MINERAL FIBRES MEASUREMENTS IN THE URBAN ENVIRONMENT

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European Conference on Asbestos Risks and Management
Rome, 4 – 6 December 2006
Russia is largest asbestos producer and consumer in the world.
In Russia, only chrysotile is produced and used in civil purposes in contrast to the widespread, past usage of crocidolite or amosite asbestos in Western Europe, United States and Australia.

Over 50 percent of chrysotile production was and is used now for inner consumption (predominantly for asbestos cement production).
Amphiboles (anthophylite and crocidolite) were produced from 1947 until 1994 in small amounts (about 40 thousand tons for all history of production) for special non-civil purposes at two deposits in Sverdlovsk region.
Погружение
в лесные дебри

Елки-палки!.. Как живые! Каждая иголочка на месте, покрыта слоем голубоватой взвеси, словно инеем. Прикоснешься к ней, и эта пыльца опадает, как робкий первый снег.

Карьер «Лазурный», расположенный близ Нижнего Тагила, заслужил себе такое название благодаря необычному для уральских водоемов, как в открытом море. Когда-то на этом месте из земных недр извлекали губчатый асбест, края карьера изрезаны машинами, как спиаль.
Chrysotile containing materials allowed for use in the Russian Federation according to:
2.1.2/2.2.1.1009–00 State Standard ”List of asbestos-cement products recommended for use”;
Letter no. 1100/3232-1-110 of Chief Deputy Hygienist of the Russian Federation from 9.11.2001 “Asbestos products recommended for production and use at transport, equipment, industrial and common life commodities”.
Safety measures in use of these materials are determined by 2.2.3.757 - 99 State Sanitary Regulations “Use of asbestos and asbestos-containing materials”.

Recently man-made mineral fibres (MMMF) have found common applications as insulation wools for sound, heat and fire protection.
Maximum permissible concentrations of harmful substances in the working zone air (total dust, mg/m³).
Hygienic standards. GN 2.2.5.1313-03

<table>
<thead>
<tr>
<th>1802. Silicate containing dusts, silicates, alumosilicates:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>asbestos and mixed dusts contained more than 20% of asbestos</td>
<td>2*/0.5**</td>
</tr>
<tr>
<td>dusts contained from 10 to 20% of asbestos</td>
<td>2*/1**</td>
</tr>
<tr>
<td>dusts contained less than 10% of asbestos</td>
<td>4*/2**</td>
</tr>
<tr>
<td>asbestos cement dusts if magnesia dioxide contain not more 5%, chrome oxide not more 7%, ferric oxide not more 10%</td>
<td>6*/4**</td>
</tr>
<tr>
<td>asbestos bakelite, asbestos rubber</td>
<td>–*/4**</td>
</tr>
<tr>
<td>talk, natural talk contained tremolite, actinolite, antophillite, etc.), contained not more 10% silica dioxide</td>
<td>–*/4**</td>
</tr>
<tr>
<td>man made mineral fibers silica contained fibers, synthetic vitreous fibers (glass wool, mineral wool, slag wool, mullite) contained not more 5% Cr³⁺)</td>
<td>–*/4**</td>
</tr>
<tr>
<td>zeolites (natural and artificial)</td>
<td>6*/2**</td>
</tr>
</tbody>
</table>

* - 30 minutes STEL / ** - 8-hour TWA
“Maximum permissible concentrations of harmful substances in the ambient air”

Hygienic standards. GN 2.1.6.1338-03

437. Asbestos 0,06 fibers/ml

(by phase contrast optical microscopy)
Asbestos fibres have been used in a broad variety of building materials.

Typical examples include asbestos cement products such as wall panels, roofing plates, water tubes and sewage pipes.
This pilot study was conducted to estimate the concentrations of respirable fibres in indoor and outdoor air as a source of nonoccupational exposure to asbestos and other fibrous particles.
The results of phase-contrast optical microscopy (PCOM) (all fibres >5 μm in length, <3 μm in diameter, aspect ratio >3/1 were enumerated at 450 X magnification) were confirmed with fibre identification by scanning (SEM) and transmission (TEM) electron microscopy and X-ray microanalysis (EDXA) to identify and count different fibrous particles at 1 500 X.
The concentration of short chrysotile fibres was also verified by transmission electron microscopy at higher magnifications.

The detection limit of the measurements was about 0.001 f/ml.
The survey included a total of twenty buildings in Moscow:

1. Fourteen residential houses
   - three 5-storey panel buildings from the 1960's,
   - four 12-storey panel buildings from the 1970's,
   - three 16-storey panel buildings from the 1980's,
   - three high-rise brick buildings from the 1950's
   - and one 9-storey panel building from the 1970's

2. Six public buildings
   - hospital,
   - covered stadium,
   - theatre
   - and three office buildings
All the buildings contained some asbestos materials: most often asbestos cement panels and pipes in dwelling areas or thermal insulations usually contained asbestos and synthetic vitreous fibers in heating rooms at the basement.
In residential houses, dust samples were taken:

- from entrance areas on the ground floor;
- near waste ducts and fire stair cases on upper floors with direct air connection to flats area;
- from indoor air of ordinary flats.
Fibre concentrations were measured also at five locations near Moscow motorways (North, East, South, West and Center).

