Morgan Advanced Materials

Thermal Ceramics is a business of Morgan Advanced Materials.

Morgan Advanced Materials is a global materials engineering company which designs and manufactures a wide range of high specification products with extraordinary properties, across multiple sectors and geographies.

From an extensive range of advanced materials we produce components, assemblies and systems that deliver significantly enhanced performance for our customers’ products and processes. Our engineered solutions are produced to very high tolerances and many are designed for use in extreme environments.

The Company thrives on breakthrough innovation. Our materials scientists and applications engineers work in close collaboration with customers to create outstanding, highly differentiated products that perform more efficiently, more reliably and for longer.

Morgan Advanced Materials has a global presence with over 10,000 employees across 50 countries serving specialist markets in the energy, transport, healthcare, electronics, petrochemical and industrial sectors. It is listed on the London Stock Exchange in the engineering sector.
Understanding the basic principles of heat transfer can ultimately save energy.

This is all the more necessary since there is a clear trend towards more complex and high performance refractory materials which require knowledge in specific application techniques to give optimal performance.

Being aware of the factors which influence good thermally efficient insulation will determine your choice of insulation material.

This manual aims to serve as a reference guide to energy saving with high temperature fibrous insulation, in particular Superwool® Plus fibre.

In this manual we have stripped down the facts and gone back to basics!

While it is recommended to read the entire manual to gain a full understanding of the benefits of Superwool® Plus, it is not necessary to read all the sections in order.

The reader is encouraged to begin with a topic of interest and follow the sections and references included.
The solution behind the theory of the 3E's -

E=SuperwoolPlus

With almost 20 years of market experience with Superwool® 607® fibre, Morgan Thermal Ceramics is taking low biopersistent fibre technology to the next step.

Superwool® Plus fibre uses the same proven chemical formulation as Superwool® 607® fibre, retaining the advantage of exoneration from any carcinogen classification. New manufacturing technology developed at our Research and Development Centre has given this well proven product many new advantages for the 21st Century.

In a world where the increasing cost of energy coupled with environmental concern is starting to dominate thinking, this product addresses this issue and offers key advantages over all other high temperature insulating fibre products currently available.

Superwool® Plus is the solution to the 3E’s. It is an engineered solution which saves energy and respects the environment.

Engineered + Energy + Environment = 3E Technology

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An engineered solution...

...takes insulation beyond normal performance

Our advanced manufacturing capabilities have changed the more conventional and traditional forms of fibre production to a more advanced and engineered process, giving improved performance and energy savings.

- Maximises the process technology
- Superior to any other product in its class
- Breakthrough in our advanced manufacturing control methods
- Engineered to maximise fibre content
- Continuous investment in research and development, designing for the future

### Superwool® Plus

**Features**

- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008
- Lower thermal conductivity
- Up to 30% more fibres
- Less shot
- High Fibre Index
- Stronger with good handleability (no tearing)
- Improved handling
- Soft & smooth feel
- Consistent use of pure raw materials
- Lower density grade for the same result
- Thinner lining for the same result
- Resistant to vibration
- An environmental solution
- Worldwide production

**Benefits**

- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Improves insulation by 20%
- Efficient prevention of heat transfer and greater strength
- Cleaner workplace
- Up to 20% reduction in thermal conductivity giving energy saving
- Ease of installation saving time and waste
- Operator satisfaction
- Less mechanical skin irritation
- Higher classification temperature, low shrinkage and consistent quality
- Material weight savings up to 25%
- Create more working space within unit
- Allows long lifetime under vibration conditions where other products fail
- Potential savings on waste disposal
- Availability
Superwool® Plus fibre the next generation of energy saving insulation...

Superwool® Plus fibre is the new and improved product from Morgan Thermal Ceramics having the same chemistry and composition as Superwool® 607® fibre. A breakthrough in our advanced manufacturing control has allowed the product to be engineered to maximise the fibre content by reducing the size and amount of shot produced thereby giving it significantly lower thermal conductivity, enhanced energy saving properties and much improved handleability.

Superwool® Plus offers more fibres giving improved insulation in a product already exonerated from carcinogen classification by the EU. More fibres give improved insulating properties and the result that everyone wants - less wasted energy.

It’s all about Superwool® fibre...

Our Superwool® brand is now globally recognised as the leading brand in high temperature low biopersistent fibre insulation, noted for its reliability and environmental benefits. All members of the Superwool® family are exonerated under the current EU H&S regulations.

Morgan Thermal Ceramics developed low biopersistence fibres and has led the revolution in their use in high temperature insulation over the last 20 years.

Our Superwool® products are patented technology - Superwool® Plus fibre and Superwool® 607® HT™ fibre are available only from Morgan Thermal Ceramics.

Our Superwool® brand has consistently lead the market with good value and reliable quality resulting in brand loyalty.

Our commitment to research and development ensures we continue to deliver Superwool® fibre products enabling you to be proactive in meeting your environmental, health and safety obligations and ensuring the Superwool® brand continues to succeed for you.

Superwool® Plus fibre gives improved insulation in a product already exonerated from carcinogen classification and the result that everyone wants - less wasted energy

The solution behind the theory of the 3E’s

Superwool® Plus fibre is the solution to the 3E’s. It is an engineered solution which saves energy and respects the environment.

E=SuperwoolPlus

Engineered solutions:

Superwool® Plus fibre utilises a new manufacturing technique which:

- Maximises the number of fibres
- Reduces thermal conductivity
- Takes the product beyond the performance of normal fibre blankets

Energy solutions:

- Energy savings
- Lower insulation k value
- Reduces thermal conductivity, lost energy and external surface temperature

Environment solutions:

- Meets increasing environmental demands
- Exonerated from any carcinogen classification and therefore has no restriction on use or waste disposal
- Provides reduction in carbon emissions
### Superwool® Plus

#### Insulating fibre

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<td>Worldwide production</td>
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Up to 30% more fibres...

...efficient prevention of heat transfer and greater strength

Superwool® Plus is a high temperature thermal insulation material, efficient at restricting energy flow, while maintaining other key material properties such as low shrinkage and good mechanical durability.

- Reduces energy losses
- With greater fibre surface area is more efficient at blocking thermal radiation
- Provides more material for the energy to pass through, resulting in better insulation
What is high temperature insulation and what are the principles of heat transfer?

High temperature insulation restricts the flow of energy from a high temperature source (i.e. a furnace interior) to a low temperature heat sink (i.e. factory air). The more the energy flow is restricted, the cooler the sink surface will be and the lower the overall energy losses.

High temperature insulation material must be efficient at restricting this flow, while maintaining other key material properties such as low shrinkage and good mechanical durability.

A good high temperature insulator restricts the following ways by which thermal energy can be transmitted:

Thermal radiation: energy moved by photons e.g. in the same way as light.

Thermal conduction: energy moved from one atom to the next i.e. similar to electricity in a wire.

Thermal convection: energy moved by gas particles e.g. central heating radiator.

Thermal radiation
Thermal radiation is the dominant form of transferring energy at higher temperatures especially above 600°C (1112°F).

Fibre structures block radiation by having a large number of surfaces which scatter the incoming light. As the radiation interacts with each surface, its intensity is reduced and so transfer through the fibre structure is restricted. A structure with more surface area will be more efficient at blocking thermal radiation.

Focus on blocking thermal radiation
Energy transmission by radiation is blocked by solid surfaces.

The energy is transferred to the surface material, which becomes hot and will re-emit radiation, but at a lower intensity, of a different wave length and in all directions.

How to improve insulation of thermal radiation
Fibre structures block radiation by having a large number of surfaces which scatter the incoming light. As the radiation interacts with each surface, its intensity is reduced and so transfer through the fibre structure is restricted.

A structure with more surface area will be more efficient at blocking thermal radiation and hence a better high temperature insulator.

Conduction is the process by which energy is passed from one atom to the next with some loss in the process. The more material the energy has to pass through the better the insulation provided.

A fibre structure can be regarded as a composite of material strands and air gaps. The volume density of fibres is normally less than 10%.

For energy to be conducted from the hot surface to the cold it has to pass along very long length of fibres and also transfer between the fibres. The ceramic nature of the fibres make them inherently poor conductors of heat.

A structure with a longer path length between the two surfaces will be more efficient at blocking solid state conduction.

Energy transmission by convection is restricted by stopping the movement of air.

A fibre structure forms small voids in which it is difficult for air to circulate and hence convection is stopped. Increasing the number of voids and decreasing their size results in more efficient blocking of energy transfer by convection.

Therefore at low temperatures the best insulation is provided by a structure in which the path length between the surfaces has been maximised and in which any conduction short-cuts have been eliminated. At high temperatures the best insulation is provided by a structure which has a lot of surface area to interact with thermal radiation and block its transmission.
### Superwool® Plus Insulating fibre

**Features**

- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008
- Lower thermal conductivity
- Up to 30% more fibres
- Less shot
- High Fibre Index
- Stronger with good handleability (no tearing)
- Improved handling
- Soft & smooth feel
- Consistent use of pure raw materials
- Lower density grade for the same result
- Thinner lining for the same result
- Resistant to vibration
- An environmental solution
- Worldwide production

**Benefits**

- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Improves insulation by 20%
- Efficient prevention of heat transfer and greater strength
- Cleaner workplace
- Up to 20% reduction in thermal conductivity giving energy saving
- Ease of installation saving time and waste
- Operator satisfaction
- Less mechanical skin irritation
- Higher classification temperature, low shrinkage and consistent quality
- Material weight savings up to 25%
- Create more working space within unit
- Allows long lifetime under vibration conditions where other products fail
- Potential savings on waste disposal
- Availability

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High fibre index...

...up to 20% reduction in thermal conductivity giving energy saving

By careful control of the manufacturing process, molten glass for Superwool® Plus insulation can be made to fibreise more completely which minimises the size of the shot pieces and improves the shot to fibre ratio.

- Up to 20% reduction in thermal conductivity
- 30% more fibres
- Effective in restricting thermal energy transfer
- Less energy loss
- Less mass of fibre required to give the same performance
- Lower shot content than all other alkaline earth silicate (AES) and refractory ceramic (RCF) fibres
What is shot and why is it important?

Shot consists of globular grains of glass that were not turned into fibre during the manufacturing process. Fibre production through a melt process is inevitably accompanied by shot. This is because the fibre starts as a ball of molten glass, which is drawn out into a long strand by the highly energetic spinning process. This globule will normally freeze before it has been completely drained into a fibre.

Shot therefore represents a lot of material which is not fibre and thus provides a short cut for thermal conduction. It has low specific surface area and as such, it is not an efficient blocker of thermal radiation.

Effect of shot on insulation
A 250µm shot particle can make 1 500 000µm (1.5 meters) of 3µm diameter fibre. A 250µm diameter particle has a specific surface area of 0.01m²/g, whereas 3µm diameter fibre has a specific surface area of 0.5m²/g the low specific surface area of shot makes it an inefficient blocker of thermal radiation.

Below is a comparison of two 1m² blanket samples each 25mm thick with a density of 128kg/m³ and weighing 3.2kg.

