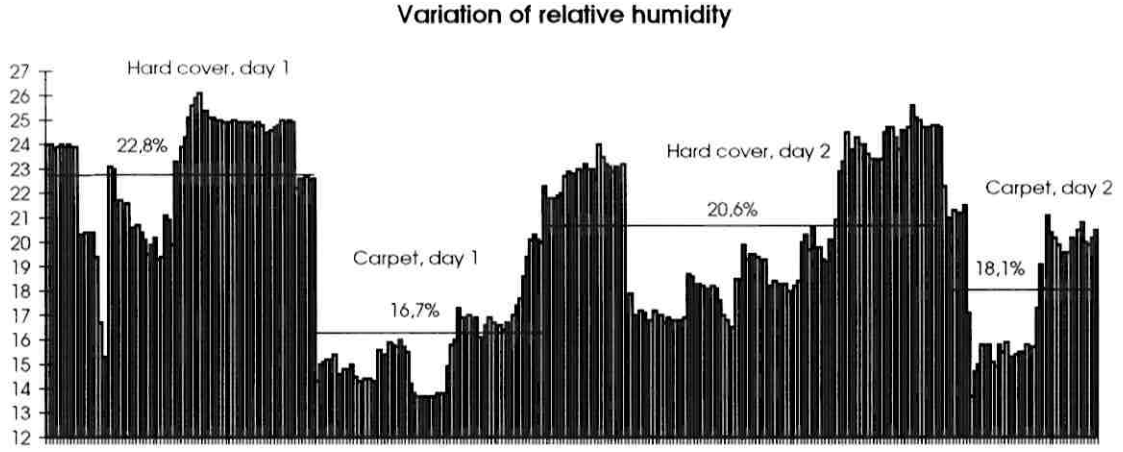

Figure 4.2.•1 Relative air humidity (%) in the different classrooms (hard cover day 1 = room 111, carpet day 1 = room 113, hard cover day 2= room 112 and carpet day 2 = room 114)

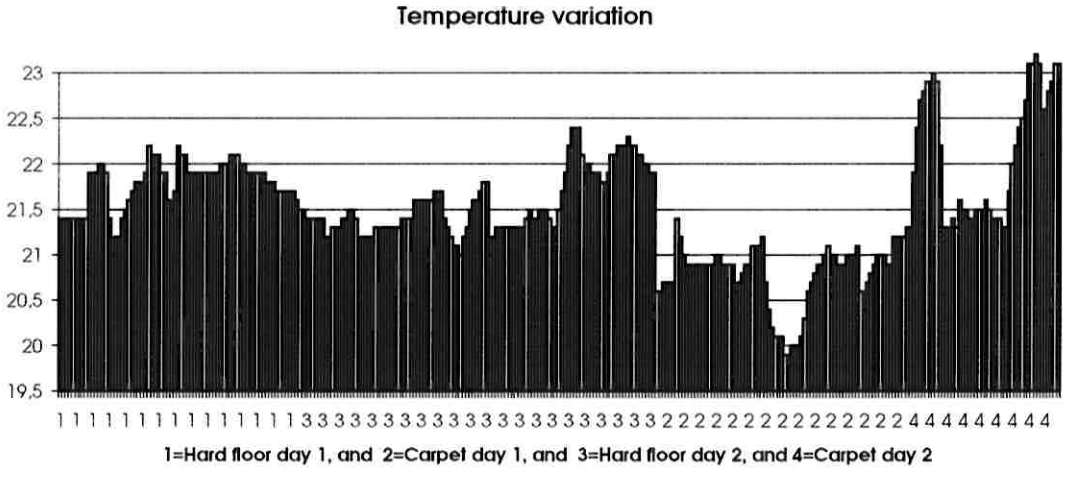

Figure 4.2.•2 Air temperature (°C) in the different classrooms (1 = room 111, 3 = room 113, 2 = room 112, 4 = room 114)

4.3 Air born dust/ particles in the air

The amount of air born dust was measured with particle counting for two days, the results for the total amount is shown in Figure 4.3.1. There are little difference between the carpeted rooms and the hard floors. When the ventilation system is on he total amount of air born dust is very low. The distribution of small dust particles (Figure 4.3.2) are much the same as for the total amount of dust. The larger particles show a slight increase of dust during the day for the hard floors compared with the textile floors (Figure 4.3.3)

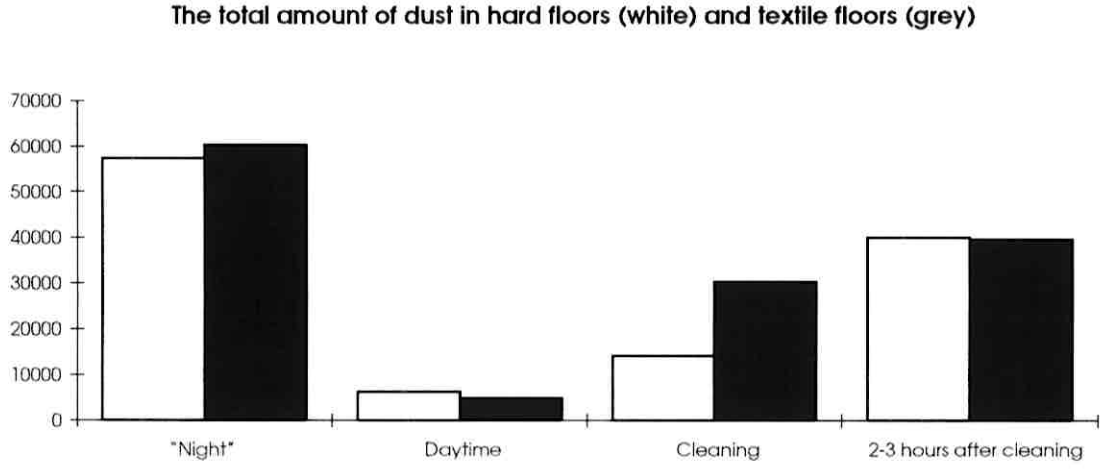

Figure 4.3•1 Comparison of the total amount of dust in the hard floors and the textile floors during the measured period.

