Solution to the Environment Issues in the National Museum

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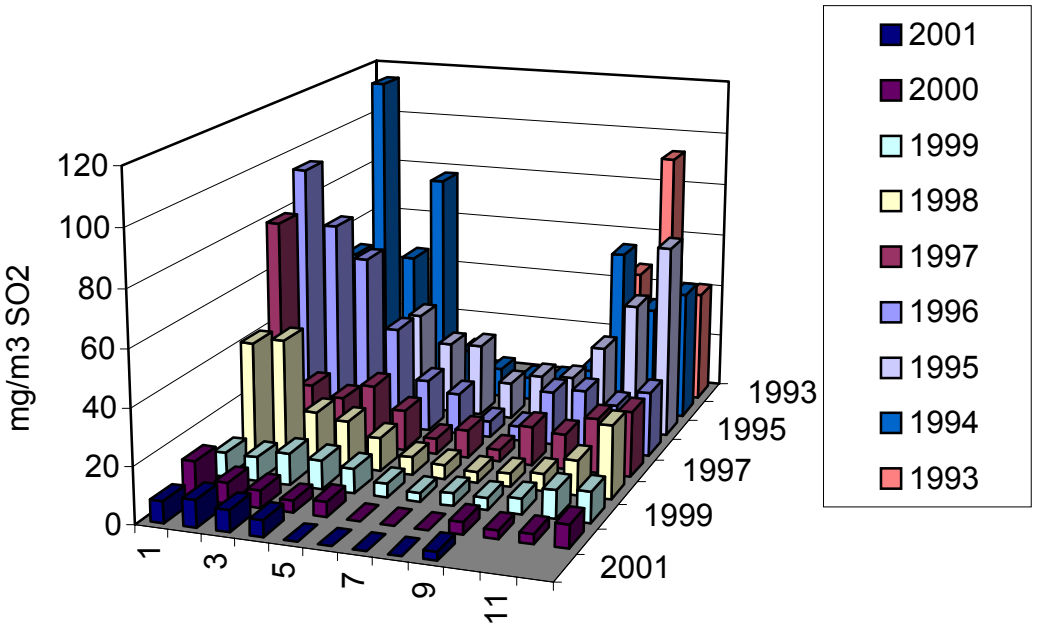
The National museum manages a collection fund of approximately 13 000 000 items, many of which are unique from the national, as well as the world-wide point of view. Its challenge is to preserve the heritage collections in a good condition for future generations and to present them to the public. Material ageing and gradual decay of objects can obviously not be entirely prevented. This process may, however be retarded, thus minimising the impact of the object authenticity. The only effective way of achieving this is thorough prevention care, which means ensuring the optimum deposition conditions and minimisation of all risks.

I am sorry to say that the National museum in Prague, the largest museum in our country, which should serve as an example and advisor to the other local museum institutions, has not yet developed a common conception of preventive care for the museum as a whole. Consequently, the care implementation is based on decisions of individual branch directors or department executives, who do not cooperate in this respect. Whereas the Naprstkovo museum, one of the National museum branches, has already established an independent department of collection funds treatment liasing with restoration facilities, other branches do not have such departments despite their continuous demand. The Zoological department of the Natural science museum, with respect to the character of their collection, has taken necessary measures to ensure suitable environment in its exposition and equipped premises with humidizers, covered window panes with UV protective films and fabric blinds. However, no such steps were taken in exposition of the Historical museum.