<table>
<thead>
<tr>
<th></th>
<th>Superwool® 607® Blanket</th>
<th>Superwool® Plus Blanket</th>
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</thead>
<tbody>
<tr>
<td>Percentage shot over 45µm %</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Average fibre diameter µm</td>
<td>3.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Specific surface area m²/g</td>
<td>0.21</td>
<td>0.39</td>
</tr>
<tr>
<td>Length of fibres km</td>
<td>60 000</td>
<td>150 000</td>
</tr>
<tr>
<td>Surface area of fibres m²</td>
<td>680</td>
<td>1240</td>
</tr>
</tbody>
</table>

Footnote: µm = micron

The new Superwool® Plus fibre yields a 20% improvement in conductivity at 1000°C (1832°F).

This translates to cooler cold surfaces, less energy loss or less mass of fibre required to give the same performance. The advanced control of the manufacturing process used in Superwool® Plus fibre also allows the fibre diameter to be kept predominantly in the optimal 1 to 6µm range. This maximises the amount of surface area available for interacting with thermal radiation.

High fibre index
By careful control of the manufacturing process, molten glass for Superwool® Plus insulation can be made to fibreise more completely, thus improving the ratio of shot to fibre and minimising the size of the pieces of shot. This enhances the thermal conductivity of Superwool® Plus fibre by 20%. Superwool® Plus fibre gives you up to 30% more fibres.

The implementation of the Jet Sieve allows us to measure the shot content at the production line quickly and regularly. This innovation allows us to use the shot content as a production control parameter.

Morgan Thermal Ceramics defines shot as any portion of the material which will not pass through a 45µm aperture on a sieve. The 45µm sieve was selected as this was the smallest that could be reliably used for frequent process control measurements in production.

It should be noted that other manufacturers use less stringent size classifications for shot. In fact ENV 1094-7: 1994 and ISO 106356: 1999 quote shot as being over 75µm and BS 1092-6: 1986 quotes shot as being over 106µm.

Fibre index
The fibre index is the proportion by weight of material which is turned into fibre during the production process and hence is effective in restricting thermal energy transfer and is just one measurement quoted in comparisons between different fibre insulation materials (Fibre index % = 100 - shot content %).
Shot content comparison for various shot sizes

Shot measurements in various fibre insulation materials were taken and compared using the Jet Sieve method. The results outlined in the chart below show a significantly lower shot content for Superwool® Plus fibre at various sizes. i.e. at 45µm (the smallest shot size that can be used reliably in process control measurements) RCF has 1.5 times more shot than Superwool® Plus fibre. Alternatively using measurements from other manufacturers who are using less stringent methods, at 300µm competitor AES contains 9 times more measured shot content than Superwool® fibre.

It is important to note that you can normally start to feel shot in the hand at shot sizes above approximately 125µm. Superwool® 607® fibre and competitor AES contain up to 17% shot – over 3 times more than Superwool® Plus fibre.

Shot content by weight %

<table>
<thead>
<tr>
<th>Shot test size µm</th>
<th>Shot content by weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>1.05 1.65 3.1</td>
</tr>
<tr>
<td>250</td>
<td>2.9 3.6 6.75</td>
</tr>
<tr>
<td>300</td>
<td>3.3 3.5 9.0</td>
</tr>
</tbody>
</table>

Beware of shot size measured by other manufacturers

Measured Shot Content using the Jet sieve test which allows regular and fast results on the production line

Lower thermal conductivity...

...improved insulation by 20%

The lower the thermal conductivity of a material, the better it is at restricting the flow of energy from hot to cold. Superwool® Plus insulation has a high fibre index which results in outstanding low thermal conductivity which is lower than all other AES and RCF fibres.

- Energy savings up to 17%
- Material weight savings up to 25%
- 20% lower thermal conductivity than other tested AES blanket materials
- Lower thermal conductivity with lower density comparisons
- Lowest thermal conductivity compared to all other AES and RCF fibres
The effect high fibre index has on thermal conductivity

The thermal conductivity of Superwool® Plus fibre is 20% better than other AES blanket materials. This is due to the large surface area of fibres available for blocking the transmission of thermal radiation and the lack of shot particles that can provide a shortcut path for conduction.

The improvement in thermal conductivity results in a 96kg/m³ density Superwool® Plus blanket providing an equivalent insulation to a 128kg/m³ (8lbs/ft³) blanket of the best competitor AES material.

The advantage of Superwool® Plus fibre is even more distinct in comparison to other brands of AES fibre which tend to have high shot content and coarse fibres, neither of which are beneficial for blocking high temperature thermal radiation.

The high fibre index in Superwool® Plus blanket provides outstanding low thermal conductivity.

Thermal conductivity - the lower the better, but why?

As previously defined, the thermal conductivity of a material is a measure of its ability to conduct energy (heat). The lower the thermal conductivity of a material, the better it is at restricting the flow of energy from hot to cold.

For a given thickness of insulation, the material with a lower thermal conductivity will give a greater temperature difference between the hot and cold faces and resulting in less energy loss.

How lower thermal conductivity relates to energy saving

All businesses around the world are increasingly aware of the urgent need to make better use of the world’s energy resources.

Improved energy efficiency is often the most economic and readily available means of reducing greenhouse gas emissions.

The demand for energy worldwide continues to increase year by year and the 2009 World energy outlook predicted the numbers would continue to rise.

Lower thermal conductivity ultimately leads to reduced energy losses. Morgan Thermal Ceramics tested different types of blanket, all at 128kg/m³ (8lbs/ft³). The results set out in the chart below show the percentage improvement in energy saved by Superwool® Plus and the percentage relative to the measured thermal conductivity of the fibres.

At 1000°C (1832°F) our results show a competitor AES blanket has approximately 31% higher thermal conductivity compared to Superwool® Plus fibre. This means Superwool® Plus fibre provides a 31% saving in energy transmitted compared to the competitor AES blanket and up to 16% compared to standard Superwool® 607® blanket.

Graph showing the effect of high fibre index (low shot content) which gives the blanket a very low thermal conductivity.

Measurements conducted using ASTM C-201 testing methods. (see page 31 for more details).
**Superwool® Plus**

**Insulating fibre**

**Features**

- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008
- Lower thermal conductivity
- Up to 30% more fibres
- Less shot
- High Fibre Index
- Stronger with good handleability (no tearing)
- Improved handling
- Soft & smooth feel
- Consistent use of pure raw materials
- Lower density grade for the same result
- Thinner lining for the same result
- Resistant to vibration
- An environmental solution
- Worldwide production

**Benefits**

- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Improves insulation by 20%
- Efficient prevention of heat transfer and greater strength
- Cleaner workplace
- Up to 20% reduction in thermal conductivity giving energy saving
- Ease of installation saving time and waste
- Operator satisfaction
- Less mechanical skin irritation
- Higher classification temperature, low shrinkage and consistent quality
- Material weight savings up to 25%
- Create more working space within unit
- Allows long lifetime under vibration conditions where other products fail
- Potential savings on waste disposal
- Availability

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**Save energy...**

...seeing is believing

Superwool® Plus fibre is the most energy efficient fibrous insulation material; it can reduce energy losses without occupying more space or using increased mass.

- Reduces thermal conductivity and energy loss and thereby reduces the outside furnace temperature
- Provides significant energy savings compared to other tested AES and RCF fibres
- Minimises the weight and thickness of the insulation layer saving up to 25% in material
- Reduces carbon emissions
- Provides more...for less...
Thermal imaging...infrared camera...energy efficiency

Maintenance of your furnace lining and insulation system can result in significant energy savings. In many cases, the extra cost of more efficient lining materials can often be recouped within a year or two.

Manufacturing costs, especially in energy-intensive processes requiring furnaces and kilns, have been negatively impacted by rising fuel costs.

The key to the energy efficiency of your furnaces and kilns is how well the refractory insulation lining is working. Refractory insulation provides many heat-saving benefits and it needs to be maintained and repaired during service. Before replacing materials, it is better to first conduct a thorough evaluation of the furnace lining condition.

The analysis of the existing furnace is critical to determining which steps to take in lining maintenance. In addition to observing the general integrity of the furnace lining, using engineering services like heat-flow calculations, infrared cameras and energy analysis enables insulation inefficiencies and inadequacies that are essential in establishing maintenance priorities to be discovered.

Infrared cameras can survey the furnace lining while the unit is operating to determine the location and severity of furnace hot spots. The infrared camera captures the thermographic data needed to assess the thermal efficiency of the existing insulation lining.

Each Morgan Thermal Ceramics sales division is equipped with its own thermal imaging camera and is able to conduct a furnace survey and assist in recommending a more energy efficient solution if available.

Energy costs continue to rise and furnace maintenance in heat-intensive industries is crucial to keeping fuel expenses under control. Routine engineering audits of the furnace lining help determine the condition of the existing equipment.

Maintaining the lining in your furnace and making the recommended and necessary changes enables you and your business to reduce energy waste and improve operating efficiencies and process consistency.

Can Superwool® Plus blanket help with energy and material weight savings?

The ability to perform tests “in-house” brings expertise and product development at a much faster rate than could be achieved by only using external laboratories.

Morgan Thermal Ceramics’ research and development facility houses a purpose designed gas-fired kiln which has the ability to test all forms of furnace wall and roof construction and to measure resulting cold face temperatures. By having a test furnace facility on-site, we are able to work closely with our customers to ensure their requirements and solutions are met.

Our furnace:

- is a 1.5 MW gas powered kiln, with 6 burners
- is 2m high x 2m deep, with a volume of 8m³
- has 2 control thermocouples and 8 monitoring thermocouples ensure uniform heat distribution in all zones
- has a maximum temperature 1300°C (2372°F) with rapid heating to allow simulation of hydrocarbon fires as well as cellulose fires
- can be set up to test bulk head (wall) or deck head (roof) panels or to test samples totally enclosed inside the furnace
- can test a complete new furnace lining using a combination of refractory products: such as blanket, modules and boards
- internal and external temperatures can be measured with up to 40 thermocouples or using an infrared camera

Examples of conducted furnace surveys
At Morgan Thermal Ceramics we have conducted a benchmark test in our R&D centre using Superwool® Plus fibre with a competitor AES blanket and Cerablanket RCF.

On the same panel, 1m² blanket was installed with 4 different insulation layers:

- 2x25mm (2x1 inch) 128kg/m³ (8lbs/ft³) competitor AES blanket
- 2x25mm (2x1 inch) 128kg/m³ (8lbs/ft³) Cerablanket RCF
- 2x25mm (2x1 inch) 96kg/m³ (6lbs/ft³) Superwool® Plus blanket
- 2x25mm (2x1 inch) 128kg/m³ (8lbs/ft³) Superwool® Plus blanket

We clearly observed that:
- Superwool® Plus 128 blanket provides a significantly lower cold face temperature than a competitor AES 128Kg/m³ (8lbs/ft³) blanket and Cerablanket RCF 128Kg/m³ (8lbs/ft³)
- Superwool® Plus 96 blanket provides a lower cold face temperature compared to a competitor AES blanket 128Kg/m³ (8lbs/ft³) and Cerablanket RCF 128Kg/m³ (8lbs/ft³)

The results outline the thermal insulation superiority of Superwool® Plus fibre with energy savings up to 25%

The panel was heated up to a temperature of 1000°C (1832°F) for 2 hours until steady state was achieved. Thermocouples were placed on the cold face (casing) of the 4 zones to follow the temperature evolution in real time.