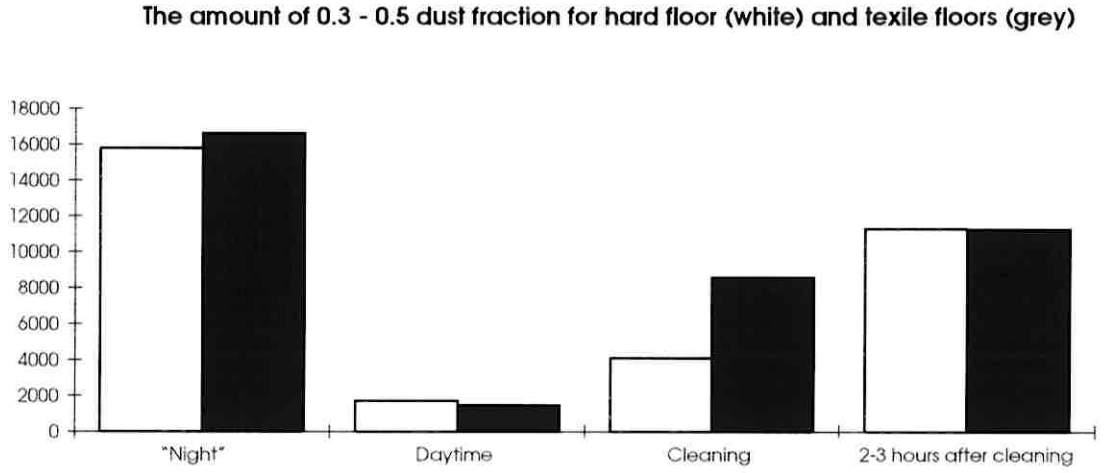

Figure 4.3•2 The amount of the small particles for the hard floors and the textile floors.

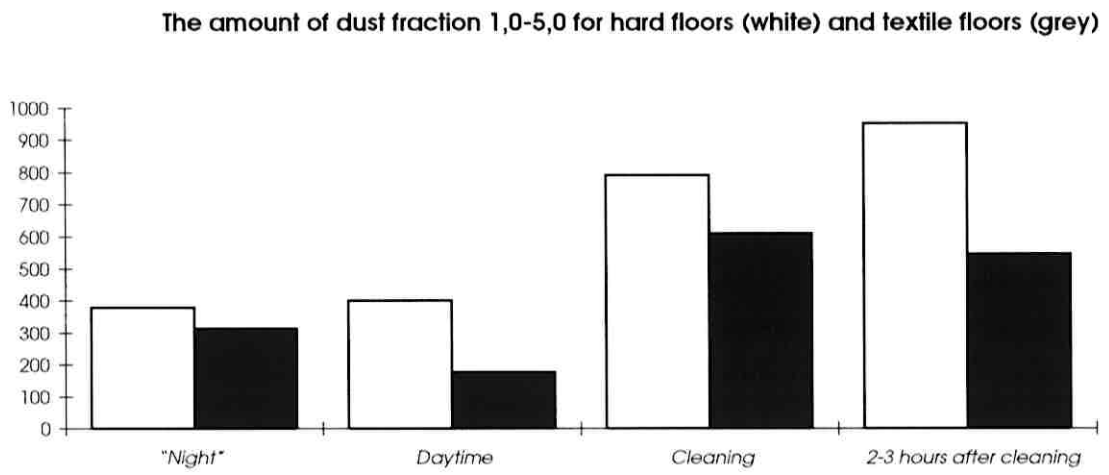

Figure 4.3•3 The amount of "larger particles" for the hard floors and the textile floors.

First principle component shows the correlation of the amount of dust. There was a positive correlation between the amount of the different fractions. The relative amount of dust during the measured day, divided into different floor coatings are shown in Figure 4.3.4. The analysis give statistical significant only for the difference of dust in carpeted rooms and hard floors during the cleaning period.

