Refractory Ceramic Fiber (RCF) and Regulatory Changes
ASGE, June 2010
• **Refractory Ceramic Fiber** (RCF) materials are a common insulation type utilized in the thermal process industries for over 50 years.

• Increasing concerns over the health effects relating to RCF have caused players in the ceramic fiber industry to develop alternative fibre products, as well as to work with existing process upgrades to address concerns related to RCF.

• Today we’ll review some of the most recent changes to EH&S in relation to RCF as well as potential options to the consumer.
The RCFC members have been proactive in studying the health aspects of RCF for more than 20 years.

All members have helped to lead the work in the USA and in the EU through ECFIA in the fields of:
- Epidemiological (human) studies
- Toxicological (animal and in vitro) studies

The studies have been carried by independent scientists and organisations and are used as references by regulators.

Members of the RCFC provide occupational hygiene services to help its customers control and reduce RCF exposure at their premises.
Health and safety reference sources

- TC and members of the RCFC/ECFIA are not expert bodies in the field of toxicology and epidemiology
- We consistently rely upon officially recognised sources of information and advice.
- The most common sources of information are expert or regulatory bodies including:
  - US NTP, NIOSH, Cal OSHA, EU Commission, ECHA, AFSSET,
  - IARC, University of Cincinnati, Institute of Occupational Medicine, Fraunhofer Institute, ACGIH
  - The regulatory agencies of Canada, Australia and Korea.
Why are regulators concerned about RCF?

- History shows that fine asbestos fibres inhaled into the lungs may cause cancer.
- RCF is not asbestos.
- However, RCF has a higher biopersistence than most glass wools and mineral wools.
- Animal testing of RCF in the early 1990s showed signs of carcinogenicity.
- Human epidemiology has shown
  - reduction in lung function among smokers exposed to RCF
  - a correlation between pleural plaque development and cumulative RCF exposure
  - No increase in lung cancer above that found in general population
RCF is classified as a possible or probable carcinogenic substance by many agencies

• IARC (WHO) has classified RCF as a possible human carcinogen (Group 2B).
• In the USA NTP has classified respirable RCF as a substance reasonably anticipated to be carcinogenic.
• CEPA (Canada) has classified RCF as “Probably carcinogenic” (Group 2);
• In Europe RCF are classified as a carcinogenic substance in animals. (1B under new CLP classification system)
• ACGIH has classified RCF in category A2: Suspected human carcinogen
More and more stringent RCF airborne dust limits

- For some years, the RCFC has recommended a maximum workplace exposure of 0.5 f/ml.
- Many local jurisdictions have set up limit values for RCF to the same or even lower values:
  - France, Norway: 0.1 F/ml,
  - Sweden, Korea, California: 0.2 F/ml
  - NL, Australia, Austria: 0.5 F/ml
- Other organisations have recommended OELs, such as ACGIH, 0.2f/ml and NIOSH, 0.5f/ml.
- Most recent standard change is the PEL of 0.2 f/cc adopted by the State of California in February of 2010.

(1) NIOSH stands for National Institute for Occupational Safety and Health
Criteria for a Recommended Standard:  
Occupational Exposure to Refractory Ceramic Fibers (2006)  
The following statement is from the NIOSH document summary:

[...]NIOSH proposes a recommended exposure limit (REL) for RCFs of 0.5 F/cm³ of air as a time weighted average (TWA) concentration [...] Limiting airborne RCF exposures to this concentration will minimize the risk for lung cancer and irritation of the eyes and upper respiratory system and is achievable based on a review of exposure monitoring data collected from RCF manufacturers and users. However, because a residual risk of cancer [...] may still exist at the REL, continued efforts should be made toward reducing exposure to less than 0.2 F/cm³.
RCF Regulatory aspects

Summary of Cal-OSHA OEL
Passed into law: 3rd February 2010
Effective: 3rd August 2010
Cal-OSHA regulation: simple summary

- Applies to RCF dust in the workplace.
- Legally enforceable from 3rd August 2010
- Workplace PEL of 0.2 f/ml TWA
- Inspectors may accept individual measurements up to 0.5 f/ml …..
- If the employer can demonstrate that normal exposure is maintained at below 0.2 f/ml
- Declared intention is that employers using RCF should be able to demonstrate regular workplace dust monitoring.
RCF Regulatory aspects
Europe
(relevant to exporters as well)

Summary of European REACH
RCF is “Substance of Very High Concern”
RCF added to “Annex XV” on January 13th 2010
Registration, Evaluation and Authorisation of Chemicals (REACH)