A second test was performed with another set of insulation materials. The layout aimed to show that a thinner insulation of Superwool® Plus blanket will perform comparably to competitor AES or RCF blankets:

- 2 layers of 25mm 128Kg/m³ (2 layers of 1 inch 8lbs/ft³) Superwool® Plus blanket
- 1 layer of 38mm 128Kg/m³ (1 layer of 1.5 inches 8lbs/ft³) Superwool® Plus blanket
- 2 layers of 25mm 128Kg/m³ (2 layers of 1 inch 8lbs/ft³) Superwool® Plus blanket
- 2 layers of 25mm 128Kg/m³ (2 layers of 1 inch 8lbs/ft³) a competitor AES blanket

These materials were heated up to a hot face temperature of 1000°C (1832°F) for 2 hours until steady state was achieved. Thermocouples were placed on the cold face (casing) of the 4 zones to follow in real time the temperature evolution.

Our thermal image shows that at the same thickness of material, 50mm (2 inches), Superwool® Plus blanket out-performs all other materials. If you were to use a thinner insulation lining, just 38mm (1.5 inches) of our Superwool® Plus blanket performs better than 50mm (2 inches) of Cerablanket RCF and a competitor AES blanket.
The most energy efficient insulation

Superwool® Plus fibre is independently proven to be the most energy efficient fibrous insulation material; it provides superior insulation and reduces energy losses without occupying more space or using increased mass.

- Provides the lowest thermal conductivity compared to other tested AES and RCF blankets
- Reduces energy loss
- Provides significant energy cost savings
- Minimises the weight and thickness of the insulation layer
- Provides more... for less...

### Superwool® Plus Insulating fibre

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Superwool® Plus is independently tested to have the lowest thermal conductivity

At Morgan Thermal Ceramics we recognise that third party testing of our high performance insulation provides invaluable data in support of our in-house R&D results.

Our Superwool® Plus insulation blankets have been independently tested by a French laboratory in accordance with the ASTM C201 – 93(2009) standard test method for thermal conductivity of refractories.

Insulation tested includes:

- Superwool® Plus blankets of density:
  - 128 Kg/m³ (8 lbs/ft³), 96 Kg/m³ (6 lbs/ft³) and 80 Kg/m³ (5 lbs/ft³)
- EU and non-EU Competitor AES blankets of density:
  - 128 Kg/m³ (8 lbs/ft³) and 96 Kg/m³ (6 lbs/ft³).

Superwool® Plus is proven to present...

...up to 40% lower thermal conductivity than competitive insulation at 1000°C

The results:
The results clearly demonstrate that Superwool® Plus fibre:

- Has superior thermal insulation properties
- Is the most energy efficient insulation
- Enables you to save energy and associated costs
- Enables you to use a lower density or thinner blanket and achieve the same or even better insulation performance

Test 1 - Superwool® Plus blanket 128 Kg/m³

- Has the lowest thermal conductivity compared to all other blankets of the same density
- Is the most energy efficient insulation
- Gives a better thermal insulation performance
- Enables you to make energy savings
- Enables you to make significant cost savings
**Test 2 - Superwool® Plus blanket 96 Kg/m³**

Superwool® Plus insulation blanket 96 Kg/m³:

- Enables you to make weight savings
- Allows you to use a lower density or thinner blanket and achieve the same high insulation performance
- Has a lower thermal conductivity than competitive AES 128Kg/m³ blanket
- Enables you to make significant cost savings

---

**Test 3 - Superwool® Plus blanket 80 Kg/m³**

Superwool® Plus insulation blanket 80 Kg/m³:

- Allows you to use a lower density blanket and achieve a better insulation performance
- Has a lower thermal conductivity than competitive AES 96Kg/m³ blankets
- Enables you to make significant cost savings
- Enables you to make weight savings

Thermal images from in-house R&D kiln-test @1000°C are consistent with third-party independent results.
Consistent use of pure raw materials...

...higher classification, low shrinkage, consistent quality

### Superwool® Plus Insulating fibre

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The consistent use of pure raw materials in all our factories worldwide has lead to the 4% shrinkage temperature rising from >1100°C (2012°F) Superwool® 607® to >1200°C (2192°F) Superwool® Plus.

- For AES fibres the shrinkage is low at the maximum continuous use temperature
- European standard EN 1094-1 test methods are used for tensile strength, permanent linear change and temperature classification
- ASTM C-201 equipment used for thermal conductivity
Does Superwool® Plus blanket withstand high temperatures?

Permanen linear shrinkage
Shrinkage is generally to be avoided in designs using fibre products as it results in gap formation at joints, which can give a path for heat to penetrate deeper into the insulation structure. A low linear shrinkage is therefore highly desirable and AES fibres have a low shrinkage at the maximum continuous use temperature. With Superwool® Plus fibre, the consistent use of pure raw materials has lead to the 4% shrinkage temperature rising from >1100°C (2012°F) to >1200°C (2192°F). For this reason, the classification temperature is now given as 1200°C in line with EN1094 norm.

What is the difference between classification temperature and maximum continuous use temperature?

- **Classification temperature (EN1094-3)** is the temperature at which the product has a linear shrinkage not exceeding 4% (for blanket, paper, felt) or 2% (for vacuum formed shapes, board).

- **Maximum continuous use temperature** is the temperature in an oxidising atmosphere (no pollution) at which products show fibrous structure and very low linear and thickness shrinkages. Above that temperature, crystallisation can occur and the mechanical properties may be reduced.

### Superwool® 607® vs. Superwool® Plus vs. Superwool® 607® HT®

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<th>Superwool® 607® HT®</th>
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<td>Continuous use temperature</td>
<td>1000°C (1832°F)</td>
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<td>1150°C (2102°F)</td>
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<td><strong>Benefits</strong></td>
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<td>Higher temperature allows additional applications</td>
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The Classification temperature 1200°C (2192°F) does not imply that the product can be used continuously at this temperature. In practice, as for Superwool® 607®, the maximum continuous use temperature for Superwool® Plus is 1000°C (1832°F) (this applies only under oxidising atmosphere without presence of contaminants).

What is melting point and why is it important?

The melting point of Superwool® Plus blankets (or similar products) is defined as the temperature when the material exceeds 20% linear shrinkage. At this level of shrinkage the blanket will have lost virtually all of its thermal insulation properties and will become liquid with only a relatively small increase in temperature. It is therefore important to know the temperature of the melting point to ensure that the material is only installed into appropriate areas where the melting point will not be exceeded.

Testing methods (ASTM C-201 and EN 1094-1)

For test methods measuring the properties of high temperature insulation wools (HTIW), the European standard EN 1094-1 (2008) is used for the test methods where appropriate. Superwool® Plus data sheets refer to measurements such as tensile strength, permanent linear change and temperature classification.

These characterisations are made according to the test methods given in this standard. However there are several test procedures for HTIW products which are currently in development and will not be included into the EN 1094-1 standard until they have been ratified.

Some tests, such as thermal conductivity and leachable chloride use the ASTM methods. In particular the thermal conductivity test uses the methods based on the ASTM C-201 equipment as it is believed that this gives the most accurate data for high temperature insulation. The thermal conductivity method given in the draft European Standard EN 1094-1 has been withdrawn as it was was inaccurate and so was not included in the current standard.
### Superwool® Plus

#### Insulating fibre

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Up to 30% more fibres...

...efficient prevention of heat transfer and greater strength

A stronger blanket is desirable for easy installation and handling. The more fibres available to link together the stronger the product.

- Up to 30% more fibres give a higher potential for good tensile strength
- Maximum in-service performance
- Good handleability with no breakages
- Low installation costs
- Stronger than any other tested AES blanket and equal to RCF blanket

---

THERMAL CERAMICS
Tensile strength explained

Fibre blankets derive their tensile strength (important for resistance to pulling apart during installation) from the interlinking of fibres during manufacture. The more fibres that are available to link together, the stronger the product. Superwool® Plus fibre has approximately 30% more fibres per unit mass than competitor products giving a higher potential for good tensile strength.

Good tensile strength

The tensile strength of a blanket is a measure of the load that can be put onto the end of a blanket before it is pulled into pieces. In practice, a stronger blanket is desirable for easy installation and handling. Pieces should not break or crumble in the hand when a long length is gripped and suspended.

The graph shows a comparison of tensile strengths measured for a typical range of blankets over a given time.

Tensile strength test

The higher the tensile strength, the longer the section of blanket can be suspended, before its own weight causes it to rip at the hand grips.

Sufficient and consistent density of fibres throughout a full roll of blanket is important for tensile strength and to withstand tearing or breakages when fully suspended.

Blanket tears where there are not enough fibres or they are variable in areas.

Superwool® Plus blanket offers 30% more fibres in a consistent density which enables it to withstand the suspended tensile strength test for over 3 minutes.

Test 1
A full roll of a Superwool® Plus blanket was suspended 8m from the ground at full length of 7.32m.

After more than 3 minutes, Superwool® Plus blanket did not break.

Test 2
A full roll of competitor AES blanket was suspended 8m from the ground at full length.

The blanket failed in under a minute.
## Superwool® Plus

**Features**
- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008

**Benefits**
- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Lower thermal conductivity
- Improves insulation by 20%
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- Consistent use of pure raw materials
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- Create more working space within unit
- Resistant to vibration
- Allows long lifetime under vibration conditions where other products fail
- An environmental solution
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**Improved handling...**

...operator satisfaction

**Superwool® Plus blanket** has virtually no large shot and an excellent feel to the hand.

- Soft and smooth
- Operator satisfaction
- Less/no irritation to the skin
**Does Superwool® Plus offer improved handling?**

Typically, when a hand is run across a fibre blanket, only shot greater than 125μm can be felt. Superwool® Plus blanket has virtually no large shot and as a result has an excellent feel to the hand.

This is a sharp contrast to other AES fibre blankets which have approximately 15wt% of material in particles over 200μm and the difference is immediately apparent in the hand.

The very coarse fibres found in material can be irritating to the skin; however control of fibre diameter in Superwool® Plus blanket results in far less sharpness to the touch and better operator satisfaction.

**Shot content comparison**

Superwool® Plus blanket has been shown to resist vibration under the most severe testing.

- Virtual elimination of large shot
- 30% more fibres
- All shot is locked up in fibre network

Resistant to vibration...

...allows long lifetime under vibration conditions where other products fail
Good vibration performance

Some applications in which AES fibres are used combine high vibration with cyclic heating. Generally fibre products perform very well in vibration applications. However in some situations, where large acceleration forces are present, large shot particles can break loose from the fibre structure and, if retained close to the surface, with freedom to move these particles can damage the local fibre structure and cause holes.

For good vibration performance it is important to eliminate large shot particle and the shot that is present needs to be restrained in the fibre matrix. Surfaces should be slightly compressed to stop the physical movement of the fibre structure or any shot particles that do become free from the structure.

Superwool® Plus blanket has been shown to resist vibration under the most severe testing.

How does Superwool® Plus blanket react to vibration?

