



## COLORADO METALLURGICAL SERVICES

### OUR COMMITMENT

Colorado Metallurgical Services (CMS) prides itself in its role as *the* premier third-party, independent metals testing laboratory of the Front Range community. We embrace and fully commit to the responsibilities that our customers place on us regarding their need for material testing services.

### OUR MISSION

Material performance in any application or industry is critical to the safe, efficient, and economical operation of any component. By testing your materials today, we can assure your product performance tomorrow.

This price schedule is effective as of February 1, 2023, and subject to change without notice.

It is CMS' policy to complete routine jobs in five to ten business days. If expedited services are required, surcharges will be applied to the overall cost of laboratory services. Surcharge percentages are as follows: 48 hour expedite (100%), 72 hour expedite (50%).

### PRICE SCHEDULE

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## CHEMICAL COMPOSITION ANALYSIS

### OPTICAL EMISSION SPECTROSCOPY OR XRF (per ASTM A751 OR E1621)<sup>1,2</sup>

ALLOY BASE	PRICE (USD)
Aluminum	\$75.00
Cast iron (ductile <sup>3</sup> , grey, white) per	\$75.00
Copper	\$75.00
Iron (plain-carbon, LSLA, HSLA, stainless, tool steels, etc.)	\$75.00
Nickel, Ni-base super alloys	\$75.00
Titanium	\$75.00
Specimen meltdown <sup>2</sup>	\$35.00

### GAS ANALYSIS (per ASTM E1447 & E1019)

ELEMENT	PRICE (USD)
Hydrogen	TBD
Nitrogen	\$60.00
Oxygen	\$60.00
Carbon	\$60.00
Sulfur	\$60.00
Combine Carbon and Sulfur	\$90.00

### FTIR

POLYMERS & RUBBERS	PRICE (USD)
Full Validation Analysis	\$250.00

1. Does not include analysis for interstitial elements, such as (but not limited to) hydrogen, nitrogen, oxygen, or yttrium.
2. Specimens submitted for spectrographic analysis should measure (at minimum) 1/2 inch by 1/2 inch by 1/4 inch (L x W x H) and be dimensionally flat. Spectrographic analysis of specimens that do not fall into this size range, such as wire, chips, powder, or larger specimens, will be subject to additional charges associated with specimen meltdown and/or sectioning.
3. Ductile cast iron specimens will *always* be subject to the meltdown specimen preparation charge.
4. TBD – To Be Determined by subcontractor.

**MECHANICAL TESTING**

<b>SERVICES</b>	<b>PRICE (USD)</b>
Tensile Test (per ASTM A370 & E8) <sup>3,4</sup> A: specimens tested to 60,000 lb <sub>f</sub> B: specimens tested to 110,000 lb <sub>f</sub> C: specimens tested between 110,000 lb <sub>f</sub> - 155,000 lb <sub>f</sub> D: specimens tested above 155,000 lb <sub>f</sub> E: sub-size specimens (less than 0.250 inches in outer diameter) F: tubing or wire specimens (Over 10,000 lb <sub>f</sub> ) <sup>5</sup> G: tubing or wire specimens (Under 10,000 lb <sub>f</sub> ) <sup>5</sup>	\$40.00 (A) \$45.00 (B) \$55.00 (C) \$80.00 (D) \$45.00 (E) \$45.00 (F) \$40.00 (G)
Wedge Test (per ASTM F606)	\$60.00
Bolt Tensile Test (per ASTM F606) A: full-size test specimens up to 1 inch in outer diameter B: specimens up to 2 inches in outer diameter <sup>1,3</sup> C: specimens up to 3 inches in outer diameter <sup>1,3</sup>	\$60.00 (A) \$40.00 (B) \$40.00 (C)
Proof Load Test (per ASTM A370 & F-606) A. specimens tested on 60,000 lb <sub>f</sub> testing frame B. specimens tested on 160,000 lb <sub>f</sub> testing frame	\$40.00 (set-up configuration) + \$40.00 per specimen (A) \$40.00 (set-up configuration) + \$55.00 per specimen (B)
Charpy Impact Test (3 specimens per set) <sup>2</sup> A: pre-machined sample set submitted by customer B: includes specimen machining; magnetic materials set C: includes specimen machining; non-magnetic materials set	70 to 0 °F temperature range: \$75.00 (A), \$135.00 (B), \$300.00 (C) 0 to -90 °F temperature range: \$80.00 (A), \$160.00 (B), \$300.00 (C) -90 to -320 °F temperature range: \$100.00 (A), \$250.00 (B), \$325.00 (C)
Compression Test (per ASTM E9)	\$40.00 (set-up configuration) + \$50.00 per specimen
Shear Test (single or double) <sup>1</sup>	\$40.00 (set-up configuration) + \$75.00 per specimen
Flaring/Flattening Test (for tubing specimens, per ASTM A370)	\$65.00
Nick Break (per API 1104 code)	\$65.00
Peel Test (per ASME section IX)	\$65.00
Hardness Test (per ASTM E10 & E18) A: Brinell, Rockwell B: Shore A, D C: Traverse	\$45.00 (A) \$45.00 (B) \$45.00 + \$2.50 per indentation (C)
Fillet Bend-Break Test (per governing specification/code) <sup>3</sup> A: specimens up to 0.125 inches in thickness B: specimens between 0.126 - 1.0 inches in thickness	\$45.00 (A) \$55.00 (B)
Bend Test (includes visual examination, per governing specification/code)	\$35.00
Technical Services A: in-laboratory use of mechanical testing and sectioning instrumentation, accompanied by assistance from <i>one</i> technician B: Utilization of a second machine, in addition to (A)	\$175.00 per hour (A) \$100.00 per hour (B)