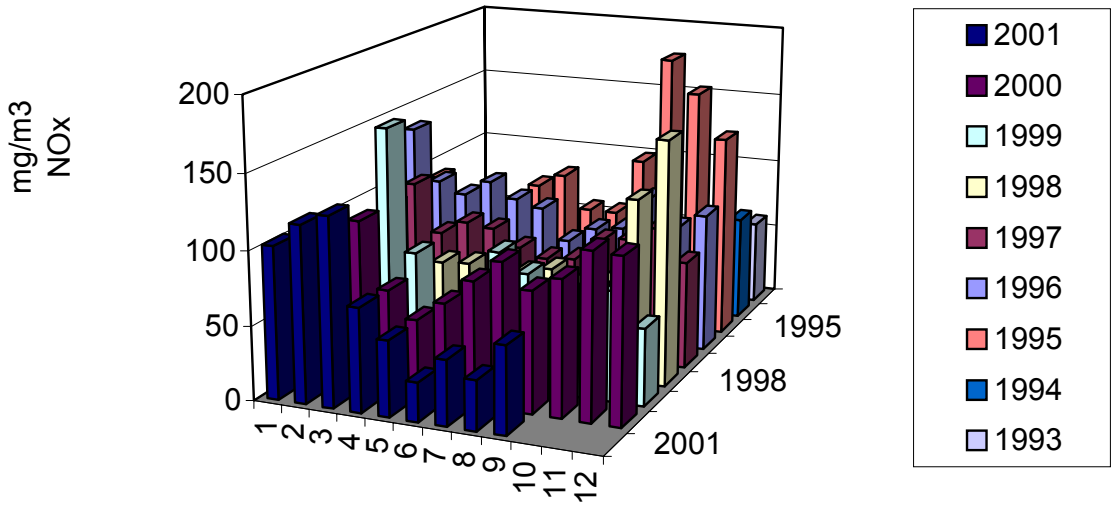
We can say that the above described situation has recently improved and most of the executives begun to appreciate the importance of preventive care. The fact that definitely speaks on the NM side is taking part in solving the preventive care issues within the international ICCROM project, which resulted in an edition of a handbook “Preventive care of collection objects “. This publication saw a great success among the museum workers, as confirmed by a fast out of print of the first edition and the preparation of a second edition. Our department, newly renamed to Preventive Conservation Laboratory (from old Research Chemical Laboratory) has been monitoring the environment in the main building premises of the NM in the past 2 years. A year ago we extended our activities to the other buildings and deposits, for example the exposition of the Bedrich Smetana Museum, deposits of the NM Library and the Historical Museum in Terezin, and freshly the Vitkov monument, recently devolved to the Modern History department of the Historical Museum.

Within the grant project of the Ministry of Culture aimed at preventive care of archaeological metal objects and new methods of collections funds conservation, we proceeded to monitoring of particular crucial factors on collection objects. Effects of these factors usually proceed concurrently, their negative impacts usually interfere and add up within a long- term time frame.

To obtain additional information on the environment quality, concentration of particular pollutants (SO_2, NO_x), infiltrating to museum premises from outside, was measured by means of passive sorption. Whereas the SO_2 content in the atmosphere has recently decreased, thanks to the implementation of emission limits for atmosphere pollution, the NO_x concentration in Prague has been the highest in the Czech Republic, showing a slight increase due to the increasing traffic density in the city centre. This is also confirmed by measurements of the Public Health Service of Prague. The above described situation is well illustrated by following graphs.



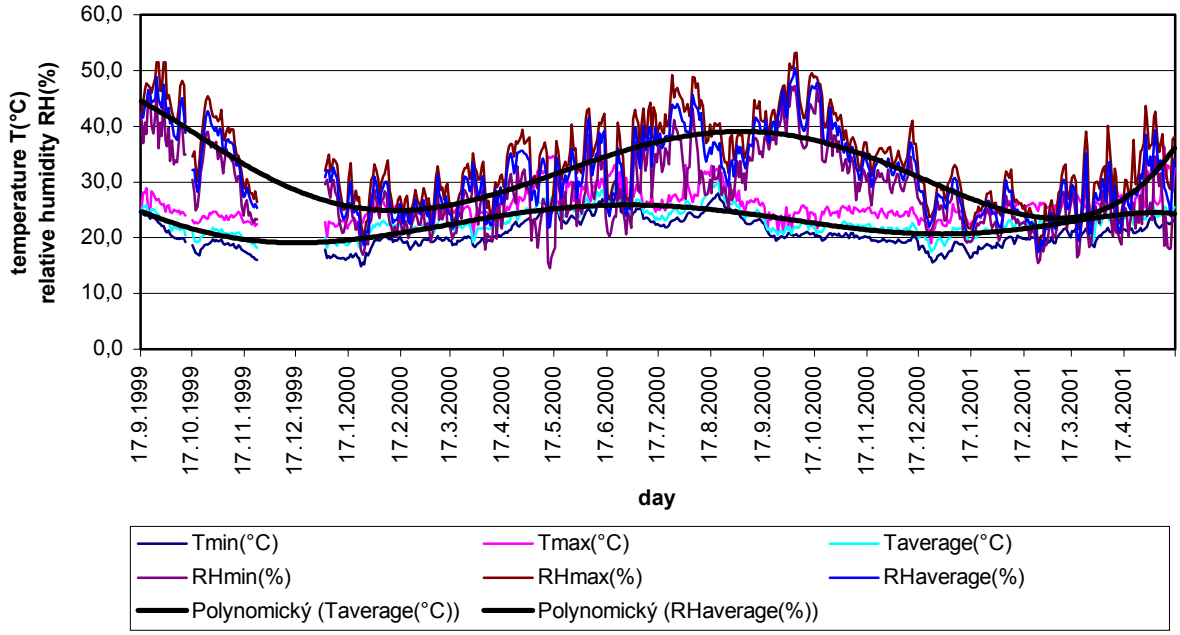
SO_2 (mg/m^3) – the National Museum surrounding exterior environment