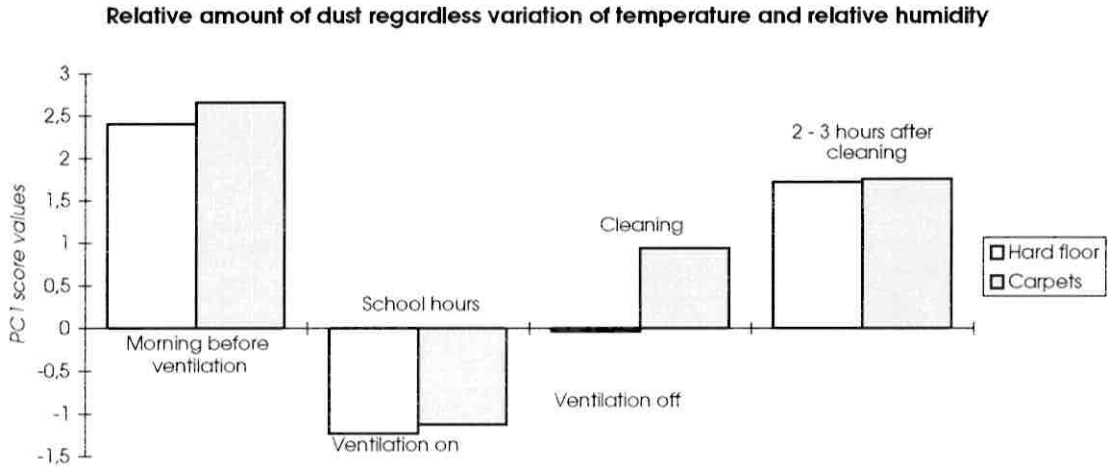

Figure 4.3•4 First principal component shows the amount of dust. Positive value at the y- axe correlates to high amount of dust, and negative value with low amount of dust.

Second principle component shows the grain size. The relative grain size distribution during the day, divided into different floor coverings are shown in Figure 4.3.5. The relative grain size distribution is regardless to the measured variation in temperature and

relative air humidity. The small dust particles dominate the morning period, before ventilation starts, and during the day the larger particles become more dominant.

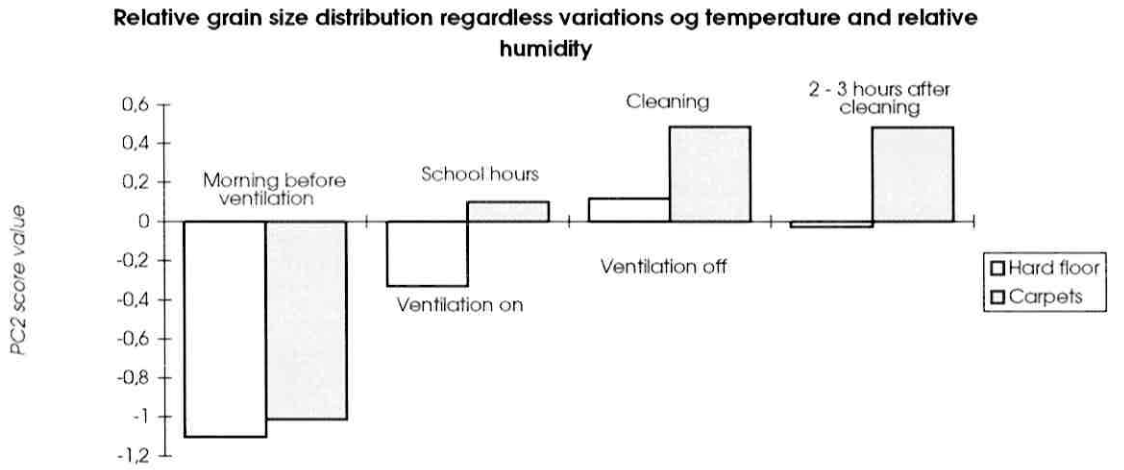

Figure 4.3•5 Distribution of grain size during the day comparison of the different rooms. Positive value of the y-axe means large grain size, negative value means small grain size.

4.4 Gravimetric examination of air born dust

The results from the gravimetric analysis of suspended particles in the air are shown in Table 4.4. There are small differences between the hard floor (room 111) and the carpeted floor (room 113). At daytime the amount of gravimetric dust is very low due to a good ventilation system. The Norwegian standard says maximum 40 µg/m³ fine-fraction, and a maximum sum of air born dust at 90 µg/m³.

Table 4.4 The results from the gravimetric examination

Room	Date	Start time	Stop time	Air born dust (µg/m³)		
				Fine-fraction (gravimetric dust) ($PM_{2.5}$)	Coarse-grained dust (2.5<dp<10)	Sum of air borne dust (PM_{10})
113	20/3	22:00	06:00	14	4	18
111	20/3	22:00	06:00	9	5	14
113	21/3	07:00	15:00	4	26	30
111	21/3	07:00	15:00	5	16	21

4.5 Acoustics measurement of reverberation time

There are little difference between the reverberation time results for the different class rooms (Table 4.5). The results satisfy the Norwegian standards. The rooms with carpets have a value of 0,1 sec. better than the hard floors. People can hardly distinguish this difference.

Table 4.5 The results of the measurement of the reverberation time.

Room	Floor	Reverberation time, T_m
111	hard cover	0,8
112	hard cover	0,8
113	carpet	0,7
114	carpet	0,7

5 Conclusion

The investigation was done after only one years use of the textile floors. The parameters to be compared were the volatile organic compounds (VOC), particles in the air and reverberation time. We have not investigated the accumulation of allergens in textile floors, or the possible health effects of allergens and micro organisms.

The summary of the results shows the following:

- The concentration of total VOCs from tenax analysis is significantly higher in the rooms with hard floors than in the carpeted rooms, when the ventilation system is off. During the school time there is no significant difference between textile floor and hard floor.
- The amount of air born dust is higher in the carpeted rooms than in the hard floors during the cleaning period, and it is mainly of the large particles. During the schooldays and the "night" the amount of particle is a little lower in the carpeted rooms than for the hard floors.
- The reverberation time does not differ significantly between the four classrooms, the carpeted rooms have 0,1 sec better reverberation time than the hard floors.