A series of measurements were made near a thermal power plant where large quantities of asbestos and MMMF insulations were removed, repaired and installed.
Five points where technical maintenance of motorcars is provided were also examined:

- one private garage, where individual technical service for domestic and old imported cars is provided;

- two car-repair shops situated on highways for domestic and imported cars;
- authorized service center for “Lada” cars;

- department of technical services for small lorries, produced by domestic industry consists of two big free connected departments: garage and repair department (works with asbestos containing friction materials using high speed processing equipment are performed in turnery section of repair department).
For results accessing we have used:

- established in Russia threshold level (measured by optical microscopy)
  0,06 f/ml

- and proposed in Russia for chrysotile fibres (measured by SEM with EDXA) “air clearness indicator”
  \( \leq 0,01 \text{ f/ml} \).
In summertime samples, low concentrations of all fibres (> 5µm) and chrysotile (>1 µm) were found at five locations near Moscow motorways. The mean concentrations were 0.002 f/ml and below 0.001 f/ml, respectively.
The concentration of all respirable fibres (>5 μm) ranged from <0,001 to 0,058 f/ml (n=234) in fifteen residential and public buildings, which were sampled without ongoing renovation.

By SEM analyses, the fibrous particles consisted of:
- organic fibres (55 %),
- chrysotile (7 %)
- and other inorganic fibres (38 %).
Fibre concentrations in hospital building air

Concentration f/ml

Corridor Elevator hall Street near entrance of building

- Corridor: 0.022
- Elevator hall: 0.02
- Street near entrance of building: 0.011

- All fibers longer 5 mkm (optical microscopy)
- Chrysotile fibers longer 5 mkm (electron microscopy)
Fiber concentrations in living buildings

Concentration (f/ml)

All fibers longer 5 mkm (PCOM)
Organic fibers longer 5 mkm (SEM)
Chrysotile asbestos fibers longer 5 mkm (SEM)
Other inorganic fibers longer 5 mkm (SEM)
Fiber concentrations in 2-storey office building air

Concentration (f/ml)

- All fibers longer 5 mkm (optical microscopy)
  - Second floor: 0.011
  - Third floor: 0.011

- Chrysotile fibers longer 5 mkm (electron microscopy)
  - Second floor: 0.001
  - Third floor: 0.001
In one residential house and three public buildings (theatre, two offices), the sampling was made during the period of large renovations but without ongoing working activities.
The mean concentration of all respirable fibres was 0.087 (range 0.002-0.570) f/ml in 77 samples, which were taken from five renovated buildings.

About 52 % of these fibres (>5 μm) were chrysotile.

Gypsum and MMMF fibres were identified in some samples but no amphibole asbestos was detected.
Fiber concentrations in the theatre building air

Conc. (f/ml)

- All fibers longer 5 mkm (optical microscopy)
- Organic fibers longer 5 mkm (electron microscopy)
- Chrysotile fibers longer 5 mkm (electron microscopy)
- Other inorganic fibers longer 5 mkm (electron microscopy)

Old building technical premises
- 0.008
- 0.009

New building technical premises
- 0.003
- 0.004

Old building scene
- 0.011
- 0.006

All fibers longer 5 mkm (optical microscopy)
- 0.009
- 0.004

Organic fibers longer 5 mkm (electron microscopy)
- 0.008
- 0.012

Chrysotile fibers longer 5 mkm (electron microscopy)
- 0.002
- 0.003

Other inorganic fibers longer 5 mkm (electron microscopy)
- 0.003
- 0.004
Fiber concentrations in the covered stadium building air

Concentration (f/ml)

Hall
- All fibers longer 5 mkm (optical microscopy) = 0.012
- Organic fibers longer 5 mkm (electron microscopy) = 0.006
- Chrysotile fibers longer 5 mkm (electron microscopy) = 0.002
- Other inorganic fibers longer 5 mkm (electron microscopy) = 0.007

Technical premises
- All fibers longer 5 mkm (optical microscopy) = 0.012
- Organic fibers longer 5 mkm (electron microscopy) = 0.009
- Chrysotile fibers longer 5 mkm (electron microscopy) = 0.009
- Other inorganic fibers longer 5 mkm (electron microscopy) = 0.01
Fiber concentrations in the 3-storey office building air

- **Second floor**
  - All fibers: 0.17 fibres/ml
  - Chrysotile fibers longer 5 mkm: 0.11 fibres/ml