NO_x (mg/m^3) – the National Museum surrounding exterior environment

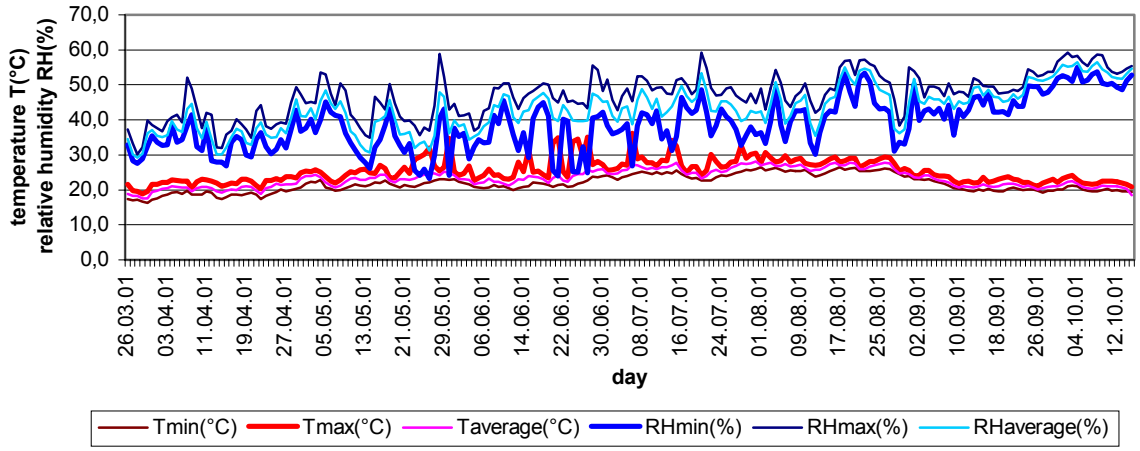
These measurements were performed from July to September last year, and subsequently from February till July this year. The SO_2 concentration is lowered due to absorption of the gas on alkaline surfaces reaching 10-15% of the outer pollution level (0,8 – 1,8 μgm^{-3}). The NO_x concentrations are significantly higher (due to the location of the main building, adjacent to a center dense traffic), reaching values from 16,6 till 45 μgm^{-3}. Obtained results show the NO_x level dependence on the distance and isolation from the surrounding traffic. NO_x concentration on the 3rd floor is lower than at the ground floor. Most of NO_x penetrates into the entrance hall which is the most open to the surroundings. We can as well assume the influence of organic pollutants in premises visited by public and staff. Its determination is, however, unaffordable for us now. Pollution by NO_x is higher than desirable but it is impossible to reach lower values unless the air is filtrated in the center. Afterwards this should be a question of reconstruction which is expected to take place in near future. It is well known that the recommended temperature range for an exhibition is around 20 – 22° C and the relative humidity RH value should be approximately 50%. Fluctuation of these values is usually much more damaging for the collection objects than permanently higher or lower values, although neither these cases should be overseen. As you can see from the enclosed

chart, temperature increases mainly in the summer time, which, as will be shown later, is related to inadequate illumination. IR slot, then causes a damage by the radiation heat, plays its role in an increase of the room temperature and consequently causes a decrease of the air humidity.



