MATERIAL SAFETY DATA SHEET

Section 1- PRODUCT IDENTIFICATION

<table>
<thead>
<tr>
<th>COMPOSITION</th>
<th>PRODUCT NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hf</td>
<td>Hafnium</td>
</tr>
</tbody>
</table>

Section 2- HAZARDOUS INGREDIENTS

Note: Products under normal conditions do not represent an inhalation, ingestion or contact health hazard.

<table>
<thead>
<tr>
<th>MATERIAL OR COMPONENT</th>
<th>CAS NUMBER</th>
<th>WT%</th>
<th>EXPOSURE LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hf</td>
<td>7440-58-6</td>
<td></td>
<td>OSHA PEL (Mg/M3) ACGIH TLV(MG/M3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA=0.5mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

Section 3- PHYSICAL DATA

<table>
<thead>
<tr>
<th>MATERIAL IS (AT NORMAL CONDITIONS)</th>
<th>APPERANCE AND ODOR</th>
<th>MELTING POINT (BASE METAL):</th>
<th>SPECIFIC GRAVITY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Liquid</td>
<td>□ Solid □ Gas □ Other</td>
<td>2227°C</td>
<td>13.3</td>
</tr>
</tbody>
</table>

Section 4- FIRE AND EXPLOSION

<table>
<thead>
<tr>
<th>Flash Point (Method Used)</th>
<th>Flammable Limits</th>
<th>LEL</th>
<th>UEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EXTINGUISHING MEDIA

Type D fire extinguisher. Dry table salt.

SPECIAL FIRED FIGHTING PROCEDURES & UNUSUAL FIRE AND EXPLOSION HAZARDS

See Attached List

Section 5- REACTIVITY DATA

<table>
<thead>
<tr>
<th>STABILITY</th>
<th>INCOMPATABILITY (MATERIALS TO AVOID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable</td>
<td>See Attached List</td>
</tr>
</tbody>
</table>

CONDITIONS TO AVOID

Keep away from source of ignition.

HAZARDOUS DECOMPOISTION PRODUCTS

Will not occur.

Section 6- HEALTH HAZARD GUIDE

<table>
<thead>
<tr>
<th>MAJOR EXPOSURE HAZARD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Inhalation □ Skin □ Skin Absorption □ Eye Contact □ Ingestion</td>
<td></td>
</tr>
</tbody>
</table>

EFFECTS OF OVEREXPOSURE

TOXICITY DATA: Hafnium metal has no known toxicity. The metal is completely insoluble in water, saline solutions or body chemicals.

COMMENT: Soluble hafnium compounds have been reported to cause liver damage in lab tests on animals. The Ld50 of hafnium chiefly as the oxychloride was 76 mg/kg for mice. A 90 day hafnium chloride feeding study in rats at 1.0% and 0.1% resulted in unspecified liver effects. No industrial disease has been evident with up to 20 years exposure to hafnium compounds.
EMERGENCY & FIRST AID PROCEDURES

**SKIN CONTACT**: Normal procedure for cuts from sharp metals.
**EYE CONTACT**: Normal procedure for inert foreign objects.

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**Section 7- SPILL OR LEAK PROCEDURES**

**SPILL OR LEAK PROCEDURES**

**No special procedures indicated**

**WASTE DISPOSAL METHODS**

Fine non-recyclable scrap should be burned in small quantities under controlled conditions. Resultant hafnium oxide can be deposited in a landfill.

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**Section 8- SPECIAL PROTECTION**

**RESPIRATORY**

Wear appropriate NIOSH approved respirator while conducting operations such as surface grinding which will generate dust.

**VENTILATION**

Normal

**EYE PROTECTION & PROTECTIVE CLOTHING**

Eye protection is recommended when surface grinding which will generate flying particles. Use gloves to avoid cuts.

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**Section 9- SPECIAL PRECAUTIONS**

Machining of hafnium may result in fine turnings, chips and/or dust. Any material with a dimension of less than 0.0235” or a cross section less than 0.0078” can be ignited and can sustain combustion. Keep away from any source of ignition. Keep fine turnings completely dry, or very wet. If wet, the water content should be more than 25% by weight for maximum safety in handling. Severe explosions can result from ignition of hafnium powder or machining fines containing moisture in the concentration range of 5-10%. Do not accumulate large quantities of fines or machining residues. Dispose of materials immediately.

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FIREFIGHTING PROCEDURES:
Isolate burning material. It is advisable to allow large fires to burn out, keeping the fire from spreading. Wear reflective heat resistant suit. Small fires can be controlled by smothering with dry salt or using Type D dry powder fire extinguishing material.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Do not spray water on burning fines, chips, powder or sponge as a violent explosion may result. This hazard increases with finer particles. If a fire starts in a mass of wet metal fines, such as a barrel of damp machining chips; the initial fire may be followed by an explosion and a very high temperature flash radiation. Therefore, when in doubt, personnel should retire and not attempt to extinguish the fire. The explosive characteristic of such material is caused by the hydrogen and steam generated by the burning mass. Carbon dioxide is not effective in extinguishing burning hafnium.