- **Ground floor**
  - All fibers: 0.37 fibres/ml
  - Chrysotile fibers longer 5 mkm: 0.25 fibres/ml

*Notes:
- All fibers longer 5 mkm (optical microscopy)
- Chrysotile fibers longer 5 mkm (electron microscopy)*
Fibres concentrations in the air at car repair stations (f/ml)

<table>
<thead>
<tr>
<th>Place of sampling</th>
<th>PCOM (all fibers longer 5 mcm.)</th>
<th>SEM (chrysotile fibers longer 1 mcm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conc. (f/ml)</td>
<td>Samples &gt; 0,01 f/ml</td>
</tr>
<tr>
<td>Private garage</td>
<td>0,008</td>
<td>no</td>
</tr>
<tr>
<td>Car-repair shop - 1</td>
<td>0,005</td>
<td>no</td>
</tr>
<tr>
<td>Car-repair shop - 2</td>
<td>0,004</td>
<td>no</td>
</tr>
<tr>
<td>“Lada” authorized service center</td>
<td>0,007</td>
<td>3 from 10</td>
</tr>
</tbody>
</table>
## Fibres concentrations in the air at car repair stations (f/ml)

<table>
<thead>
<tr>
<th>Place of sampling</th>
<th>PCOM</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conc.</td>
<td>Samples &gt; 0.01 f/ml</td>
</tr>
<tr>
<td>Department of technical services for small lorries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unit repair section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>before beginning of works</td>
<td>0.013</td>
<td>2</td>
</tr>
<tr>
<td>high speed processing of asbestos containing friction materials</td>
<td>3.1</td>
<td>3</td>
</tr>
<tr>
<td>mechanical section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>before processing</td>
<td>0.024</td>
<td>3</td>
</tr>
<tr>
<td>processing</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>turnery section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>before processing</td>
<td>0.29</td>
<td>3</td>
</tr>
<tr>
<td>processing</td>
<td>3.1</td>
<td>3</td>
</tr>
<tr>
<td>Garage</td>
<td>0.017</td>
<td>4</td>
</tr>
</tbody>
</table>
When asbestos cement materials demolition is proceeded without use of high speed electric equipment emission of free asbestos fibres is minimal.

In most samples conglomerates of fibrous and nonfibrous particles were found, unable to float in the air, tend to fast precipitation.
Textile chrysotile fibres and EDXA spectra.
Chrysotile fibres for asbestos cement production and EDXA spectra
Chrysotile fibre from asbestos cement matrix and EDXA spectra
Conglomerates of chrysotile fibres with other particles released from different asbestos contained materials
In general, the results of this study in Moscow are consistent with measurements of nonoccupational exposure to fibrous particles in other urban areas in Russia.
In two large industrial centers concentrations of respirable fibres in the ambient air (>5 μm) ranged from 0.001 to 0.06 f/ml.

These samples were taken from public buildings, urban environment and above asbestos cement roof for the estimation of fibre emissions from asbestos products, which are permitted for use in civil engineering according to Russian standards.

From the total number of airborne fibres, chrysotile formed 1.8 - 5.5 % when the particles were classified by electron microscopy.

(Plotko E. G. et al., 1999; Kuzmin S.V. et al. 2003)
Conclusion

In outdoor samples, the background level of chrysotile fibres was below 0.001 f/ml (>1 μm), which indicated only minimal environmental exposure originating from the friction materials of motor vehicles.

Local emissions from industrial activities may occasionally contribute to the air contamination of nearby residential areas.
Conclusion

At most sampling points of our studies the concentration of asbestos fibres was below the limit of 0.06 f/ml (measured by PCOM) that was established in Russia for atmospheric air of occupied places and proposed “clearance value” established as 0.01 f/ml (measured by SEM-EDXA).

Exceptions were cases when friable asbestos and MMMF containing materials were destroyed without any precautions.
Conclusion

On the average, only 7% of the fibres were chrysotile (by electron microscopy analyses). During renovation the dust concentrations were much higher and about one half of all respirable fibres were chrysotile.
Conclusion

Asbestos cement materials and other asbestos containing construction materials when used with ordinary precautions without intensive destruction can not release asbestos fibers into the environment.