Superwool© Plus blanket has been extensively tested on an automotive grade shaker table to assess and benchmark its performance in high vibration environments. Samples which had been heat stressed at 950°C (1742°F) for 20 hours showed no degradation during a 100Hz, 60g accelerated life cycle test. This is in contrast to Superwool® 607© material which was badly affected by vibration of large shot particles.

Superwool® 607© blanket after vibration testing

Superwool® Plus blanket vibration performance

Superwool® Plus blanket excels in a high vibration environment due to:

- Virtual elimination of large shot
- 30% more fibres
- All shot locked up in fibre network
- High tensile strength

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Morgan Thermal Ceramics aims to create consistent, long-term value by becoming a world leader in advanced insulation materials.

Morgan Thermal Ceramics is the only company which manufactures and supplies the total package of both AES (Superwool®) and RCF fibres, insulating firebricks, monolithic refractories and microporous insulation.

- Low thermal conductivity providing energy saving is key in our product portfolio of high temperature insulation solutions
- Product quality, availability and price are key to our strategic thinking
- Engineered solutions for high temperature applications
- Solutions for a broad spectrum of industrial and non-industrial markets
Superwool®, refractory ceramic fibre, insulating fire bricks, monolithics and microporous

Morgan Thermal Ceramics leads the way bringing technical solutions to all problems of heat containment. As with all high temperature insulation projects, selection of insulation materials is dependent on a number of factors such as:

Technical aspects of the industry and application
- Different industries and applications have different requirements for heat containment and temperature levels. Today at Morgan Thermal Ceramics we offer a full range of products and services for applications ranging from 500°C (932°F) to 1800°C (3272°F) covering diverse uses from fire protection in buildings to the refining of aluminium.
- Morgan Thermal Ceramics is the only company which manufactures and supplies the total range of insulation materials comprising both AES (Superwool®) and RCF fibre, insulating firebricks and monolithic refractories.
- Low thermal conductivity and energy savings are key in our product portfolio of high temperature insulation solutions.
- Insulation solutions for temperatures ranging from 500°C (932°F) to 1800°C (3272°F).
- Alternatives to fibre based on mechanical strength and resistant to pollution.

Regulation / Legislation
- In 1997 the European Commission added man-made vitreous (Silicate) fibres (MMVFIs) to the list of dangerous (hazardous) substances in Appendix 1 of the European Union Directive 67/548/EEC. This Directive classifies substances according to their specific hazard and sets out requirements for hazard communications to users through packaging, labelling and material safety data sheets.

In 2008 the classification and labelling of packaging regulation was replaced by Regulation (EC) No. 1272/2008. This regulation often called the CLP regulation has modified the various hazard classes to adapt them to the Global Harmonised System (GHS).

- Under this new system high temperature insulating wools are classified as follows:
  - Refractory ceramic fibres (RCF) as a CLP category 1B carcinogen.
  - AES wools, including the Superwool® range of products are not classified.
  - No hazard labelling is required for handling AES wools.

Product quality
- Morgan Thermal Ceramics has established a set of global standards that all our manufacturing plants adhere to. These standards have been based on market trends and demanding applications required for materials used in our industries.
- Quality standards are set with minimum and maximum tolerances for all our fibre production, these include: chemistry, tensile strength, thickness etc.
- Pure raw materials are specially selected to ensure consistency in the manufacturing process and product performance.

- Our standards are reviewed in regular global benchmarking meetings involving representatives from every one of our plants:
  - Global manufacturing standards in all our plants
  - ISO 9001 accreditation in all our plants

Availability
- Morgan Thermal Ceramics is strategically placed to supply high temperature insulating fibre, insulating firebricks and monolithic solutions for all your project requirements it has an extensive network in over 50 locations worldwide, with more than 30 manufacturing sites that truly reach all regions of the globe.
- In no other high temperature insulation company will you find an integrated and extensive network of over 30 manufacturing facilities, strategically located around the world, giving you the opportunity to source locally.
  - Global manufacturing, local delivery
  - We are globally placed to offer local delivery from a plant or operating facility near you
  - Exchange of references worldwide
  - Engineering know-how transferred from worldwide expertise
  - Continuous energy saving programmes
  - Lowering your operating costs
  - Increased savings for you

Morgan Thermal Ceramics is the only company which manufactures and supplies the total package of both Superwool® fibres and RCF fibre, insulating firebricks, monolithic refractories and microporous insulation
An environmental solution...

...potential savings on waste disposal

Superwool® Plus a new standard of high temperature insulation wool which has both health and performance advantages for designers, installers and users alike.

We are committed to protecting the environment by minimising the impact of our operations and our products through continuous improvement in environmental performance and control.

- Potential savings on waste disposal
- A reduction in CO₂ emissions
- Not classified as hazardous under EU waste regulations

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Health and Safety - the hazard classification of man-made vitreous (silicate) fibres in the European Union (EU)

In 1997 the European Commission added man-made vitreous (silicate) fibres (MMVFs) to the list of dangerous (hazardous) substances under the European Union Directive 67/548/EEC. This Directive classifies substances according to their specific hazard and sets out requirements for hazard communications to users through packaging labelling and material safety data sheets. The classification framework for MMVFs is complicated, but may be summarised for the purposes of this manual as:

- Some MMVFs were classified as category 2 carcinogens (substances which should be regarded as if they are carcinogenic to man).
- Most commercial MMVFs were classified, by default, as category 3 carcinogens (substances which cause concern for man owing to possible carcinogenic effects). However, these MMVFs may be exonerated from category 3 carcinogen classification if they meet certain criteria in the Directive.

For high temperature insulation wools, this regulation classified Refractory Ceramic Fibres (RCFs) as category 2 carcinogens and exonerates the Superwool® range of products from any carcinogen and skin irritancy classification.

In 2008 a new regulation - classification, labelling and packaging of substances and mixtures (Regulation (EC) No 1272/2008) came into force with the main aim of bringing EU CLP (Classification, Labelling of Packaging) into line with GHS. (Global Harmonised System).

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Notes Q and R still apply

The consequences of carcinogen hazard classification in the European Union

Classification of RCFs in the European Union as category 2 (CLP 1b) carcinogens triggered a number of downstream regulations both across the European Union and in individual Member States. These require measures to be taken by Member States to restrict the use of and control exposures to RCFs in order to minimise possible adverse impacts to human health and the environment. The classification numbering has changed, but the regulation still remains the same.

The measures include:

- Prohibiting manufacturers and suppliers from placing RCFs on the market for use by the general public (Directive 76/769/EEC).
- Requiring employers using RCFs to seek a substitute which would present a lower risk to the health of workers, or where not technically feasible to contain the RCFs and implement measures to reduce occupational exposure to the lowest technically achievable (Directive 2004/37/EC).
- Handling and disposing of RCF hazardous waste from manufacture and use by a licensed waste contractor and in an appropriately licensed special waste landfill (Directives 91/689/EEC and 1999/31/EC).

In January 2010, the EU declared RCF to be an SVHC (Substance of Very High Concern) and added it to Annex XV of the European REACH regulation. This initiated new controls applying to companies wishing to import articles containing RCF into the EU and also started the process of evaluation which may lead to RCF uses requiring authorisation. Further information on this subject can be found at www.morganthermalceramics.com

These downstream consequences have applied to the marketing and use of RCFs since their classification as category 2 (CLP 1b) carcinogens, and have resulted in increased costs of compliance for manufacturers, suppliers and users of RCF.

They do not apply to the Superwool® range of products.

Additionally, European Union Member States have the right to implement their own worker protection measures, such as the setting of Occupational Exposure Limits. Many Member States have introduced lower Occupational Exposure Limits for MMVFs since the 1997 classification. Some of the Occupational Exposure Limits set, or proposed, in Europe for RCFs are very low and difficult to achieve.

Why Superwool® products?

For many years the European high temperature insulation wool industry association (ECFIA, www.ecfia.eu) has had a Product Stewardship Programme, which includes:

- Human effects research: such as sponsoring human health surveys and research on the biological effects of fibres.
- Exposure assessment: study of workplace controls and workplace monitoring. (These aspects of product stewardship in Europe are known as the CARE programme for Controlled And Reduced Exposure.)
- Product research: the search for new materials which might release less dust or meet the requirements for exonation from carcinogenic classification.
- Special studies: research on such subjects as waste, production of communication bulletins on the above efforts, material safety data sheets, safe handling guidelines etc.

The development and marketing of Superwool® Plus fibre is a result of Morgan Thermal Ceramics’ commitment to this Product Stewardship Programme.

1 As amended by European Commission Directive 97/69/EC
4 Member companies of ECFIA manufacture and supply RCFs and other high temperature insulation wools
Waste disposal - Superwool® products may be disposed of in non-hazardous waste landfill

Key points summary

- Disposal of waste materials in EU Member States is controlled by implementation of a number of Directives.
- Wastes containing more than 0.1 wt% of (RCF) are classified hazardous under Directive 91/689/EC. RCF wastes from manufacture and use are required to be handled and disposed of by a licensed waste contractor in an appropriately licensed hazardous waste landfill. Directive 1999/31/EC enables such wastes to be disposed in a non-hazardous waste landfill provided that leaching tests have shown there is no risk of soil or ground water contamination.
- As responsibility for the implementation for EU waste Directives lies with the individual member states, local regulations are not harmonised and waste disposal restrictions vary widely from country to country.
- In practice, many RCF users have experienced significantly increased costs because local waste disposal sites are not licensed to or prepared to accept hazardous wastes.
- As responsibility for the implementation for EU waste Directives lies with the individual member states, local regulations are not harmonised and waste disposal restrictions vary widely from country to country.
- Waste containing Superwool® fibre products may be disposed in a non-hazardous waste landfill.
- Superwool® products that do not contain an organic binder may be considered as waste glass-based fibrous materials (European Waste Code 10 11 03).

In practice, Superwool® users should experience no difficulty or increased costs for disposing of waste fibre.

This is a clear benefit for Superwool® product users compared with RCF users.

Some examples in different countries

1. Superwool® product waste is considered inert waste in Germany and can be disposed of in a landfill designated for non hazardous waste according to the landfill ordinance (DepV) §6 and 7 and under §3 of the waste storage ordinance (AbfAbIV).
2. In the UK, the Environment Agency clearly suggests that Superwool® products are considered as waste glass-based fibrous materials as long as they do not contain any organic binder or are not contaminated by other hazardous material.
3. In France Directive 1999/31/EC1 has not yet been implemented. However an “Arrêté” from 30th December 2004 indicates that inert wastes can be stored in an industrial inert waste landfill as long as they meet the leaching testing limits referred to in its appendix 2.

Guidelines for handling and disposing of Superwool® product waste

- Handle the waste with care so that it does not spread. Wetting (dampening only) the waste helps to minimise dust emission.
- Do not allow the waste to accumulate around the workplace.
- In the workplace, dispose of the waste in a suitable closed container or plastic bag as soon as it is produced.
- When full, seal containers or plastic bags before removing for disposal.
- Leaching tests may be required to show that waste will not pollute groundwater or soil. Superwool® product wastes may contain organic materials and/or other contaminants.
- Do not mix Superwool® product waste with hazardous waste.
- The responsibility for waste disposal or treatment remains with the waste producer. In most jurisdictions, records must be maintained and provided by the waste contractor / transporter to the landfill to verify disposal.
- Ensure written confirmation is received from the disposal company verifying that the waste has been disposed of properly.
- Superwool® product waste may have been contaminated by hazardous substances during its normal use. In such cases expert guidance should be sought.
Key health properties - do low biopersistent fibres pose risks?