Measurements results RH -T in the National Museum in exhibition hall prehistory No. 146 on the 1st floor (16.9.1999 – 17.4.2001)

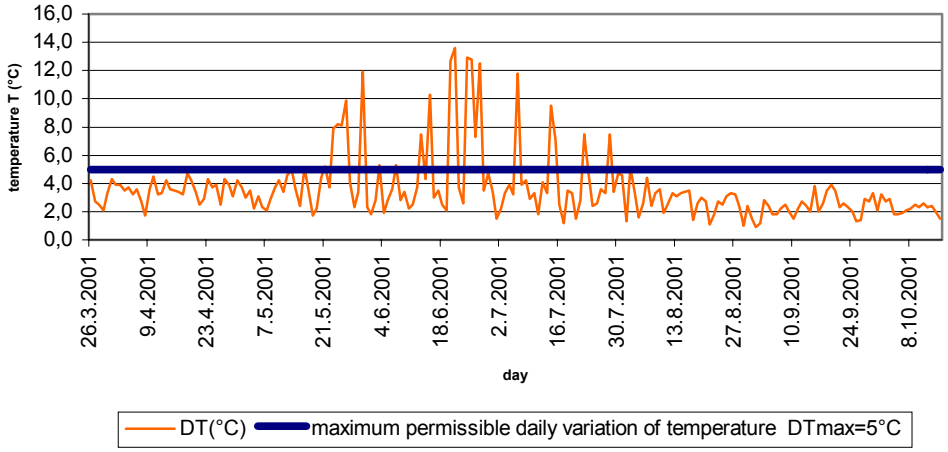
Fluctuating IR radiation intensity causes fluctuations of both of these quantities. The RH decreases mainly in winter, due to the heating, increases in summer and fluctuates thanks to high temperatures differences during the day. The chart shows a direct relation between the temperature maxims and humidity minims.



Measurements results RH -T in the National Museum in exhibition hall prehistory No. 142 on the 1st floor (26.3.2001 – 15.10.2001)

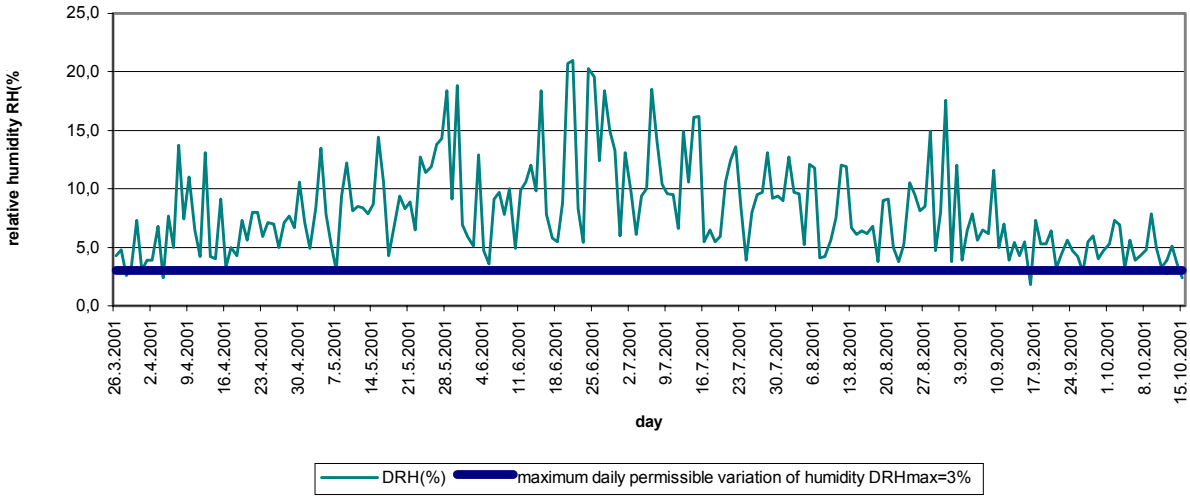
The values are determined in 1 hour period by means of temperature-humidity sensors produced by a Czech company COMET. The values presented here are the calculated maximum, minimum and average daily values. The maximum daily deviation at a particular place during a particular period reaches up to 21% of RH, which corresponds to 49% divergence from the average value of the RH similarly, the maximum temperature deviation is 13,6%, corresponding to 58% divergence of the average value. With regards to the

recommended maximum daily deviations, stated as 3% for RH and 5° C for T it is clear that the found values are alarming. Temperature fluctuations in the monitored period meet these criteria in app. 83%.