- RCF was classified by EU in 1997 as carcinogen 2 following a full review of available test data on animals (97/69/EC).
- This new EU regulation came into force on the 1\textsuperscript{st} of June 2007. Under REACH carcinogen 2 becomes “1B”.
- A registration dossier has to be submitted for each substance, providing a body of HSE information. These include:
  - AES (Alkaline Earth Silicates) deadline: 1\textsuperscript{st} December 2010
  - RCF (Refractory Ceramic Fibres) deadline: 1\textsuperscript{st} December 2010
  - PCW (polycrystalline fibres); deadline: 1\textsuperscript{st} of December 2013.
- The new REACH regulation states that Carcinogen 1A and 1B are considered as Substances of Very High Concern (SVHC), this includes RCF.
RCF is a Substance of Very High Concern (SVHC)

• Member States may propose substances to be added to Annex XV (The candidate list for authorisation).

• This candidate list is the portal for potential further regulation including restrictions and authorisation.

• In September, Germany submitted 2 dossiers to ECHA, requesting the inclusion of RCF and ZrRCF in the candidate list for authorisation.

• RCF’s were added to the candidate list in January 2010.
Consequences of adding RCF to the candidate list

- Suppliers of RCF articles containing more than 0.1% RCF are required to provide sufficient information to the users to allow safe use of the article. (i.e. MSDS…)

- A further step is required under REACH to get to the authorisation process.

- If RCF is “elected” the process might take another 2-3 years before it happens.

- Authorisation would mean that RCF could only be used in precisely defined application areas and be banned elsewhere.
Example: What does it mean to reduce dust levels?
RCF lines at St Marcellin (0.1 f/ml from 1st July 09)

- RCF workshop is divided from Superwool section by a wall.
- Operators wear respirators to achieve 0.1 f/ml
- Open environment is typically 0.2 f/ml
RCF alternatives

The industry (TC included) has developed a series of alternatives to RCF in many applications
One unanimous recommendation given by all regulators is to look for alternatives to RCF.

For many years, the refractory material industry have been providing a series of non-fibrous products that can be used as an alternative to RCF in a number of applications (IFB’s, Monolithics, Micro-porous products).

Furthermore, listening to its customers, TC has worked since early 90’s on the development of fibrous alternatives.

Over time this constant effort has provided fibrous alternatives with improved properties in terms of temperature, chemical stability and physical properties.

All these products have been certified according to the latest available standards.
RCF and AES materials on a chart showing the EU 18% oxides rule for vitreous silica fibres

Fibres with more than 18% soluble oxides avoid the C2 classification. Animal testing is needed for complete exoneration.

SW607HT: 74% Silica/23% CaO/3% Other
SW607: 64% Silica/30% CaO/6% MgO

Alkali and Alkaline Earth oxides

RCF

Silica

18% divide

C3 or exonerated

C2

Aluminium and Zirconium oxides
Examples of some AES materials:

<table>
<thead>
<tr>
<th></th>
<th>Classification Temperature</th>
<th>Continuous Use Temp.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superwool 607</td>
<td>1100°C</td>
<td>1000°C</td>
<td>Original Superwool, over 15 years market experience</td>
</tr>
<tr>
<td>Superwool 607HT</td>
<td>1300°C</td>
<td>1150°C</td>
<td>Highest melting point, launched in 2006</td>
</tr>
<tr>
<td>Superwool Plus</td>
<td>1200°C</td>
<td>1000°C</td>
<td>New manufacturing process gives improved insulation</td>
</tr>
</tbody>
</table>

Classification temperature: <4% shrinkage after 24 hours
Continuous Use Temp: Long term exposure in oxidising atmosphere
Short term exposure is permitted at temperatures up to Classification.
RCF Regulatory aspects
Workplace Controls
The State of California Passed a Permissible Exposure Limit of 0.2 f/cc for Refractory Ceramic Fiber (RCF) on February 3, 2010

Effective August 3, 2010

Enforcement of California’s occupational health standards is the responsibility of the Division of Occupational Safety and Health (DOSH).
Permissible Exposure Limit of 0.2 f/cc

- What does it mean to my company?
- Are we in compliance?
- What is current industry exposure status?
- How can I establish my own RCF exposure profile?
- What can I do if my exposure exceeds the PEL?
- What are the control options for exposure reduction?
- How much will it cost to be in compliance?
Product Stewardship Program

- Exposure Assessments
- Health Effects Research
- Communications
- Workplace Controls
- Special Studies
- Workplace Monitoring
- Product Research
- RCF Product Stewardship Program (PSP)
Exposure Time Trends

* Data weighted by population at risk in each different job functional category
Job Functional Categories of PSP Monitoring Data