Key health properties
The key health property of all Superwool® products, including the latest member of the family, is that any fibres that might be breathed in and reach the lungs are rapidly removed. This characteristic is referred to as low biopersistence. As a consequence fibres do not accumulate in the lung, preventing the occurrence of any significant inflammatory effect that might affect the lungs.

Low biopersistence is achieved by producing the fibres that are a glassy material, which partially corrodes and then fragments when it comes into contact with the fluids found in the lungs.

However, does this ensure that these fibres are really as safe as they can be?
Can we be sure that the fibre fragments and leached materials do not pose any danger?

Superwool® fibres are made only using chemical elements that are themselves generally regarded as safe. Non-fibrous materials with the same chemical composition as Superwool® are permitted ingredients in foods, medicines and cosmetics as well as having many uses in industry. In none of these applications has this group of compounds been found to be dangerous. Even fibrous calcium silicate is not regarded as carcinogenic by the World Health Organisation and is exonerated under the extremely rigorous German regulations and in the entire EU.

We are all exposed to considerable amounts of dust from environmental as well as industrial sources.

A lot of this dust resembles Superwool® fibres in that, among other components, it contains a great deal of silicates and calcium.

If fine enough to reach the lungs, this dust is removed by cells known as macrophages - the “dust carts” of the lungs. These cells with their dust content are eliminated through the lymphatic system or swept up the airways, swallowed and the dust voided via the gut. Superwool® fibres, which are initially too long to be carried away by the macrophages, are partially corroded and break into short pieces which are then cleared in a similar manner to dust particles. Chalk and cement are good examples of dusts, which contain the same elements as Superwool® fibres that are found naturally in the body. These also partially corrode and their components are eliminated via the natural lung clearance system. These calcareous dusts do not cause disease unless they are contaminated by other materials.

Of course the body also needs a regular input, usually from food, of all the major elements making up Superwool®. A simple calculation taking into account Superwool® fibre workplace levels of fibrous dusts, the amount of air breathed and fibre deposition in the lungs, shows that fibre concentrations in the air would have to be hundreds of times greater than they are to provide inputs which even approach those from food.

It is true that the concentrations and distribution of these elements in the blood, tissue and other “compartments” is very carefully controlled by a number of more or less complicated mechanisms.

Maintaining this control is essential for good health.

Could inhaled Superwool® fibres affect these control mechanisms?
This is unlikely as the body can easily handle dusts with similar components. The dissolved elements coming from such dusts are the same as those which dissolve out of Superwool® fibres, and no effect of even large exposure to these materials has been detected.

Conclusion
Although AES fibres, such as Superwool®, are designed to corrode and fragment after being inhaled, the chemical elements released into the body are the same as those commonly found in nuisance dusts or in food.

The quantity released is very small in comparison to these other sources and so the body’s normal systems of regulation are easily able to cope.

These considerations have been central in the development of all Superwool® products.

Prof. R.C. Brown
Toxicology Services, Stretton, Rutland

To view our Fraunhofer Exoneration Certificates visit our website:

www.morganthermalceramics.com
SECTION 3

H&S in Europe & REACH...
...all you need to know and how this will affect you

REACH places greater responsibility on industry to identify and manage the risks posed by chemicals to human health and the environment. Under this new legislation, both manufacturers/importers and downstream users have obligations to communicate uses and risks up and down the supply chain.

- Morgan Thermal Ceramics has registered the Superwool® fibres we manufacture and import into the EU as substances
- Morgan Thermal Ceramics is committed to meeting our legal obligations under REACH, as a manufacturer, supplier and downstream user
- All products imported or manufactured within the EU by Morgan Thermal Ceramics that meet the criteria for registration under REACH have been registered. This enables us to ensure that supply to customers is unaffected by the implementation of REACH
- Morgan Thermal Ceramics is also continuing to work closely with suppliers to ensure that the REACH process continues as smoothly as possible. We are communicating with suppliers to ensure that both our and our customers’ uses are included in their registration documents
What is REACH?
Registration, Evaluation, Authorisation and Restriction of Chemicals

REACH is the new chemical regulation within the EU. It applies to the manufacture and import of all chemical substances that are placed on the market in quantities greater than 1 Tonne per year. It came into force on 1st June 2007 and replaces a number of European directives and regulations with a single system. Further information on REACH can be found on the European Chemicals Agency (ECHA) website http://echa.europa.eu/home_en.asp

We are also working with our suppliers to ensure that our raw materials are registered correctly to ensure continued supply of our other product ranges, including Tri-mor, monolithic refractories and insulating firebricks.

What is the REACH process?

REACH places greater responsibility on industry to identify and manage the risks posed by chemicals to human health and the environment. Under this new regulation, both manufacturers/importers and downstream users have obligations to communicate uses and risks up and down the supply chain.

Under REACH, all substances manufactured or imported in volumes greater than 1 Tonne p.a. must be registered and H&S advice must be supplied to downstream users in a standardised format. Thermal Ceramics fibre products, both RCF and AES were registered for REACH in 2010 and now have REACH compliant Safety Data Sheets (SDS).

Since RCF is classified as CLP 1b carcinogen, RCF products carry a CLP hazard warning label on the packaging.

What is authorisation?

The authorisation procedure aims to ensure that the risks from Substances of Very High Concern (SVHC) are properly controlled and that these substances are progressively replaced by suitable alternatives while ensuring the proper functioning of the EU internal market.

If a substance is subject to authorisation it will be placed on Annex XIV of the REACH regulation and a sunset date will be set beyond which the substance cannot be used, except in authorised applications. Prior to the sunset date, sufficient time (18 months) is allowed for those wishing to continue use to prepare and submit an application for authorisation. Applications may be authorised if there is no feasible alternative or the risk can be shown to be low.

Authorisation applies specifically to the use of the substance on its own or in mixtures. This includes the use of the substance in manufacturing articles. The application process requires a “cradle to grave analysis” of health risk and also a full analysis of why substitution is not possible. This is a very demanding requirement.

Prioritisation in Europe of Refractory Ceramic Fibres (RCF) for authorisation under REACH Regulation No. 1907/2006.

On June 24th 2013, the European Chemicals Agency (ECHA) published its fifth recommendation of substances to be placed on the REACH authorisation list (Annex XIV). This recommendation included both Alumina-Silica RCF and Zirconia-Alumina-Silica RCF. This means that if confirmed by the European Commission later in the year, the future use of RCF within the European Union will be subject to the authorisation process.

Following the publication of the ECHA’s fifth recommendation, there was a public consultation period lasting three months. This has been completed and the results evaluated by the Member State Committee (MSC) in co-operation with the ECHA. This evaluation took longer than expected since there were a number of arguments raised in the public consultation questioning whether the quality of information to support RCF authorisation was adequate. On Feb 10th, the ECHA website confirmed the decision to refer the 5th recommendation, including RCF, to the European Commission for final review and decision. The earliest date for that decision is May 2014.

The decision to continue with the process by passing the 5th recommendation to the European Commission is supported on the ECHA website by a comprehensive document, entitled “Member State Committee Opinion”. This can be obtained using the following link:

http://echa.europa.eu/de/view-article/-/journal_content/title/echa-propo

Once the decision to place RCF on Annex XIV has been confirmed by the European Commission, the following deadlines will apply:

21 months: Last Application Date for authorisation (LAD)
39 months: Sunset Date after which RCF may only be supplied into authorised applications.

Work has started to identify the scope of a future authorisation application for those furnace linings where RCF cannot currently be substituted. That is at an early stage and will be developed further while the European Commission decision is awaited.

Additional updates will be provided as and when new information becomes available. Thermal Ceramics is committed to maintaining close contact with its customers for RCF products during this period and will provide advice on progress with the authorisation process or the use of alternatives, as required. If you have any immediate concerns or need advice on the use and regulation of high temperature insulating fibres please contact your usual Thermal Ceramics technical sales person.
Crystallisation - no health risk from exposure to crystalline silica in after use fibre

Some users have expressed concern about possible health effects associated with the crystalline silica, which may be formed when Superwool® fibres are heated to temperatures above 900°C (1652°F). This manual therefore presents a clear answer to these concerns, including the latest research results, which were completed by the Fraunhofer Institute for Experimental Medicine (ITEM) in 2006.

The Fraunhofer results show that Superwool® fibres, when crystallised by heating right up to classification temperature, display no hazardous activity related to any silica they may contain. This result, coupled with the very low crystalline silica exposures measured during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases resulting from employment in these activities.

In our everyday lives, all of us are exposed to dusts containing crystalline silica and suffer no ill effects as a result. However, exposure to silica which is fine enough to enter the lung (respirable crystalline silica) has been observed to cause disease in specific industrial situations.

Examples are the silica dust produced during mining, quarrying, stone masonry and sand blasting, which can cause various lung diseases including lung cancer. When vitreous fibres, including both RCF and Superwool®, are heated close to their classification temperature, they will start to crystallise. In this case the components present in the glassy structure may rearrange, allowing various crystalline compounds to form within the fibre.

The exact nature of these compounds will depend on the type of fibre and also the temperature cycle that the fibres experienced. Crystalline silica is usually one of the forms produced, but is never the main crystalline form.

In a typical furnace application, devitrification will occur only in the layer nearest to the hot face of the insulation and so the fibres concerned normally represent a small part of the complete furnace lining.

For this reason, attempts to measure crystalline silica in the air during furnace wrecking often fail, as the levels are too low to be detectable. This information offers some degree of reassurance; however it was the view of Thermal Ceramics that direct testing of heated Superwool® fibres was also necessary to ensure that the dust produced during furnace wrecking did not show any effects similar to those associated with free crystalline silica.

It was an unexpected but important result that this sample caused fewer lung effects than any other sample tested. A second group of independent scientists in Edinburgh found this sample to be inert when injected into rats¹.

These early results with RCF already gave an indication that crystallised end of life fibres did not constitute a health hazard.

There are ethical and legal reasons for trying to avoid further experimentation on live animals, and so Thermal Ceramics was keen to undertake further tests on Superwool® fibres using proven “in-vitro” techniques. The most reliable technique available was to study the effect of fibrous dust on macrophage cells, of the type which are responsible for clearing the dust from the deepest parts of the lung.

It is well known that toxic forms of crystalline silica have been found both to kill macrophages in-vitro and to cause disease in animals. The investigation chosen therefore was to observe the effect of heated Superwool® fibres on macrophage cells. The experimenters have therefore searched for any effect produced by the Superwool® fibre, which was similar to that produced by toxic crystalline silica.

Such an experiment requires considerable expertise to produce reliable results. For this reason the Fraunhofer ITEM was contracted to design and carry out the macrophage experiments.

Samples of Superwool® 607® and Superwool® 607® Max™ were heated to 150°C below their classification temperature and also to classification temperature in order to simulate fibres which had been used near the hot face of a furnace insulation. Unheated fibres were also produced as controls.