The results from this preliminary project show that the air mass and then a good or a bad ventilation system affect the air quality both in regard to volatile organic compounds (VOC) and to particles in the air, and here specially the small particles. When the ventilation system is on in the school of Tranberg the indoor air quality

measured with these two parameters is very good. The designed amount of outside air was about 1300 m^3/h or 360 l/sec per classroom in this school.

The maintenance is important in all classrooms, and then also in carpeted rooms, and the maintenance has to be done due to specifications from the carpet supplier.

Carpets can be a good alternative to other floor coatings, when maintenance is well taken care of. The project can only make this conclusion for new carpets, because the carpets was installed about a year before the investigation. The intention of the project has been to make a following up study after 3 to 5 years and maybe again after 10 years. Such a following up study has also to include investigation of allergens and micro organisms.

According to the reverberation time results the investigation should have included measurements of noise levels, because we think this parameter will distinguish carpeted room and hard floor room better.

So when using carpets in schools we have to focus on the use of the room, and on the maintenance of the carpets and to the general indoor air quality in the these rooms.

6 References

1 Bronswijk J.E. M. H and Pauli G. (1996). An updating on long-lasting mite avoidance. *A symposium at the 1996 Annual Congress of the European Respiratory Society in Stockholm.*

2 Dybendal T., Wedberg W.C. and Elsayed S. (1991). Dust from carpeted and smooth floors. *Allergy 46*

3 The Norwegian Health Inspection (in Norwegian) /Statens Helsetilsyn "Rundskriv nr. IK-21/91 Teppegulv i barnehager og skoler".

4 Masuda S. et. al. (1996). Mite allergen levels in dust from carpeted floors in schools. *Proceedings of the 7th International Conference on Indoor Air Quality and Climate. Nagoya, Japan.*

5 Dingle P. and Whyte S. (1996) Contaminants in carpets in homes. *Proceedings of the 7th International Conference on Indoor Air Quality and Climate. Nagoya, Japan.*

Appendix

Tenax and charcoal results

The VOC results for each room are presented in the following figures. The numbers at the compounds refers to the Table 4.1.1 which is copied here at this page.

Figure 4.1.1. Name of the compounds

1 Toluol	2 Ethylbenzol	3 Sum of Xylole
4 Sum Trimethyl-benzole and Ethylbenzole	5 Styrol	6 Benzaldehyd
7 Acetophenon	8 Phenol	9 Naphtalin
10 Dodecen A	11 Dodecen B	12 alpha pinen
13 beta phinen	14 3-Caren	15 I-Limonen
16 Isopropanol	17 Butanol	18 Ethylhexanol
19 Furanmethanol	20 Sum Butylacetat and Tetrachlorethen	21 Butanon-2
22 Methyl-methoxi-pentanon	23 Methyl-pyrrolidionon	24 Methyl-dihydro-furanon
25 Cyclohexanon	26 Propylenglycol	27 Methoxiethanol
28 Phenoxiethanol	29 Butoxiethanol	30 Ethoxiethoxiethanol
31 Pentanal	32 Hexanal	33 Nonalnal
34 Dekanal	35 Ethylhexansäure	36 Diethylphtalat
35 Ethylhexansäure	36 Diethylphtalat	37 Hexamethyl-cyclotrisiloxan
38 Octamethyl-cyclotrisiloxan	39 Decamethyl-cyclotrisiloxan	40 Heptan
41 Octan	42 Nonan	43 Dekan
44 Undekan	45 Dodekan	46 Tridekan
47 Tetradekan	48 Sum of the aromats	49 Sum of all components