The National Museum in exhibition hall prehistory No. 142, Maximum daily temperature variation DT (°C)

The chart shows that they are higher in the summer time. In the case of max daily deviations of the RH, only less than 3% lie below the criteria values, which comes clearly from the following chart.



The National Museum hall prehistory No. 142, Maximum daily humidity variation DRH(%)

There is a relation with the inadequate daily illumination, but the values reflect as well visitors' density and disorganized ventilation, these being less adjustable.

Light damages and may further destroy many of museum objects which are presented to the public. It is though necessary to keep a high standard of exposition and illumination to ensure the smallest possible damage and, on the other hand, the best visibility by a visitor. Daylight is composed next to the visible (380-780 nm) light region of the ultra violet part (100-380nm) and infra red (780-10^6). The shorter wave length, the more intense severity of damage it may cause. That is why the UV lengths are especially dangerous. Regarding the fact that the light effect cumulates, the objects can be damage by even low-length light if the exposure time is long enough. The damage extent depends on the intensity if illumination E(lx) = square density of the light year, descending on a unit area, the wave length λ (nm) , the total exposure (lx.h/year) = equals to the intensity level of illumination and time of

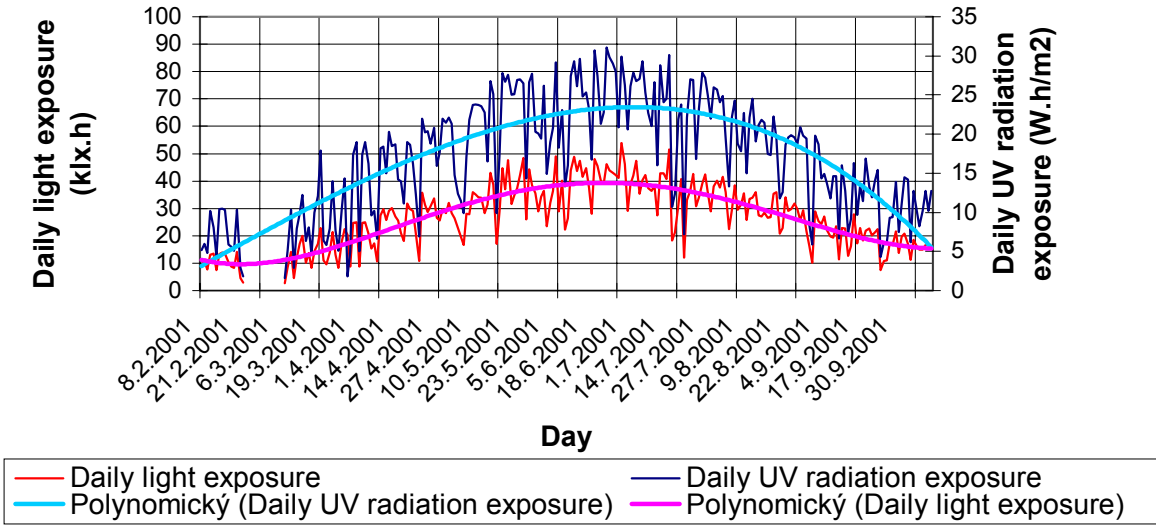
illumination, the material properties (organic materials are light sensitive, such as a fabrics, leather or inorganic materials - metals, silicates which are almost immune to light). The damage extent depends as well on the material condition, age and level of its damage. Museum objects are divided into 3 categories as to the dependence on light sensitivity (see the table).

