SAE J2975 & J866
Copper, heavy metals, and asbestos detection for environmental markings

**single-source service** for friction edge-code and environmental markings testing

**integrated testing service** from initial debris extraction to test report with A, B, or N letter coding

**approved third-party testing facility** by U.S. industry registrars for California and Washington requirements

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typical uses for SAE J2975

SAE J2975 testing and its report with the environmental letter coding per SAE J866 are valuable tools to:

- determine the level of compliance to state rules and regulations for heavy metals and asbestiform fiber content
- compare different friction material formulations, production batches, or manufacturing sites
- support the declaration of conformity requirements for vehicle manufacturers, distributors, wholesalers, retailers, installers, and friction material suppliers

- debris extraction per SAE J2975 drilling and layout parameters using standard drilling sequence:
  - standardized and efficient process for common applications (D-numbers)
  - ensures uniform and repeatable drilling pattern and depth to minimize results variability from different drilling techniques
  - ensures chain-of-custody and traceability to the original sample while eliminating the delays from outsourced drilling (or manufacturer’s internal drilling process)

- microwave digestion for rapid, high-pressure, high-temperature preparation of samples for ICP-OES:
  - using encapsulated vessels with acid mix per SAE/EPA standard method
  - 1,200 W; 2.45 MHz high-frequency; up-to-800 psi (54 atm);
  - and up-to-240 °C cycle
  - batch processing with real-time monitoring, automated cycle, and fixed digestion time

- inductively coupled plasma and optical emission spectrometry (ICP-OES) for simultaneous analysis of large number of trace elements:
  - using auto-sampling system for automated batch operation, including quality control testing samples (blanks and spiked) for each analyte
  - charge injection device with solid state camera with large dynamic range and dual-wavelength measurement
  - Cr⁶⁺ detection with alkaline digestion and absorption spectrophotometer unit

- asbestiform fiber detection using polarized light microscopy (EPA-PLM):
  - high-resolution digital imaging system and control software
  - 1,000-point count with birefringence and dispersion staining techniques
  - documentation of fiber finding with digital pictures as part of test report
SAE J866 and chemical summary

overall assessment with an intuitive, easy-to-understand tabular summary to answer two questions (1) what is the level of compliance of a given formulation or batch, and (2) which were the individual results for each replicate

c: average level measured on the three replicates (three samples) for the same formulation from the same manufacturing process
b: limit values for each applicable element per SAE J866 and in accordance with the California and Washington state rules and regulations
c: standard letter designation (A, B, or N) for the material as a function of percent-by-weight and the specific percent-by-weight of copper
d: smallest measurable value of concentration and percent-by-weight for each element
e: individual results for each test replicate

### Material Summary and Designation

<table>
<thead>
<tr>
<th>Chemical analysis summary</th>
<th>Method</th>
<th>Average / %</th>
<th>Limit / %</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium and its compounds</td>
<td>Cd</td>
<td>ND</td>
<td>0.01</td>
<td>B</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>0.083</td>
<td>note 1</td>
<td>n.a.</td>
</tr>
<tr>
<td>Chromium-VI salts</td>
<td>Cr&lt;sup&gt;+6&lt;/sup&gt;</td>
<td>n.a.</td>
<td>0.1</td>
<td>B</td>
</tr>
<tr>
<td>Lead and its compounds</td>
<td>Pb</td>
<td>0.017</td>
<td>0.1</td>
<td>B</td>
</tr>
<tr>
<td>Mercury and its compounds</td>
<td>Hg</td>
<td>ND</td>
<td>0.1</td>
<td>B</td>
</tr>
<tr>
<td>Asbestiform fibers</td>
<td>—</td>
<td>n.a.</td>
<td>note 2</td>
<td>n.a.</td>
</tr>
<tr>
<td>Copper and its compounds</td>
<td>Cu</td>
<td>4.85</td>
<td>note 3</td>
<td>B</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>1.71</td>
<td>note 4</td>
<td>n.a.</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
<td>0.0057</td>
<td>note 4</td>
<td>n.a.</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>2.05</td>
<td>note 4</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