Suitable samples of each type were then supplied to Fraunhofer ITEM for the experimental programme. Since fibres can also cause damage to cultured cells simply through their shape, it was necessary to use a method to distinguish such non-specific toxicity from the effects of silica. This was accomplished using aluminium lactate. This is a proven compound which binds to silica and renders it non-toxic but has no effect on other activities.

All samples were therefore tested both alone and with a very low concentration of aluminium lactate; the difference in the measured effects between the two samples was then a direct measure of silica activity (see results table). A standard quartz (crystalline silica) sample (DQ12) known to be toxic was used as a reference to verify that the methods worked.

Two measures of toxic activity were used. Firstly, the ability of the fibres to cause the cells to leak was determined by measuring the amount of an enzyme (lactate dehydrogenase) normally found inside the cells that had leaked into the medium outside. Secondly, the amount of DNA (chromosome) damage was measured using an assay in which the number of strand breaks in the DNA from individual cells is quantified. The standard active quartz sample (DQ12) was clearly positive in both these assays; however, none of the heated fibres showed significant silica activity.
We can conclude that heated Superwool® fibres display no hazardous activity related to any silica they may contain. This result, coupled with the very low crystalline silica exposures during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases from employment in these activities.

Prof. R.C. Brown. Toxicology Services, Stretton, Rutland


- The resistance of Superwool®, RCF and competitive AES fibre to pollution from elements which may be found in kilns operating at high temperature.

Contamination and pollution study...

<table>
<thead>
<tr>
<th>Fibre type</th>
<th>Silica activity in fibres as a proportion of activity of quartz (DQ12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DQ12 quartz (Crystalline silica positive control)</td>
</tr>
<tr>
<td>2</td>
<td>Superwool® 607™ &amp; Plus</td>
</tr>
<tr>
<td>3</td>
<td>Superwool® 607™ &amp; Plus</td>
</tr>
<tr>
<td>4</td>
<td>Superwool® 607™ Max™</td>
</tr>
<tr>
<td>5</td>
<td>Superwool® 607™ Max™</td>
</tr>
<tr>
<td>6</td>
<td>Superwool™ 607™ HT™</td>
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<tr>
<td>7</td>
<td>Superwool™ 607™ HT™</td>
</tr>
<tr>
<td>8</td>
<td>Superwool® 607™ &amp; Plus</td>
</tr>
<tr>
<td>9</td>
<td>Superwool® 607™ Max™</td>
</tr>
<tr>
<td>10</td>
<td>Superwool™ 607™ HT™</td>
</tr>
</tbody>
</table>

Key to results:
1. DQ12 quartz (Crystalline silica positive control)
2. Superwool® 607™ & Plus
3. Superwool® 607™ & Plus
4. Superwool® 607™ Max™
5. Superwool® 607™ Max™
6. Superwool™ 607™ HT™
7. Superwool™ 607™ HT™
8. Superwool® 607™ & Plus
9. Superwool® 607™ Max™
10. Superwool™ 607™ HT™
Contamination / Pollution Study

What does a contamination study involve?

The aim of this study was to evaluate the resistance of Superwool®, RCF and a competitor AES fibre to pollution from the elements which may be found in kilns operating at high temperature.

Examples are the firing of glazed ceramics and steel heat treatment. The pollutants are generally inorganic elements or oxides which can form a damaging eutectic reaction with the fibre. The result can be melting, crystallisation or powdering of the fibre.

The products tested were:
- Superwool® Plus
- Superwool® 607®HT™
- Cerablanket (RCF 1260)
- A similar competitor AES 1260°C product

Test method:
Three layers of blanket of 128kg/m³ density and 25mm thick are overlaid. The mid layer has a hole at the middle so the pollutant powder (6g) can be inserted. This technique offers the advantage that the test can evaluate both contact reactivity in the bottom layer and also vapour reactivity in the top layer.

The 3 layers are heat treated for 6 hours at the following temperatures:
1000°C (1832°F)
1100°C (2012°F)
1150°C (2102°F)

After heat treatment the three layers are observed to evaluate potential powderiness, melting, discolouration or any signs of reaction.

Pollutants tested:
The pollutants tested were as follows:
- Mo = molybdenum / MoO₃ = molybdenum trioxide
- Cu = copper / copper (II) oxide
- Zn = zinc / ZnO = zinc oxide
- Pb = lead / PbO = lead (II) oxide
- V = vanadium / V₂O₅ = vanadium pentoxide
- Mn = manganese / MnO = manganese oxide
- Ni = nickel / NiO = nickel (II) oxide
- Cr = chromium
- Sn = tin / SnO₂ = tin (IV) oxide
- Na₂CO₃ = sodium carbonate
- K₂CO₃ = potassium carbonate
- B₂O₃ = boric oxide
- Bi₂O₃ = bismuth trioxide
- P₂O₅ = phosphorus pentoxide

What were the test results?

<table>
<thead>
<tr>
<th>Elements</th>
<th>SW60HT</th>
<th>RCF 1260</th>
<th>Competitor AES 1260°C</th>
<th>SW Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Silicate</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
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<tr>
<td>Alumino Silicate</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
<td>800°C (1472°F)</td>
</tr>
<tr>
<td>Silicon Carbide</td>
<td>1100°C (2012°F)</td>
<td>1100°C (2012°F)</td>
<td>1150°C (2102°F)</td>
<td>1100°C (2012°F)</td>
</tr>
</tbody>
</table>

Legend:
- Reaction starts from this temperature
- No reaction observed along its typical range of use

Conclusions / recommendations

- All fibre chemistries demonstrate varying degrees of reactivity with a majority of elements.
- In Superwool® 607®HT™ and Superwool® Plus applications, the following elements indicate a risk to product performance:
  - Mo/MoO₃
  - Alkali (such as K₂CO₃/K₂O, Na₂CO₃/Na₂O, B₂O₃)
  - Pb/PbO
  - P₂O₅
  - V₂O₅
  - Cu/CuO
  - Bi₂O₃

- A combination of contaminants will worsen the chemical attack
- From experience it is known that both sulphur and HF will produce a strong attack
- If an application does not contain these elements or are working at a lower temperature than the reaction starting temperature, Superwool® 607®HT™ and Superwool® Plus will perform well in the application. Where contamination is anticipated which may cause a reaction with the fibre lining, it is recommended to discuss the best practical solution to lining design with your local Morgan Thermal Ceramics office.
**Superwool® Plus**

**Insulating fibre**

### Features
- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008
- Lower thermal conductivity
- Up to 30% more fibres
- Less shot
- High Fibre Index
- Stronger with good handleability (no tearing)
- Improved handling
- Soft & smooth feel
- Consistent use of pure raw materials
- Lower density grade for the same result
- Thinner lining for the same result
- Resistant to vibration
- An environmental solution
- Worldwide production

### Benefits
- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Improves insulation by 20%
- Efficient prevention of heat transfer and greater strength
- Cleaner workplace
- Up to 20% reduction in thermal conductivity giving energy saving
- Ease of installation saving time and waste
- Operator satisfaction
- Less mechanical skin irritation
- Higher classification temperature, low shrinkage and consistent quality
- Material weight savings up to 25%
- Create more working space within unit
- Allows long lifetime under vibration conditions where other products fail
- Potential savings on waste disposal
- Availability

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**Superwool® Plus product range includes:**

<table>
<thead>
<tr>
<th>Product type</th>
<th>Superwool® Plus products</th>
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<tr>
<td>Blanket</td>
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<td>Superwool® Plus Rope Lagging</td>
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<td>Superwool® Plus Braided Sweating</td>
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<td></td>
<td>Superwool® Plus Cloth</td>
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</table>
Data sheet
Superwool® blankets

Description
Superwool® Plus and Superwool® HT blankets offer the same benefits as the other members of the Superwool fibre family but with improved handling strength and enhanced thermal properties.

Superwool® Plus and Superwool® HT blankets are manufactured from pure raw materials using a new manufacturing technology. In addition to enhanced thermal properties, large nuisance dust particles have been effectively eliminated making the product soft to the touch and less irritating during use.

Superwool® Plus Blankets are made of Superwool® Plus long fibres
Superwool® HT Blanket is made of Superwool® HT long fibres

Superwool® Plus and Superwool® HT blankets have excellent thermal stability and are their original carbon fibres, with no maximum continuous use temperature. Superwool® Plus and Superwool® HT blankets are tested from both sides and possess high strength bearers and a shear strength.

Superwool® Plus blankets and Superwool® HT blankets contain neither binder nor lubricant and do not emit any fumes or small dust during the firing. Superwool® Plus and Superwool® HT blankets are flexible, easy to cut and shape and easy to install.

Benefits
- Exceptional thermal insulating performance - conforming to industry standards
- Free of binder or lubricants
- Thermal stability
- Low heat storage
- Good resistance to bearing
- Flexible and resilient
- Good sound absorption
- Exposed to any existing wear classification under ISO Q of E nbr 1916/EC

Classification temperature
Superwool® Plus blanket: 1200°C (2192°F)
Superwool® HT blanket: 1300°C (2372°F)

The maximum continuous use temperature depends on the application. Please contact Morgan Advanced Materials, Thermal Ceramics for advice.

Typical applications
- Power generation especially HRSG duct insulation
- Chemical insulation
- Process heater linings
- Pipe wrap
- Annealing furnace linings
- Furnace and kiln back-up insulation
- String heater insulation
- Domestic oven insulation
- Automotive exhaust heat shields
- Aluminium transfer hearth covers
- Welding stress relief

Data Sheet:

<table>
<thead>
<tr>
<th>Material</th>
<th>Superwool® Plus blanket</th>
<th>Superwool® HT blanket</th>
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</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Carbon (%)</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>Chemical composition, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiC</td>
<td>62-68</td>
<td>70-80</td>
</tr>
<tr>
<td>CaO+MgO</td>
<td>-</td>
<td>10-15</td>
</tr>
<tr>
<td>MnO</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MgO</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other oxides</td>
<td>&lt;1</td>
<td>&lt;3</td>
</tr>
</tbody>
</table>

Availability and Packaging
Superwool® HT Blankets are packed in cartons, 1260 x 914mm pull + attachment film. Marks (ii) and width 1220mm upon request (subject to minimum order requirements).

Superwool® Plus blanket

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Density (kg/m³)</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Carbon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>12</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>18</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>30</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
</tbody>
</table>

Superwool® HT blanket

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Density (kg/m³)</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Carbon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>12</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>18</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
<tr>
<td>30</td>
<td>80</td>
<td>1200</td>
<td>120</td>
<td>92</td>
</tr>
</tbody>
</table>

THERMAL CERAMICS
MATERIAL SAFETY DATA SHEET

IDENTIFICATION OF THE PRODUCT
SUPERWOOL PLUS blanket AC2®
SUPERWOOL PLUS BLANKET®
SUPERWOOL PLUS WATER REPELLENT,
SUPERWOOL PLUS BULK
SUPERWOOL PLUS PYRO-BLOC,
SUPERWOOL PLUS PYRO-LOG,
SUPERWOOL PLUS 2-BLOC,
SUPERWOOL PLUS THERMO-BLOC MODULE,
SUPERWOOL PLUS PYRO-MODULE,

(') With or without aluminium facing and corresponding strip and die-cut

The above-mentioned products contain Alkaline-earth silicate wools (AES wools)

Index Number: 650-016-00-2 Annex VI
CAS number: 436083-99-7
Registration number: 01-2119475644-32-0000

USE OF THE PRODUCT
Application as thermal insulation, heat shields, heat containment, gaskets and expansion joints in industrial furnaces, ovens, kilns, boilers and other process equipment and in the aerospace, automotive and appliance industries, and as passive fire protection systems and firestoppers. (Please refer to specific technical data sheet for more information).