- **Finishing** - sanding or grinding, cutting, sawing, die cutting, milling or routering of RCF products
- **Installation** - fitting/packing/wrapping, cutting, pounding/tamping, and hardware installation
- **Removal** - furnace repair, disassembly of furnace/heater/oven, clean up/disposal, mode knock out
- **Assembly** - encapsulation/lamination, stapling, module fabrication, heater/oven assembly
- **Mixing/forming** - batching, casting, forming
- **Auxiliary** - maintenance, shipping, laboratory, Quality Control, supervision
- **Other** - paper making, textile, automotive
- **Fiber Production**
Exposure Data Ladder Diagram

CA OSHA
PEL of 0.2 f/cc

REG 0.5

Functional Job Category

Dataset: Personal samples collected at customer plants from 2004 through 2008 (1,366 observations)
Exposure Monitoring – What you need to know

- Take representative sample air monitoring – NIOSH method 7400 (using B counting rule for respirable fiber)

- Determine compliance by compare 8-hour time weighted average exposure (8-hr TWA) to OSHA PEL

\[ 8\text{-hr TWA} = \frac{(T_1 \times C_1 + T_2 \times C_2 + T_3 \times C_3 + \ldots)}{T_{\text{total}} (480 \text{ min})} \]

- If 8-hr TWA < 0.2 f/cc, no action required, continue monitoring is recommended

- If 8-hr TWA > 0.2 f/cc, corrective actions need to be implemented to reduce exposure
What is Representative Sampling?

Prefer sampling approach -
- Take 8-hr TWA samples for different jobs/positions
- Using “robust and proactive sampling” base on “statistically driven, multiple-samples approaches” to establish your representative 8-hour TWA exposure

Alternative approach -
- Sample at worst condition or
- Sample at average condition

Work with your local professional IH specialist to determine your own unique sampling strategy

Locate an Industrial Hygienist via the American Industrial Hygiene Association web site, www.aiha.org
TWA found >0.2 f/cc – What do you do?

- Substitute with less hazardous material
- **Engineering Controls** - exposures shall be prevented by engineering controls whenever feasible
- **Administrative Controls** - whenever engineering controls are not feasible or do not achieve full compliance, administrative controls shall be implemented if practicable (e.g. job rotation; work practices)
- **Control by Respiratory Protective Equipment** –
  - Respiratory protective equipment can be used to prevent excessive exposures as follows:
  - During the time period necessary to install or implement feasible engineering controls;
  - Where feasible engineering controls and administrative controls fail to achieve full compliance
  - In case of emergencies
Engineering Control Example

Exhaust hood for mixing

Local exhaust for planer sander

Enclosure with exhaust ventilation

Local exhaust for disc sander
Environmental Control Booth
for large RCF part manipulation of duct source can not easily be isolated
Engineering Control Example

Down Draft Bench

for RCF product sanding, blanket cutting or small assembly

![Down Draft Bench Image]

DB-3000
Consult engineer firms or manufacturers who specialize in industrial ventilation control such as:

- Torit, www.donaldson.com
- Camfil Farr APC, www.farrapc.com
- United Air Specialists, www.uasinc.com
- Microair, www.microaironline.com
- Nilfisk, www.nilfiskcfm.com
Engineering Controls may be upset by…

- Cross wind from cooling fan use or any other surrounding activities
- Use of pressurized air for clean up
- Blockage of airflow
- Position of operator
- House keeping / clean up activities
Work Practice Guidelines

RCF Blanket Cutting

Engineering Controls

1. Local exhaust ventilation (LEV) should be used at the point of generation of the RCF and associated material. Capture and transport velocities of the LEV system must be sufficient to capture and remove the airborne material and to prevent the material from reaching the breathing zone of the operator. In general, for manual cutting, a capture velocity of 150 to 250 feet per minute (fpm) and a transport velocity of 3,000 to 4,000 fpm are recommended. Please refer to OSHA’s “Ventilation lupr - Ventilation: A Manual of Recommended Practice” of consult an engineer specializing in industrial ventilation for proper LEV system design specifications.

2. When hand saw is used for finishing, refer to RCF “Unit Operational Code of Practice & Engineering Control Guidebook,” Bend Saws for reference. In addition, stockpiles created by fan use, traffic, or trailing off in the area may affect the efficiency of the LEV.

Work Practices

1. Ensure LEV system is operating properly.

2. Avoid performing blanket cutting operations in any manner that would create unnecessary generation of airborne dust. Hand tools, rather than mechanical tools, should be used whenever possible.

3. Do not throw, drop, or handle RCF materials excessively. Gently place RCF materials in staging area or packaging material.