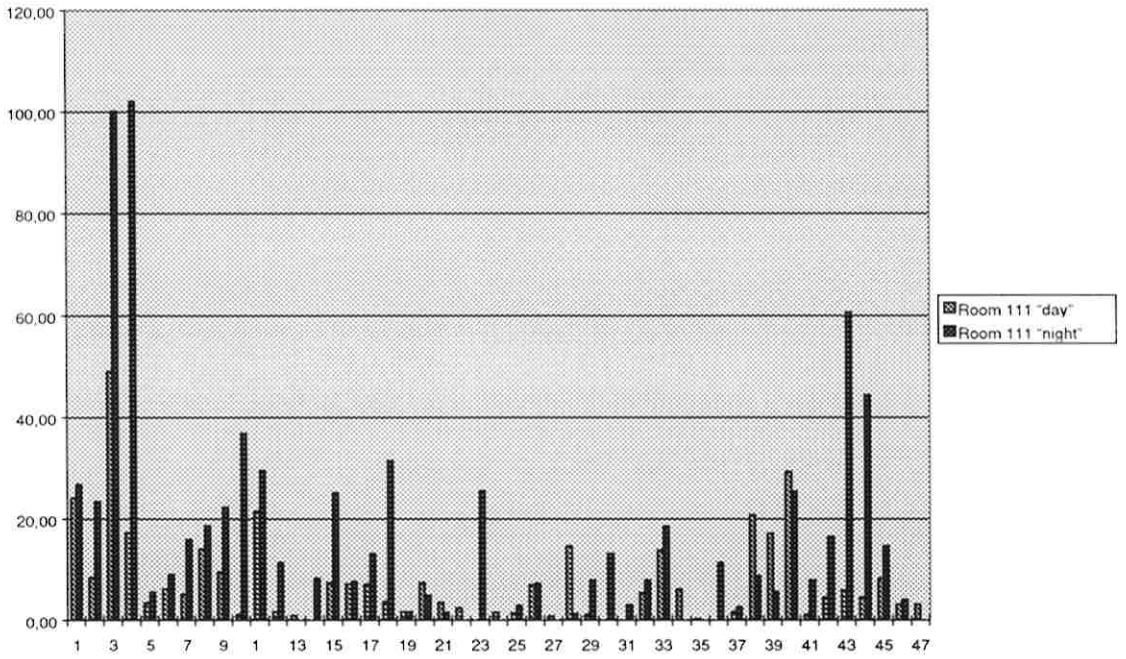

Figure 6.1 VOC-values from tenax analysis for room 111, hard floor

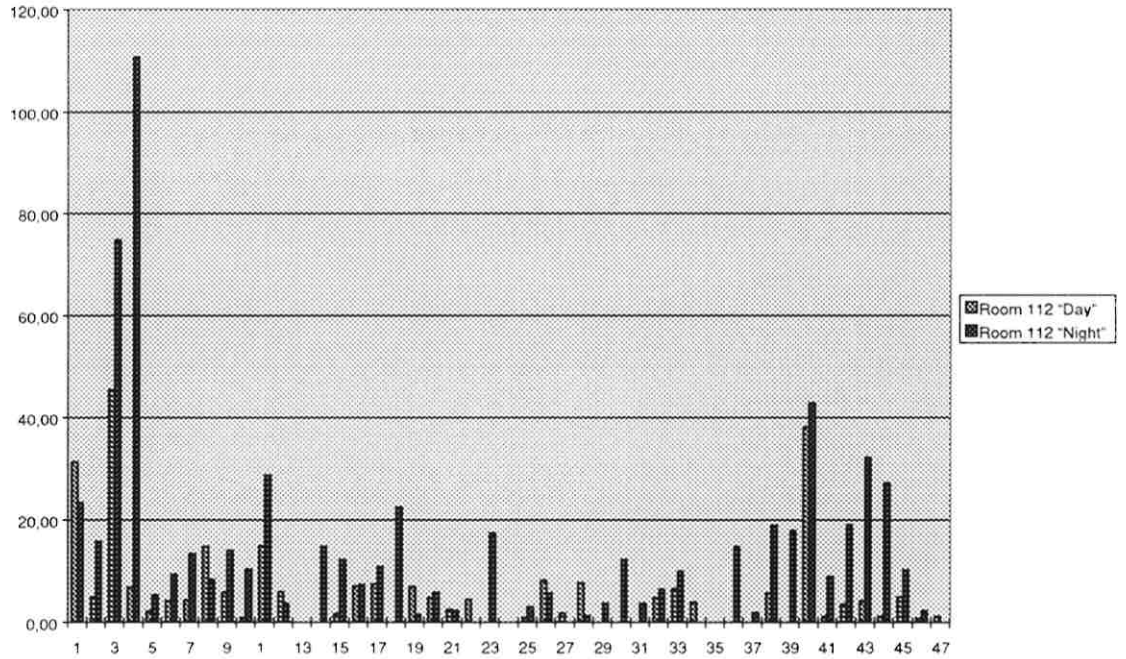

Figure 6. 2 VOC-values from tenax analysis for room 112, hard floor

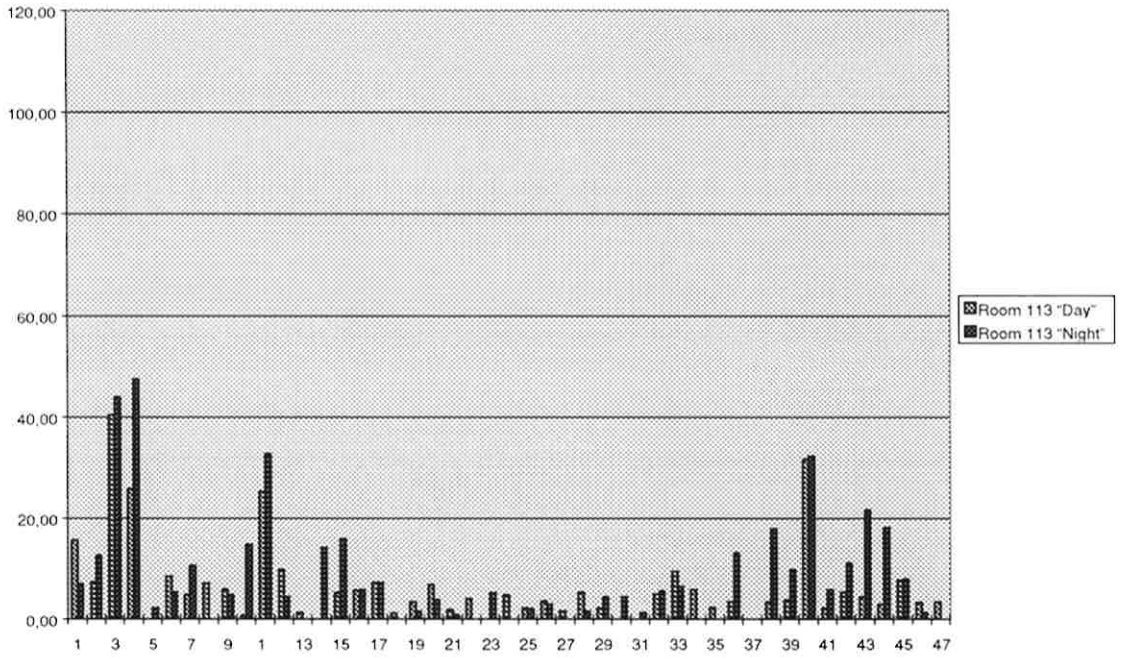