Table 1: Three categories of museum objects divided by the sensitivity for the light and UV radiation

Categories of sensitivity	Exhibits
Very sensitive	Textile, costumes, tapestry, natural fibres, writing ink, newspaper, all paper and greaseproof paper works, watercolours, changeable dyes and pigments (of natural origin), most of the historical dyed fabrics, old dyed photographs and slides, stamps, painted and dyed wood, dyed leather, fur, feather, most of the natural science collections including botanical specimens Recommended values: Luminosity 50 lx, exposure to radiation 3,75 mW/m^2, UV radiation share 75 µW/lm, exposure to light 50 klx.h/year, exposure to UV radiation 16,5 W.h/year.
Mid-sensitive	Textiles coloured by unchangeable dyes, oil and tempera paintings realised by quality pigments, indigo, modern coloured photography, fresco, rag paper, undyed leather, horn, bone, ivory, undyed wood and varnishes (Oriental and European), some plastic. Recommended values: Luminosity 200 lx, exposure to radiation 15 mW/m^2, UV radiation share 75 µW/lm, exposure to light 480 klx.h/year, exposure to UV radiation 66,7 W.h/year.
Not sensitive	Metal, stone, glass, ceramics, jewellery, enamel, most of the minerals, natural pigments. Luminosity, light exposition and UV radiation unlimited, depends on the exposition situation. Max illumination is mostly 1000 lx.

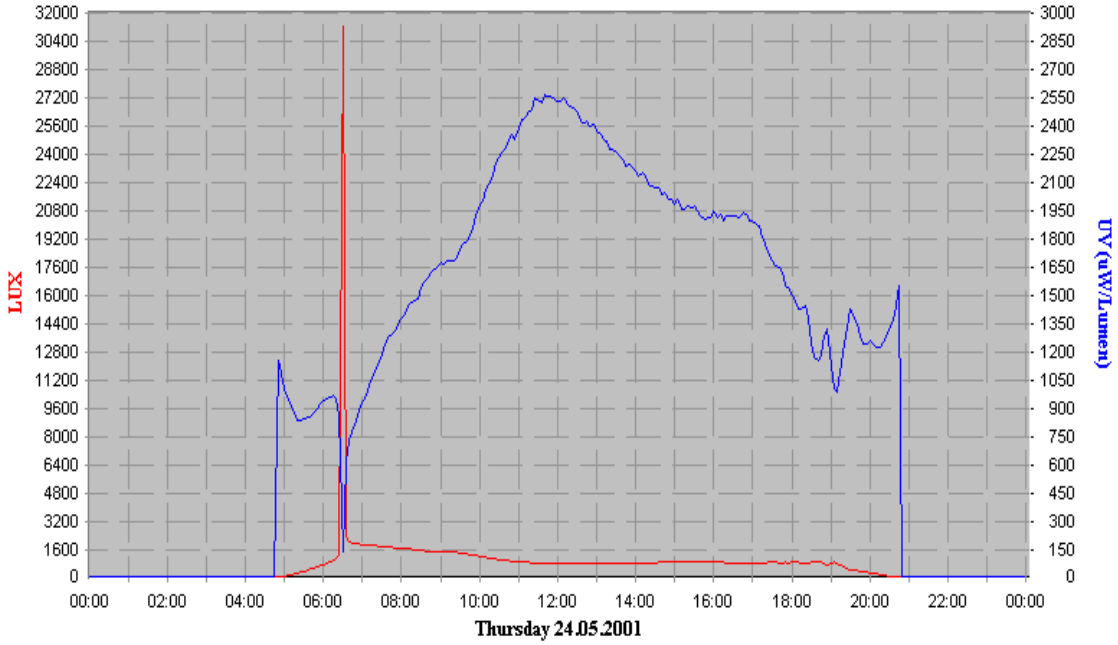
It can be seen that in the exhibition room “Prehistory” there are mostly objects of the 3rd type (stone, metals) and, only to a lesser extent, objects of the second type (bones, ivory). Nevertheless, it is necessary to categorize the exhibited objects as the mid-sensitive, which means that light and UV radiation may reach following values: luminosity 200lx, share of the UV exposure 75 µW/lm, exposure to the light 480 klx.h/year and an exposure to UV radiation 66,7 W.h/year (µW/lumen).