Uncontrolled demolition and repair of friable asbestos and MMMF materials can be an important source of occupational and nonoccupational exposure to mineral fibres.
Thank you for your attention
Worldwide Production of Asbestos in 2002

Canada: 241,000 tons
Russia: 750,000 tons
Kazakhstan: 235,000 tons
Japan: 18,000 tons
China: 450,000 tons
Brazil: 195,000 tons
India: 20,000 tons
South Africa: 13,000 tons
Zimbabwe: 135,000 tons
Colombia: 8,000 tons
Other Countries: 25,000 tons
TOTAL: 2,090,000 tons
Chrysotile deposit «Bazhenovskoe» is working out since 1889.
«Uralasbest» enterprise produces now about 25% of total world chrysotile production.
MESOTHELIOMA MORTALITY IN GREAT BRITAIN: ESTIMATING THE FUTURE BURDEN

December 2003
Mesothelioma observed and fitted/projected deaths among males aged 20-89, asbestos imports and estimated/projected exposure index

- Crocidolite
- Asbestos
- Chrysotile
- Exposure Index
- Central estimate
- Observed Mesothelioma deaths

Year: 1900 to 2050
Number of deaths: 0 to 2000
Asbestos Exposure / Imports Index: 0 to 200,000
SOURCE – JOHN HODGSON

Oldershaw P., 2004
Annual risk of death in the workplace

Health and Safety Commission Paper

Meeting Date: 4 July 2006
Type of Paper: Above the line

Paper File Ref:

Exemptions: None

HEALTH AND SAFETY COMMISSION
A comparison of the risks from different materials containing asbestos

A Paper by: Kevin Watkin and Geoff Lloyd
Name of Board Member lead: Giles Denham
Cleared by Jonathan Rees on 21 June 2006

Workplace activities

Annual risk of death per million

Spray and other insulation (dry) 1903
A1B and milliboards (dry) 274
Agriculture 104
Spray and Construction other insulation (wet) 75
Self employed 34
A1B and milliboards (wet) 13
Employees 7
Asbestos cement 7
TCs (dry) 0.8
TCs (wet) 0.1
TCs (wet) 0.03
Mesothelioma (cases per million person per year)

- Russia (Asbest City) *: 2,8
- Russia (Ekaterinburg region) *: 2,4
- Russia (republic Karelia) *: 3
- Latvia: 3
- Lithuania: 3
- Estonia*: 3
- Slovenia: 3
- Poland: 3
- Latvia: 3
- Slovakia: 4
- Japan: 5
- Romania: 6
- Hungary*: 8
- USA: 9
- Croatia: 10
- Finland: 11
- Norway: 11
- Sweden: 12
- Germany: 12
- Denmark: 13
- The Great Britain: 17
- France: 17
- Italy: 17
- Netherlands: 21
- Australia: 22
- Belgium: 29

«...The risk estimates used in the calculations ... were derived from past exposures to relatively high levels of chrysotile. Current levels of exposure are much lower ... and as such risk extrapolations may be an overestimate. There are several other reasons why there is a great deal of uncertainty regarding these risk estimates...»
Asbestos production and number of mesotheliomas in Russia (1871-2005)

Kashansky S V, 2006
In the areas of asbestos mines and mills of the Sverdlovsk Region mesothelioma incidence rates vary from 4.3 (Asbest - chrysotile) to 27.1 (Novoasbest - crocidolite), and reach 7.1 per million a year in the Sysertsky anthophyllite province of the Urals.
Dust levels at “Uralasbest” and incidence rates of malignant pleural mesothelioma in Asbest

(* - according to F.M. Kogan, 1986)

Kashansky S V, 2006
Occupational exposure to asbestos and man-made vitreous fibres and risk of lung cancer: a multicenter case-control study in Europe

Rafael Carel, Ann C. Olsson, David Zaridze, Neopilia Szeszenia-Dabrowska, Peter Rudnai, Jolanta Lissowska, Eleonora Fabianova, Adrian Cassidy, Dana Mates, Vladimir Bencko, Lenka Foretova, Vladimir Janout, Joelle Fevotte, Tony Fletcher, Andrea van Mannetje, Paul Brennan and Paolo Boffetta

Objectives: To investigate the contribution of occupational exposure to asbestos and man-made vitreous fibres (MMVF) to lung cancer in high-risk populations in Europe.

Methods: A multi-center case-control study was conducted in six Central and Eastern European countries and the UK, during the period 1998-2002. Comprehensive occupational and socio-demographic information was collected from 2205 newly diagnosed male lung cancer cases and 2305 frequency matched controls. Odds ratios (OR) of lung cancer were calculated after adjusting for other relevant occupational exposures and tobacco smoking.

Results: The OR for asbestos exposure was 0.92 (95% confidence interval (CI) 0.73-1.15) in Central and Eastern Europe and 1.85 (95%CI 1.07-3.21) in the UK. Similar OR were found for exposure to amphibole asbestos. The OR for MMVF exposure was 1.23 (95%CI 0.88-1.71) with no evidence of heterogeneity by country. No synergistic effect either between asbestos and MMVF or between any of them and smoking was found.

Conclusion: In this large community-based study occupational exposure to asbestos and MMVF does not appear to contribute to the lung cancer burden in men in Central and Eastern Europe. In contrast, in the UK we found an increased risk of lung cancer following exposure to asbestos. Differences in fibre type and circumstances of exposure may explain our results.