Figure 6. 3 VOC-values from tenax analysis for room 113, carpet

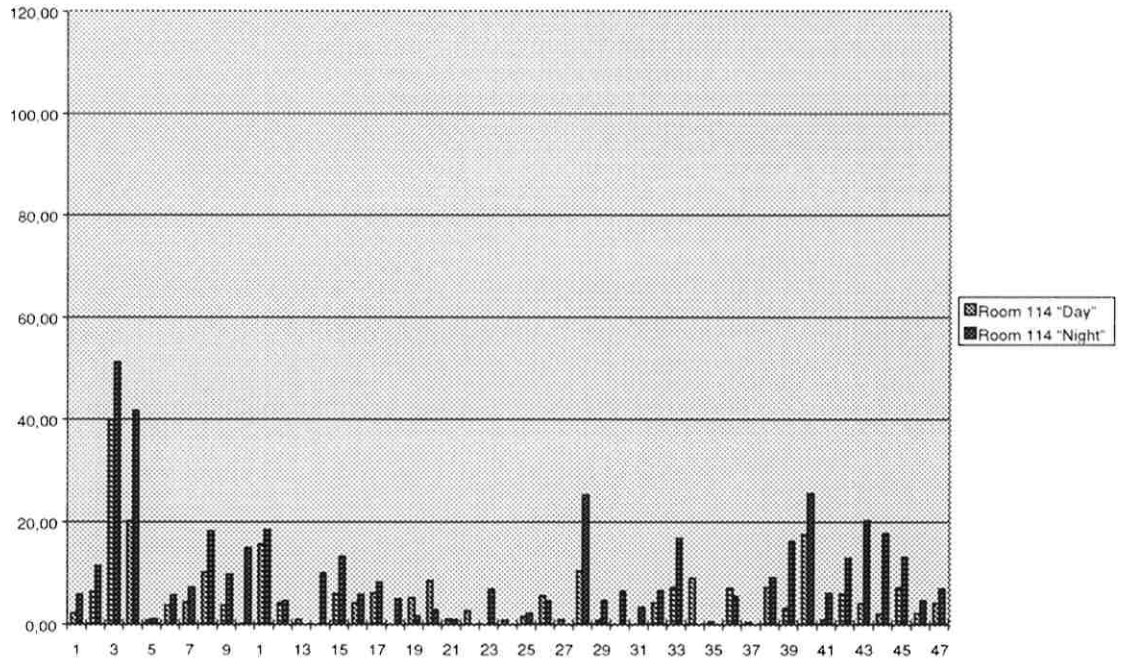

Figure 6. 4 VOC-values from tenax analysis for room 114, carpet

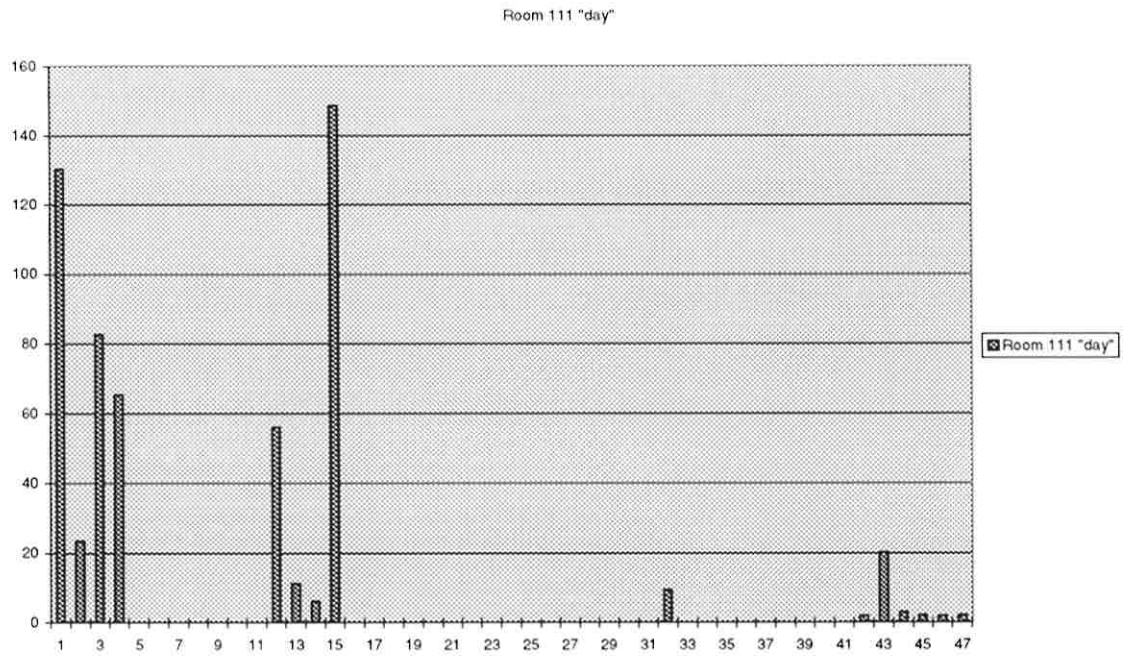

Figure 6.5 VOC-values from charcoal analysis for room 111, hard floor