4. Keep work area clean. Do not permit RCF waste material to accumulate in the work area. (Waste or scrap material should be placed into a covered container.) Waste or scrap RCF material should be removed from the work area often to avoid unnecessary generation of airborne dust.

5. Use a HEPA-filtered vacuum or wet sweeping method for clean up when vacuuming is not possible.

6. Clean personal clothing with HEPA-filtered vacuum before leaving the work area.

7. Launder work clothes separately.

8. DO NOT USE COMPRESSED AIR FOR CLEANING ACTIVITIES.

Personal Protective Equipment

1. Because blanket cutting activities can result in exposures in excess of the TWA, the use of a half-face respirator with P-100 filters is recommended.

Note: If occupational RCF exposure levels are known, a lower level of respiratory protection may be used as recommended in the Material Safety Data Sheet guidelines.

2. Long-sleeved clothing or disposable coveralls.


4. Safety glasses or goggles.
Respiratory Protection

The 3M™ Half and Full Facepiece Respirators 6000 Series, Reusable with replaceable cartridges/filters

P-100 filters
# Respirator Selection

## Table I: Assigned Protection Factors

<table>
<thead>
<tr>
<th>Type of Respirator</th>
<th>Quarter mask</th>
<th>Half mask</th>
<th>Full facepiece</th>
<th>Helmet/Hood</th>
<th>Loose-fitting facepiece</th>
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</thead>
<tbody>
<tr>
<td>1. Air-Purifying Respirator</td>
<td>5</td>
<td>10</td>
<td>50</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2. Powered Air-Purifying Respirator (PAPR)</td>
<td>—</td>
<td>50</td>
<td>1,000</td>
<td>25/1,000</td>
<td>25</td>
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<tr>
<td>3. Supplied-Air Respirator (SAR) or Airline Respirator</td>
<td>—</td>
<td>10</td>
<td>50</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Demand mode</td>
<td>—</td>
<td>50</td>
<td>1,000</td>
<td>25/1,000</td>
<td>25</td>
</tr>
<tr>
<td>• Continuous flow mode</td>
<td>—</td>
<td>50</td>
<td>1,000</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>• Pressure-demand or other positive pressure mode</td>
<td>—</td>
<td>50</td>
<td>1,000</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. Self-Contained Breathing Apparatus (SCBA)</td>
<td>—</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>• Demand mode</td>
<td>—</td>
<td>—</td>
<td>10,000</td>
<td>10,000</td>
<td>—</td>
</tr>
<tr>
<td>• Pressure-demand or other positive pressure mode (e.g., open/closed circuit)</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>—</td>
</tr>
</tbody>
</table>

Written Respiratory Protection Program

Mandatory elements of a Respiratory Protection Program:

- Respirator selection
- Medical Evaluations
- Fit-testing
- Respirator storage, cleaning, maintenance and repair
- Respirator Use
- Maintenance and care of respirators
- Breathing air quality and use (when supply-air respirators are used)
- Training and information
- Program Evaluation
## Cost Estimates for Compliance – Cal. OSHA
(annual costs per worker)

<table>
<thead>
<tr>
<th></th>
<th>VACUUM FORMERS</th>
<th>FABRICATION</th>
<th>FURNACE RELATED</th>
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<td>HEPA vacuums</td>
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<td>$ 502</td>
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<tr>
<td>Engineering controls</td>
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<tr>
<td>Monitoring program</td>
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<tr>
<td>Disposable PPE</td>
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<tr>
<td>Respirator costs</td>
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<td>$ 394</td>
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<tr>
<td>Training, Compliance Program</td>
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<td>$ 149</td>
<td>$ 339</td>
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<table>
<thead>
<tr>
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<tr>
<td>HEPA vacuums</td>
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<tr>
<td>Engineering controls</td>
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<tr>
<td>Monitoring program</td>
<td>$1,735</td>
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Summary

- New PEL poses a challenge to the use of RCF in California
- If possible, substitution could be considered?
- Many applications will need engineering control (EC) to reduce fiber exposure
- Routine air monitoring becomes a must
- However, well designed EC still needs to cope with stringent work practices, OP&M procedure to achieve lower exposure
- There is no guarantee of low exposure even with EC on many of the applications
- When respirator is used, a mandatory “respiratory protection program” must be implemented
- (REACH)- In the case of export article containing RCF, care should be taken to review the most recent REACH policy details
Questions?

- RCFC website, www.RCFC.net
- ECFIA website, www.EFICA.eu
- Your local Thermal Ceramics Representative
- Thermal Ceramics PSP Hotline for Health & Safety 1-800-722-5681
- Steve.Chen@thermalceramics.com