### Elemental Analysis with Individual Results

<table>
<thead>
<tr>
<th>Chemical Analysis Summary</th>
<th>Detection limit</th>
<th>test 1</th>
<th>test 2</th>
<th>test 3</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/kg %w/w</td>
<td>123205-1</td>
<td>123205-2</td>
<td>123205-3</td>
<td></td>
</tr>
<tr>
<td>Cadmium and its compounds</td>
<td>Cd</td>
<td>2.5 %w/w</td>
<td>0.00025</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>2.5 %w/w</td>
<td>0.00025</td>
<td>848 %w/w</td>
<td>0.085</td>
</tr>
<tr>
<td>Chromium-VI salts</td>
<td>Cr&lt;sup&gt;+6&lt;/sup&gt;</td>
<td>50.0 %w/w</td>
<td>0.005</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Lead and its compounds</td>
<td>Pb</td>
<td>25.0 %w/w</td>
<td>0.0025</td>
<td>170 %w/w</td>
<td>0.017</td>
</tr>
<tr>
<td>Mercury and its compounds</td>
<td>Hg</td>
<td>25.0 %w/w</td>
<td>0.0025</td>
<td>49821 %w/w</td>
<td>4.982</td>
</tr>
<tr>
<td>Copper and its compounds</td>
<td>Cu</td>
<td>250.0 %w/w</td>
<td>0.0250</td>
<td>16715 %w/w</td>
<td>1.672</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>250.0 %w/w</td>
<td>0.0250</td>
<td>17315 %w/w</td>
<td>1.731</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
<td>2.5 %w/w</td>
<td>0.0025</td>
<td>20412 %w/w</td>
<td>2.041</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>250.0 %w/w</td>
<td>0.0250</td>
<td>20412 %w/w</td>
<td>2.041</td>
</tr>
</tbody>
</table>

### Asbestos Detection with Individual Results

<table>
<thead>
<tr>
<th>Asbestos Method Summary</th>
<th>Detection limit</th>
<th>test 1</th>
<th>test 2</th>
<th>test 3</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%w/w</td>
<td>123205-1</td>
<td>123205-2</td>
<td>123205-3</td>
<td></td>
</tr>
<tr>
<td>Asbestiform fibers (PLM)</td>
<td>—</td>
<td>0.1 %w/w</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Asbestiform fibers (TEM)</td>
<td>—</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

NOTES:

1: no limit specified
2: 0.1% for PLM. If detected by PLM, the quantity is verified by TEM
3: A = n.a.; 0.5 < B ≤ 5; N ≤ 0.5
4: for reference only for WA

LEGENDS:

*: marks an element with an average content above the stated limit
n.a.: not applicable (or not measured) for the tested material
ND: Non Detected. Actual value is below the measurable value
%w/w: percent by weight measurement method for a particular element
Link Engineering Co. – Laboratory Testing Services has a unique position to provide a single-source for friction material testing and certification per SAE J886 testing in accordance to VESC-V-3 (friction level) and SAE J2975 (chemical and asbestos analysis). These measurements allow the supplier to demonstrate compliance to the California and Washington state upcoming limits on heavy metals and asbestos in friction materials.

Link’s business model already includes the best practices from third-party laboratory testing per ISO 17025, specific to automotive friction materials. This is unique to our proposal compared to other potential bodies or agencies with certification background.

Lastly, our international network of testing facilities allows local interaction with customers outside the U.S.

- Single-source, avoiding multiple laboratories, duplicate logistics, and additional shipping costs
- Entire sample preparation (coupon for friction test and debris for chemical element measurements) and testing process within Link to avoid variation due to different sample (and debris) preparations
- Friction and chemical laboratories specialized on friction material testing and measurements
- Use of latest-technology for CNC-automated drilling, sealed/high-pressure acid digestion, automated spectrometer analysis, and asbestos detection with high-resolution microscopes with digital imaging

**timeline for limits by state and by constituent**

The two states currently with limits and future bans on heavy metals and asbestiform fibers on friction materials are California and Washington.

The industry and different organizations are cooperating with state ecology departments to educate the public and to gain consensus with federal agencies for a comprehensive endorsement of current state rules.

Antimony, nickel, and zinc, will be initially monitored, not regulated.

**CA & WA limits**

- Cadmium
- Chromium salts, Lead, Mercury, Asbestos
- Copper-CA
- Copper-WA

**Diagram showing limits by weight / % w/w for CA & WA**

- Cadmium
- Chromium salts, Lead, Mercury, Asbestos
- Copper-CA
- Copper-WA

**Timeline for CA & WA limits**

- Cadmium
- Chromium salts, Lead, Mercury, Asbestos
- Copper-CA
- Copper-WA

**Brimley, Canton, Dearborn, Detroit, Plymouth, Michigan – Los Angeles, California**

**Stanfield, Wittmann, Yucca, Yuma, Arizona – East Liberty, Ohio – Laurel Mtn., Pennsylvania**

**Limburg, Germany – Manchester, UK – Paris, France – Chennai, India**

**Seoul, Korea – Shanghai, China – Sorocaba, Brazil – Tokyo, Japan**