IDENTIFICATION OF THE MANUFACTURER/SUPPLIER
France
THERMAL CERAMICS HSE Department
Route de Lauterbourg - BP 90148
67163 WISSEMBÜRG Cedex
Tel.: +33 (0) 85 54 95 00
Fax: +33 (0) 85 54 29 50
Website: www.morganthermalceramics.com
Email: marketing.tc@morganplc.com

U.K.
THERMAL CERAMICS LIMITED
Tebay Road, Bromborough
Wirral, Merseyside CH62 3PH
Tel.: +44 (0) 151 334 4030
Fax: +44 (0) 151 334 1684

EMERGENCY CONTACT NUMBER
Tel 1: +44 (0) 7931 963 973. Tel 2: +33 (0) 6 07 42 97 74
Language: English (tel 1), French & German (tel 2)
Opening hours: Only available during office hours

2. Hazards Identification

CLASSIFICATION OF THE SUBSTANCE/MIXTURE
Not applicable

LABELLING ELEMENTS
Not applicable

OTHER HAZARDS WHICH DO NOT RESULT IN CLASSIFICATION
Mild mechanical irritation to skin, eyes and upper respiratory system may result from exposure.
These effects are usually temporary.

3. Composition / information on ingredients

DESCRIPTION
These products in the form of bulk, blanket (pre-sized or not), strip, die-cut and modules, bloc, log (encapsulated or not), are made of AES wool (synthetic fibres, alk. earth silicate).

COMPOSITION

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>%</th>
<th>CAS NUMBER</th>
<th>Index Number</th>
<th>REACH Registration Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES wool (synthetic fibres, alk. earth silicate)</td>
<td>100</td>
<td>436083-99-7*</td>
<td>650-016-00-2</td>
<td>01-2119457644-32-0000</td>
</tr>
<tr>
<td>iner water repellent</td>
<td>0-15</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not yet available</td>
</tr>
</tbody>
</table>

Composition:
* CAS definition: Alkaline earth silicate (AES) consisting of silica (50-82 wt%), calcia and magnesia (18-43 wt%), alumina, titania and zirconia (less than 6 wt%), and trace oxides.

None of the components are radioactive under the terms of European Directive Euratom 96/29.

4. First-aid measures

SKIN:
Handling of this material may generate mild mechanical temporary skin irritation. If this occurs, rinse affected area with water and wash gently. Do not rub or scratch exposed skin.

EYES:
In case of eye contact flush abundantly with water; have eye bath available. Do not rub eyes.

NOSE AND THROAT:
If these become irritated move to a dust free area, drink water and blow nose.

If symptoms persist, seek medical advice.

5. Fire-fighting measures

Non-combustible products.
Packaging and surrounding materials may be combustible
Use extinguishing agent suitable for surrounding combustible materials.

6. Accidental release measures

Where abnormally high dust concentrations occur, provide the workers with appropriate protective equipment as detailed in section 8.
Restore the situation to normal as quickly as possible.
Prevent further dust dispersion for example by damping the materials.
Pick up large pieces and use a vacuum cleaner.
If brushing is used, ensure that the area is wetted down first.
Do not use compressed air for clean up.
Do not allow being windblown. Do not flush spillage to drain and prevent from entering natural watercourses.

For wastes disposal refer to section 13.
7. Handling and storage

HANDLING/TECHNIQUES TO REDUCE DUST EMISSIONS DURING HANDLING
Handling can be a source of dust emission. The process or processes should be designed to limit the amount of handling. Wherever possible, handling should be carried out under ventilation with filtered exhaust. Regular good housekeeping will minimise secondary dust dispersal.

STORAGE
Store in original packaging in a dry area. Always use sealed and clearly labelled containers. Avoid damaging containers. Reduce dust emission during unpacking.

SPECIFIC USE
Please refer to your local Thermal Ceramics' supplier.

8. Exposure controls / personal protection

HYGIENE STANDARDS AND EXPOSURE LIMITS
Industrial hygiene standards and occupational exposure limits vary between countries and local jurisdictions. Check which exposure levels apply to your facility, and comply with local regulations. If no regulatory dust or other standards apply, a qualified industrial hygienist can assist with a specific workplace evaluation including recommendations for respiratory protection. Examples of exposure limits applying (in January 2010) to mineral wools in different countries are given below:

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>EXPOSURE LIMIT*</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>3 mg/m³</td>
<td>TRGS 900</td>
</tr>
<tr>
<td>France</td>
<td>1.0 t/ml</td>
<td>Circulaire DRT No 95-4 du 12.01.96</td>
</tr>
<tr>
<td>U.K.</td>
<td>2.0 t/ml and 5 mg/m³</td>
<td>HSE - EH40 - Workplace Exposure Limit</td>
</tr>
</tbody>
</table>

*Time weighted average concentrations of airborne respirable fibres measured over 8 hours by the conventional membrane filter method or the total inhalable dust using standard gravimetric techniques.

ENGINEERING CONTROLS
Review your applications in order to identify potential sources of dust exposure. Local exhaust ventilation, which collects dust at source, can be used. For example down draft tables, emission controlling tools and materials handling equipment.

Keep the workplace clean. Use a vacuum cleaner. Avoid brushing and compressed air.

PERSONAL PROTECTIVE EQUIPMENT
Skin protection:
Wear gloves and work clothes, which are loose fitting at the neck and wrists. Soiled clothes should be cleaned to remove excess fibres before being taken off (e.g. use vacuum cleaning, not compressed air).

Eye protection:
As necessary wear goggles or safety glasses with side shields.

Respiratory protection:
For dust concentrations below the exposure limit value, RPE is not required but FFP2 respirators may be used on a voluntary basis.
For short-term operations where excursions are less than ten times the limit value use FFP2 respirators.
In case of higher concentrations or where the concentration is not known, please seek advice from your company and/or local Thermal Ceramics supplier.

INFORMATION AND TRAINING OF WORKERS
Workers should be trained on good working practices and informed on applicable local regulations.

ENVIRONMENTAL EXPOSURE CONTROLS
Refer to local, national or European applicable environmental permitted standards for air, water and soil. For waste, refer to Section 13.

9. Physical and chemical properties

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPEARANCE</td>
<td>White fibre</td>
</tr>
<tr>
<td>PARTITION COEFFICIENT</td>
<td>Not applicable</td>
</tr>
<tr>
<td>ODOUR</td>
<td>None</td>
</tr>
<tr>
<td>BOILING POINT</td>
<td>Not applicable</td>
</tr>
<tr>
<td>FIBRE MELTING POINT</td>
<td>&gt; 1200°C</td>
</tr>
<tr>
<td>AUTOFLAMMABILITY</td>
<td>None</td>
</tr>
<tr>
<td>FLAMMABILITY</td>
<td>Not applicable</td>
</tr>
<tr>
<td>OXIDISING PROPERTIES</td>
<td>None</td>
</tr>
<tr>
<td>EXPLOSIVE PROPERTIES</td>
<td>None</td>
</tr>
<tr>
<td>RELATIVE DENSITY</td>
<td>50-140 kg/m³</td>
</tr>
<tr>
<td>VAPOUR PRESSURE</td>
<td>Not applicable</td>
</tr>
<tr>
<td>SOLUBILITY</td>
<td>Less than 1 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>Not applicable</td>
</tr>
<tr>
<td>LENGTH WEIGHTED GEOMETRIC MEAN DIAMETER OF FIBRES CONTAINED IN THE PRODUCT</td>
<td>1.4 - 3 μm</td>
</tr>
</tbody>
</table>

10. Stability and reactivity

CONDITIONS OR MATERIALS TO AVOID
None

DECOMPOSITION PRODUCTS
Upon heating above 900°C for sustained periods, this amorphous material begins to transform to mixtures of crystalline phases. For further information please refer to Section 16.

11. Toxicological information

IRRITANT PROPERTIES
Superoxid fibres are negative when tested using approved methods (Directive 67/548/EEC, Annex 5, Method B4). Like all man-made mineral fibres and some natural fibres, fibres contained in this product can produce a mild mechanical irritation resulting in temporary itching or rarely, in some sensitive individuals, in a slight temporary reddening. Unlike other irritant reactions this is not the result of allergy or chemical skin damage but is caused by mechanical effects.

OTHER ANIMAL STUDIES
Fibres contained in the products listed in the title have been designed to be rapidly cleared from lung tissue. This low biopersistence has been confirmed in many studies on AES using EU protocol EC/BTM27(rev 7).
When inhaled, even at very high doses, they do not accumulate to any level capable of producing a serious adverse biological effect. In lifetime chronic studies there was no exposure-related effect more than would be seen with any “inert” dust. Subchronic studies at the highest doses achievable produced at worst a transient mild inflammatory response. Fibres with the same ability to persist in tissue do not produce tumours when injected into the peritoneal cavity of rats.

12. Ecological information

These products are inert materials, which remain stable over the time. No adverse effects of this material on the environment are anticipated.
13. Disposal considerations

Waste from these materials may be generally disposed off at a landfill, which has been licensed for this purpose. Please refer to the European list (Decision No 2000/532/CE as modified) to identify your appropriate waste number, and ensure national and/or regional regulations are complied with.

Taking into account any possible contamination during use, expert guidance should be sought.

Unless wetted, such a waste is normally dusty and so should be properly sealed in containers for disposal. At some authorised disposal sites, dusty waste may be treated differently in order to ensure they are dealt with promptly to avoid them being windblown. Check for any national or regional regulations, which may apply.

14. Transport information

Not classified as dangerous goods under relevant international transport regulations (ADR, RID, IATA, IMDG, ADR). Ensure that dust is not windblown during transportation.

15. Regulatory information

1. FIbre TYPE DEFINITION UNDER DIRECTIVE 67/548/EEC

According to Directive 67/548/EEC the fibre contained in this product is a mineral wool belonging to the group of "man-made vitreous (silicate) fibres with random orientation with alkali earth oxide (Na₂O+K₂O+CaO+MgO+B₂O₃) content greater than 18% by weight".

Under criteria listed in nota Q of Directive 67/548/EEC, fibres contained in the products listed in the title are exonerated from carcinogen classification because of low biopersistence measured by the methods specified in European Union and German regulations (EU protocol 86/77/TM/27/rev 7).


This regulation aims at incorporating the GHS criteria into the EU Community law. Under 1.1.3.1, (nota Q) of Annex VI of regulation (EC) 1272/2008 the classification as a carcinogen 2 needs not apply on the basis of short term biopersistence test by intratracheal installation showing a half life of less than 40 days for fibres longer than 20 μm.

1\textsuperscript{st} adaptation of Technical Progress of Regulation (EC) N°1272/2008 of 10 August 2009 has removed skin irritancy classification for man-made vitreous (silicate) wools.