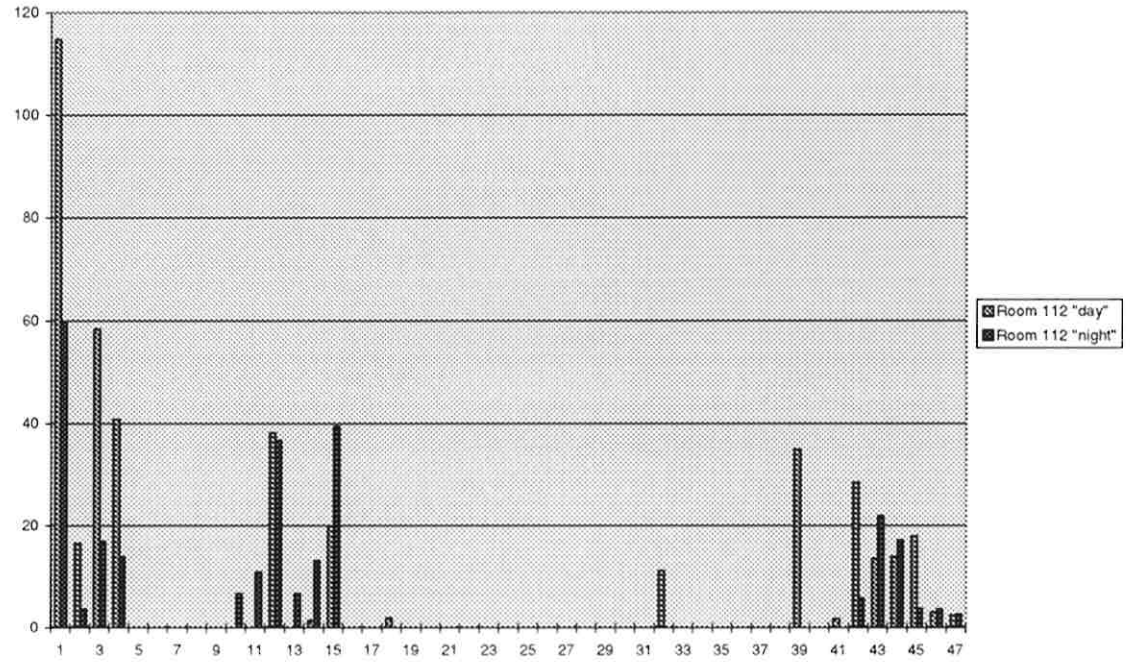

Figure 6.6 VOC-values from charcoal analysis for room 112, hard floor

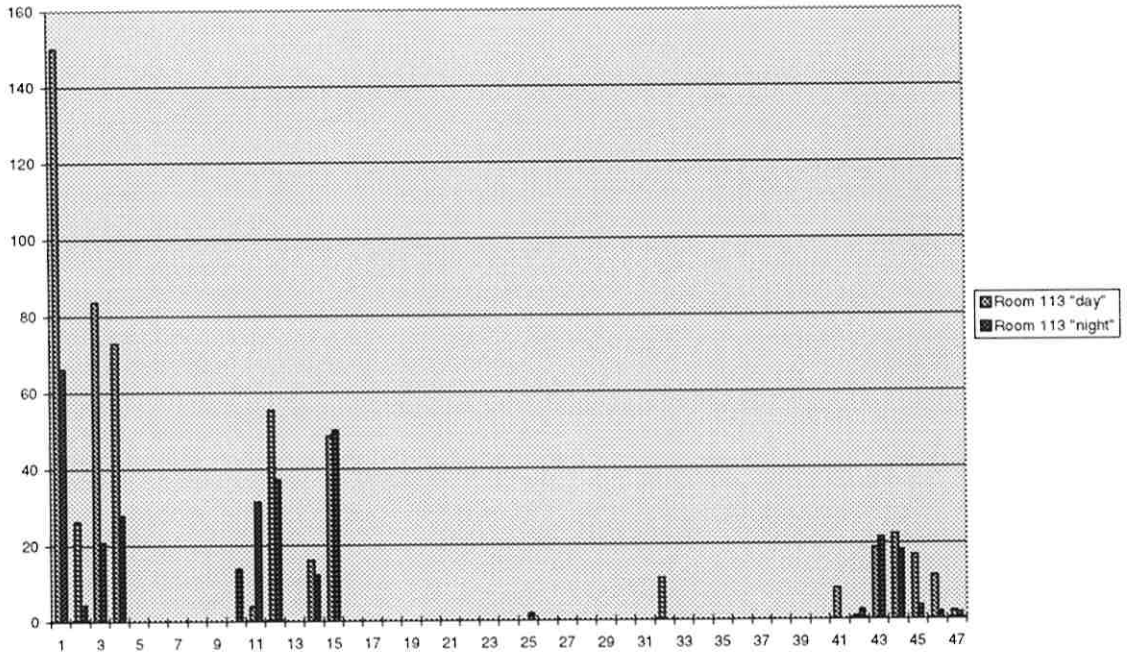

Figure 6.7 VOC-values from charcoal analysis for room 113, carpet