To measure the illumination intensity in the “Prehistory” exhibition premises, the ULM luxmeter, the product of the Henwell Environmental company, was used. This devise enables measurements and storage of illumination data (lx), UV radiation share (µW/lumen) and values of daily exposure to light (klx.h) and UV radiation (W.h/m^2). The Table 2 of measured values reveals that the average daily values of illumination from April to September significantly exceed the recommended value for the mid-sensitive objects, which is 200 lx, so it is 10 times more. Recommended total annual exposure to light (approx. 7,5 Mlx.h/year was determined) is then exceeded 15 times. The chart shows that average daily illumination intensity – luminosity considerably depends on the season and reaches maximum values in June and July. The analogous dependence is obvious from the maximum daily illumination intensity.



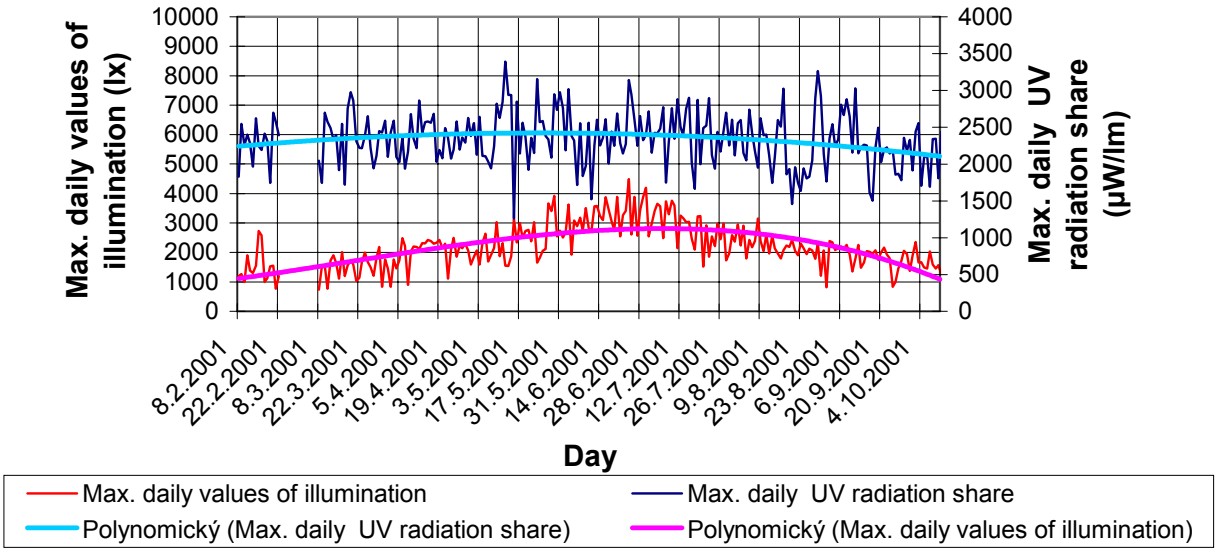
Daily light exposure and daily UV radiation exposure in the exhibition hall of PREHISTORY department – the National Museum in Prague

Relating to this must be said that considerable local maxim of illumination intensity with value 20 – 30 klx, irregularly recorded around 7 o'clock in the morning in May and August, were not included in consideration about luminosity.



Values of illumination (lx) and UV radiation share (uW/lm) in the exhibition hall of prehistory No. 142 – the National Museum

The reason of unfavourable values is obviously a short time penetration of straight solar light through windows of the Prehistory exhibition hall between buildings surrounding the main building of the NM. Much more unfavourable values were measured in the case of UV radiation. The recommended share of UV radiation is 75 μW/lm for the museum environment, which corresponds with the irradiation intensity of UV radiation 15 mW/m^2. The average daily intensity of UV radiation from April to September significantly exceed this value approx. 88 times as shown in the Table 2. The recommended annual UV exposure is 65,7 W.h/m^2. The table of measured values reveals that the annual UV exposure value is 4910 W.h/m^2 which is 75 times more. The dependence of UV radiation exposure on a season has a very similar progres as the dependence of light exposure.