Fibres contained in this product are therefore free of any classification and do not require labelling under CLP regulation.

PROTECTION OF WORKERS

Shall be in accordance with several European Directives as amended and their implementations by the Member States:


OTHER POSSIBLE REGULATIONS

Member States are in charge of implementing European Directives into their own national regulation within a period of time normally given in the Directive. Member States may impose more stringent requirements. Please always refer to any national regulation.

16. Other information

USEFUL REFERENCES (the directives which are cited must be considered in their amended version)

- Regulation (EC) No 1907/2006 dated 18th December 2006 on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
- Regulation (EC) No 1272/2008 dated 20th January 2009 on classification, labelling and packaging of substances and mixtures (CLP);

PRECAUTIONARY MEASURES TO BE TAKEN AFTER SERVICE UPON REMOVAL

In almost all applications high temperature insulating wools products (HTIW) are used as an insulating material helping keeping up temperature at 900°C or more in a closed space. As only a thin layer of the insulation hot face side is exposed to high temperature, respirable dust generated during removal operations does not contain detectable levels of crystalline silica (CS).

In applications where the material is heated soaked, duration of heat exposure is normally short and a significant devitrification allowing CS to build up does not occur. This is the case for waste mould casting for instance.

Toxicological evaluation of the effect of the presence of CS in artificially heated HTIW material has not shown any increased toxicity in vitro and in vivo. The results from different combinations of factors like increased brittleness of fibres, or microcrystals embedded in the glass structure of the fibre and therefore not biologically available may explain the lack of toxicological effects.

IARC evaluation as provided in Monograph 68 is not relevant as CS is not biologically available in after service HTIW.

High concentrations of fibres and other dusts may be generated when after-service products are mechanically disturbed during operations such as wrecking. Therefore ECFIA recommends:

a) control measures are taken to reduce dust emissions;

b) all personnel directly involved wear an appropriate respirator to minimize exposure and comply with local regulatory limits.

CARE PROGRAMME ("Controlled and Reduced Exposure")
The trade association representing the European high temperature insulation wool industry (ECFIA) has undertaken an extensive hygiene programme for High Temperature Insulation Wool (HTIW). The objectives are twofold: (i) to monitor workplace dust concentrations at both manufacturers' and customers' premises, and (ii) to document manufacturing and use of HTIW products from an industrial hygiene perspective in order to establish appropriate recommendations to reduce exposures. The initial results of the programme have been published. If you wish to participate in the CARE programme, contact ECFIA or your Thermal Ceramics' supplier.

WEB SITES:

For more information connect to:

- The Thermal Ceramics website: http://www.morganthermalceramics.com
- The ECFIA's website: http://www.ecfia.org
- Deutsche KeramikFaser-Gesellschaft e.V website: http://www.dkfg.de
For more information on individual products please see the relevant technical data sheets on the Morgan Thermal Ceramics website: www.morganthermalceramics.com

Superwool® Plus™ Blanket
Superwool® Plus™ Bulk
Superwool® Plus™ Z Blok
Superwool® Plus™ Stack Modules
Superwool® Plus™ Paper
Superwool® Plus™ Pyro-Bloc Module
Superwool® Plus™ Pyroboard
Superwool® Plus™ Clad
Superwool® Plus™ Board
Superwool® Plus™ Blok
Superwool® Plus™ VF Products
Superwool® Plus™ Cartons
Superwool® Plus™ Unifelt Board
Superwool® Plus™ Textiles

NOTICE:
The information presented herein is based on data considered to be accurate as of the date of preparation of this Material Safety Data Sheet. However, safe as provided by law, no warranty or representation, express or implied, is made as to the accuracy or completeness of the foregoing data and safety information, nor is any authorisation given or implied to practice any patented invention without a licence. In addition, no responsibility can be assumed by the vendor for any damage or injury resulting from abnormal use, from any failure to adhere to recommended practices, or from any hazards inherent in the nature of the product (however, this shall not act to restrict the vendor's potential liability for negligence or under statute).
Beware of imitations...

...look for the brand

Superwool®

Do not confuse Morgan Thermal Ceramics’ reputable products with imitations and false claims currently circulating in the market.

- Morgan Thermal Ceramics has pioneered the revolution of high temperature, low biopersistence insulation fibres for almost 20 years with patented technology.
- Morgan Thermal Ceramics is the leader...others merely follow.

---

**Superwool Plus**

**Insulating fibre**

**Features**

- An engineered solution (unique)
- Patented technology
- High temperature insulating wools (Superwool® range of products) not classified according to European Regulation (EC) 1272/2008
- Lower thermal conductivity
- Up to 30% more fibres
- Less shot
- High Fibre Index
- Stronger with good handleability (no tearing)
- Improved handling
- Soft & smooth feel
- Consistent use of pure raw materials
- Lower density grade for the same result
- Thinner lining for the same result
- Resistant to vibration
- An environmental solution
- Worldwide production

**Benefits**

- Takes insulation beyond normal performance
- Proven chemical formulation
- Restrictions on use do not apply. No special requirements for dust control, can be supplied to the general public and considered as non-hazardous waste for disposal
- Improves insulation by 20%
- Efficient prevention of heat transfer and greater strength
- Cleaner workplace
- Up to 20% reduction in thermal conductivity giving energy saving
- Ease of installation saving time and waste
- Operator satisfaction
- Less mechanical skin irritation
- Higher classification temperature, low shrinkage and consistent quality
- Material weight savings up to 25%
- Create more working space within unit
- Allows long lifetime under vibration conditions where other products fail
- Potential savings on waste disposal
- Availability
Beware of imitations

Do not confuse Morgan Thermal Ceramics’ reputable products with imitations and false claims currently circulating in the market.

Morgan Thermal Ceramics is aware that fibre imports are claiming to have low biopersistence, to conform to current EU H&S regulations and to be identical to Morgan Thermal Ceramics’ Superwool® material are being offered at highly competitive prices. Neither a comparison between the outward appearances of fibre products or the feel of the products can be used to distinguish between different fibre products. When a simple test on a sample which was marked as ‘low biopersistent’ was made using the latest AES-vs- RCF solubility test kit it was found the claimed low biopersistent product was in fact RCF. It should be emphasised that low biopersistent products are exonerated from EU legislation and RCF is classified as carcinogenic 2 (1b).

Further tests using X-ray instrumentation (XRF chemical analysis) determined that the fibre was actually a 1400 grade RCF product. This ultimately constitutes an unethical evasion of H&S regulations in Europe where regulations are becoming very stringent for RCF use.

BEWARE: Look for the brand

Morgan Thermal Ceramics has also been made aware of several occurrences in the market where customers have received what was presented to them by other manufactures as ‘Superwool®’ products, available at competitive prices, tested and able to withstand the temperatures and applications intended as stated on our technical data sheets. However, once ordered the product received was an ‘imitation of Superwool®’ and not what they had originally tested.

Morgan Thermal Ceramics has pioneered the revolution of high temperature, low biopersistence insulation fibres for almost 20 years with patented technology.

Our programme of continuous development, together with vast experience, knowledge and a great understanding of our products’ capabilities, allows us to understand the advantages and limitations of each product form and enables us to advise our customers based on factual testing results.

Morgan Thermal Ceramics is the leader…others merely follow.

A simple unambiguous colour change test is available which enables you to distinguish between the two main types of high temperature fibre: low biopersistence products (AES fibres such as Superwool® fibres) and RCF based materials.

For more details visit www.morganthermalceramics.com or contact your local Morgan Thermal Ceramics representative.

AES v RCF solubility test kit:
clearly identifies the fibre already installed.

Our technical documentation is factual and conscientious in today’s volatile market and giving security through proven quality and the use of worldwide approved testing methods.
Copyright and disclaimer information

Thermal Ceramics has made all reasonable efforts to ensure that all information provided through the technical manual is accurate at the time of inclusion. However, it is possible that there may be occasional errors or omissions for which Thermal Ceramics apologises.

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Datasheets and material safety data sheet (MSDS):

Whilst the values and application information in this datasheet are typical, they are given for guidance only. The values and the information given are subject to normal manufacturing variation and may be subject to change without notice. Morgan Advanced Materials - Thermal Ceramics makes no guarantees and gives no warranties about the suitability of a product and you should seek advice to confirm the product’s suitability for use with Morgan Advanced Materials - Thermal Ceramics.

SUPERWOOL® is a patented technology for high temperature insulation wools which have been developed to have a low bio persistence (information upon request). SUPERWOOL® products may be covered by one or more of the following patents, or their foreign equivalents:


A list of foreign patent numbers is available upon request to Morgan Advanced Materials plc.

Morgan Advanced Materials plc Registered in England & Wales at Quadrant, 55-57 High Street, Windsor, Berkshire SL4 1LP UK Company No. 286773
### Conversion tables

**TEMPERATURE - Conversion formula**

- **Celsius to Fahrenheit**
  \[ \text{Celsius degrees} \times \frac{9}{5} + 32 = ^\circ\text{F} \]
- **Fahrenheit to Celsius**
  \[ 32 \times \frac{5}{9} = ^\circ\text{C} \]

**VOLUME - Conversion tables**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cubic centimetre</td>
<td>0.0610 cubic inches</td>
</tr>
<tr>
<td>1 cubic decimetre</td>
<td>0.0353 cubic feet</td>
</tr>
<tr>
<td>1 cubic metre</td>
<td>1.3080 cubic yards</td>
</tr>
<tr>
<td>1 litre</td>
<td>1.76 pints</td>
</tr>
<tr>
<td>1 hectarolitre</td>
<td>21.997 gallons</td>
</tr>
</tbody>
</table>

**AREA - Conversion tables**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 square centimetre</td>
<td>0.1550 square inches</td>
</tr>
<tr>
<td>1 square metre</td>
<td>1.1960 square yards</td>
</tr>
<tr>
<td>1 square kilometre</td>
<td>3.861 square miles</td>
</tr>
</tbody>
</table>

**LENGTH - Conversion tables**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 millimetre</td>
<td>0.0394 inches</td>
</tr>
<tr>
<td>1 centimetre</td>
<td>0.3937 inches</td>
</tr>
<tr>
<td>1 metre</td>
<td>1.0936 yards</td>
</tr>
<tr>
<td>1 kilometre</td>
<td>0.6214 miles</td>
</tr>
</tbody>
</table>

**WEIGHT - Conversion tables**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 milligram</td>
<td>0.0154 grains</td>
</tr>
<tr>
<td>1 gram</td>
<td>0.0353 ounces</td>
</tr>
<tr>
<td>1 kilogram</td>
<td>2.2046 pounds</td>
</tr>
<tr>
<td>1 tonne</td>
<td>0.9842 tons</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ounce (oz)</td>
<td>28.35 grams</td>
</tr>
<tr>
<td>1 pound (lb)</td>
<td>453.6 kilograms</td>
</tr>
<tr>
<td>1 stone</td>
<td>6350 kilograms</td>
</tr>
<tr>
<td>1 hundredweight (cwt)</td>
<td>50.802 kilograms</td>
</tr>
<tr>
<td>1 ton (t)</td>
<td>1016 tonnes</td>
</tr>
</tbody>
</table>