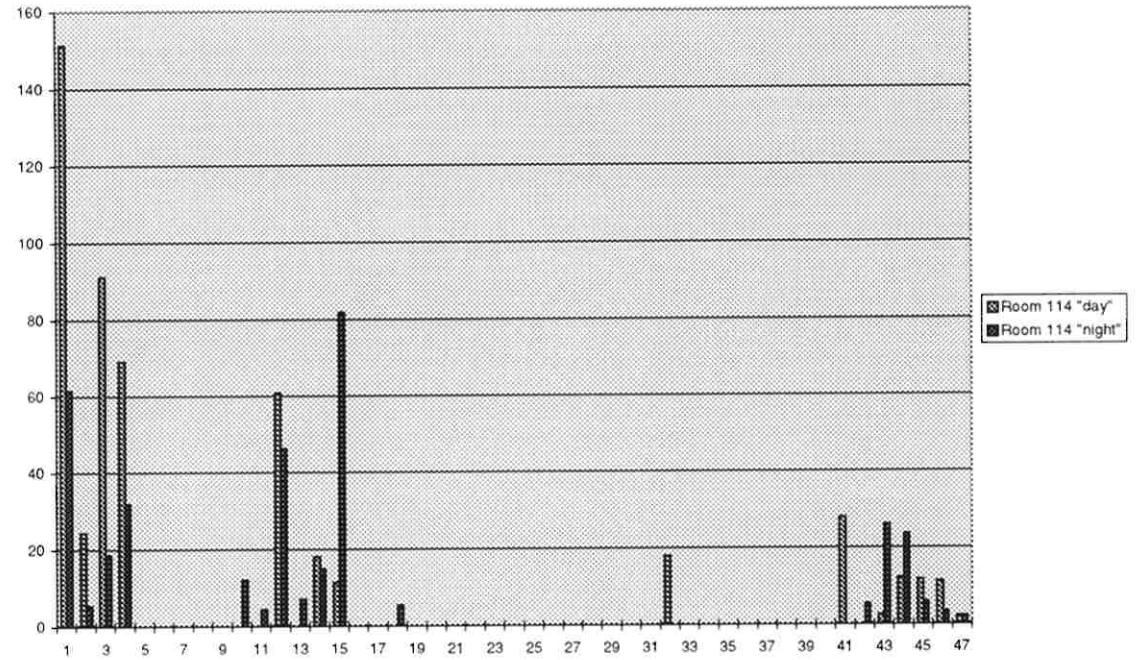

Figure 6.8 VOC-values from charcoal analysis for room 114, carpet

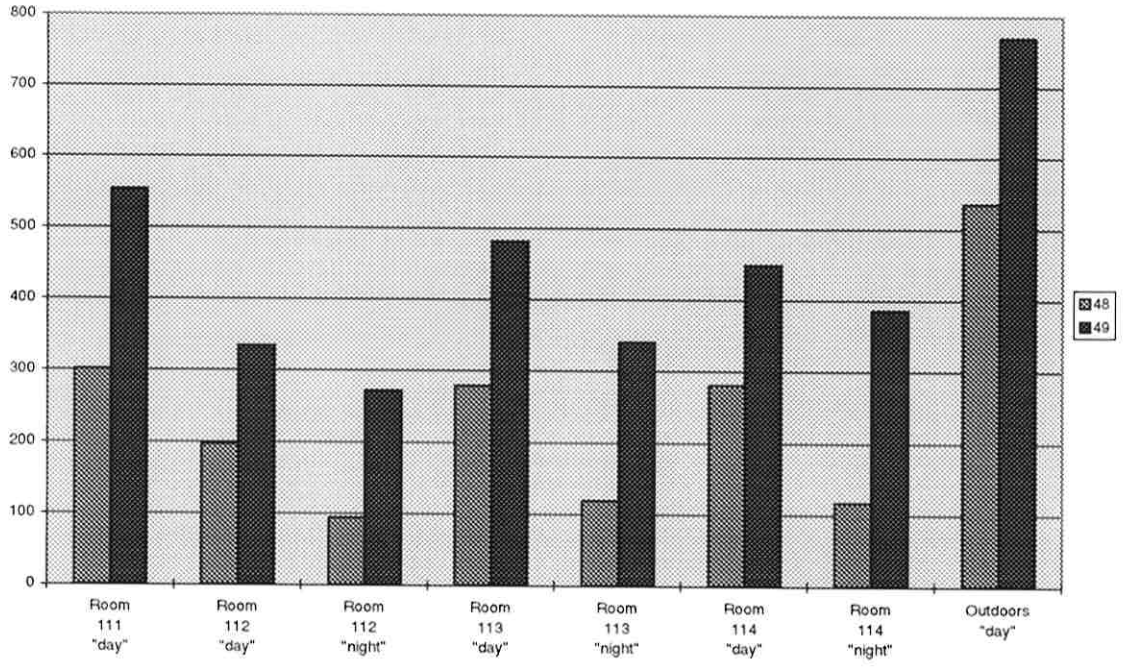

Figure 6.9 Total VOC-values from charcoal analysis for carpeted rooms and hard floor together with outdoor values.