Max. daily values of illumination and max. daily UV radiation share in the inhibition hall of PREHISTORY department – National Museum in Prague

It is clear from the picture that the location of maximum irradiation value corresponds to maximum luminosity value. Maximum daily UV radiation share during the year ranges around the average value, the dependence on a season is not very considerable. Further it was detected by measurement that items remote 8 meters from the window are exposed to the unacceptable illumination intensity which is more than 200 lx. Another important thing is that an acceptable intensity of UV radiation

(15 W.h/m^2), possibly the acceptable UV radiation share (75 µW/lm) is not managed in the exhibition hall at all (the distance 0-10 meters from the window).

From this mentioned results it definitely follows that the illumination of an Prehistory exhibition hall is not satisfactory neither from the light point view nor from the UV radiation standpoint. This factor has an influence on the temperature and relative humidity. The intensity of daily light and UV radiation share is possible to reduce by the installation of textile blinds or curtains. These protect the exhibition hall from IR radiation at the same time.

Well fitted blinds are able to reflect the majority of IR radiation and even to limit an undesirable increase and fluctuation of temperature and air humidity. The application of polymer foil capable of the UV absorption is not adequate because it does not stop the penetration of the unnecessary daily light. The foils with UV filters supplied in Czech Republic do not guarantee a long-term effectiveness. It will be necessary to extend the monitoring of illumination and UV radiation even in exhibition halls where are shown the collections of organic - very light-sensitive materials (the zoological, entomological and ethnographical department), in spite of that mentioned foils were used on the windows in the past. The collection care is more demanding from the standpoint of protection from the light and UV radiation. The implemented measurements have provided us the precious information and impulses which we gonna develop.

Table 2: Summarization of results for light and UV radiation measurement in the exhibition hall of Prehistory department – the National Museum in Prague

Month	Time of measurement (h/month)	Average time of illumination (h/day)	Month's light exposure (Mlx.h)	Average daily light exposure (klx.h)	Average daily illumination intensity (lx)	Average max. daily values of illumination (lx)	Month's UV radiation exposure ($W.h/m^2$)	Average daily UV radiation exposure ($W.h/m^2$)	Average daily intensity of radiation (mW/m^2)	Average max daily UV radiation share ($\mu W/lm$)
January		*8:02*	*0.200*	*6.40*			*150.0*			
February	352.1	9:22	0.300	10.63		1489	199.4	7.12		2292
March	563.8	11:21	0.439	14.53		1528	280.9	8.83		2371
April	720	13:18	0.746	24.85	**1872**	2007	482.2	16.07	**1210**	2349
May	744.1	15:15	1.024	33.04	**2164**	2395	667.2	21.52	**1410**	2475
June	720	16:02	1.183	39.42	**2376**	3215	719.9	24.00	**1497**	2377
July	742	15:40	1.117	36.03	**2299**	2799	722.7	23.31	**1488**	2413
August	744.1	14:16	0.929	29.98	**2053**	2204	598.6	19.31	**1352**	2245
September	720	12:03	0.579	19.30	**1602**	1832	359.0	11.98	**960**	2243
October	247.7	11:17	0.494	16.62		1674	329.6	11.20		2132
November		*9:24*	*0.300*	*10.00*			*250.0*	*8.30*		
December		*8:00*	*0.200*	*6.40*			*150.0*	*5.00*		
Average		12:00	0.63	21.89	**2061**	2127	409.1	14.24	**1320**	2353
Recommended values			0.04	1.33	**200**		5.48	0.18	**15**	
The breach of recommended values			15.7 times	16.4 times	**10.6 times**		74.6 times	79.1 times	**88 times**	
In February, March and October the measurements were incomplete and the values were calculated in a shorter period										
The values for January, November and December were valued and are written by italic										
The total year period of illumination in exhibition hall = 4380 hours.										
The sum – a year light exposure ($Mlx.h/m^2$)			**7.51**							
The recommended year light exposure			**0.48**							
The breach of recommended values			**15.6 times**							
The sum – a month UV radiation exposure							**4910**			
The recommended year UV radiation exposure							**65.7**			
The breach of recommended values							**74.27 times**			