- Does not include charge of manufacturing a specimen-specific testing fixture, if required.
- If not specified by customer, the direction of rolling or grain flow can be determined, at an additional charge; sectioning charges still apply.
- Price is *not* inclusive of sectioning & specimen machining charges, if required.
- Data values reported from a tensile test include: (1) yield strength measured at 0.2% strain off-set or at 0.5% extension, (2) ultimate tensile strength, (3) total elongation, and (4) total reduction of area. Tensile test specimens that need to be machined to a nominal size, as per ASTM E-8, will be subject to additional charges; please refer to page 4 of this price schedule for charges associated with machining.
- Specimen size is limited to 1.0 inches in outer diameter, as per ASTM A370.

**METALLURGICAL SERVICES**

<b>SERVICES</b>	<b>PRICE (USD)</b>
Case Depth Analysis (per governing specifications) <sup>1</sup> A. visual comparison method B. micro-hardness method	\$75.00 (A) \$150.00 per hour (B)
Coating/Plating Thickness Analysis (per ASTM B487) <sup>1</sup>	\$75.00
Coating Weight Analysis (per ASTM A90) (set of 3 panels) <sup>3</sup>	\$100.00
Exfoliation Analysis (aluminum specimens only, per ASTM G34)	\$100.00
Failure Analysis <sup>2</sup>	\$225.00 per hour + travel expenses, from portal to portal
Grain Flow Analysis (microscopic or macroscopic method as per ASTM E340 & E407) <sup>1</sup>	\$85.00
Grain Size Analysis (visual comparison method, per ASTM E112) <sup>1</sup>	\$85.00
Hardness Test (per E384 or E92) <sup>1</sup> A: Vickers 5g to 10kg B: Knoop 10g to 1kg	\$150 per hour (A or B)
Inclusion Rating Analysis (visual comparison method, per ASTM E-45) <sup>1</sup>	\$175 per hour
Metallurgical Consulting	\$225.00 per hour + travel expenses, from portal to portal
Digital Microscopy - Microstructural Examination (per governing specifications) <sup>1</sup>	\$175.00 per hour
Photographic Documentation (digital micrograph or macrograph)	\$175.00 per hour
Sample Preparation (includes mounting, polishing, & etching of specimen, per ASTM E3) A: Non-Mounted or Mounted in Bakelite standard size ≤1.5" OD B: Mounted in Alternative (epoxy, phenolic etc.) standard size ≤1.5" OD C: Oversized non-mount or mounted in Epoxy	\$80.00 (A) \$90.00 (B) TBD (C)
Scanning Electron Microscopy (SEM)	\$275.00 per hour
Diamond Thin Sectioning (per governing internal standard operating procedure)	\$150.00 per hour
Sputter Coating (Gold or Carbon)	\$100.00 per sample

1. Requires that specimens be mounted, polished, and etched, at an additional charge.
2. Failure analysis, as a service, includes (but is not limited to) the following aspects of an investigation: consulting with representatives from different parties affiliated with an investigation, writing of proposed protocol, in-lab and on-site photographic documentation, taking and verifying measurements, interviewing witnesses, employing investigative procedures, collecting data and component service history, conducting non-destructive analyses, conducting data analysis, reviewing component design(s), conducting microstructural analysis, conducting stereographic and microscopic fractographic examination, writing and preparation of failure analysis report, etc.
3. Samples requiring single side testing for UL underwriters require an additional \$100.00 for method performed twice.
4. Weld Macro includes polish, etch and exam for compliance to welding code. Weld thickness over 1" have additional \$25.00 charge.

## SECTIONING & SPECIMEN

SERVICES	PRICE (USD)
Sectioning (per governing internal standard operating procedure) A: standard process (abrasive cut-off and horizontal saws) B: special process (carbide tool, carbon arc, diamond blade) C: Plasma Cutting	\$80.00 per hour (A) \$125.00 per hour (B) \$150.00 per hour (C)
Machining: Flat Tensile Specimen (per ASTM E8) <sup>1,2,3</sup> A: aluminum, copper, & magnesium base-alloy specimens B: carbon, low-alloy, & stainless-steel specimens C: cobalt, nickel, & titanium base-alloy specimens, and alloys above 40 HRC	Standard size specimen for sheet, plate, and pipe: 1.500" to 0.250" reduced section:  \$50.00 (A), \$60.00 (B), \$85.00 (C)
Machining: Round Tensile Specimen (per ASTM E8) <sup>2,3</sup> A: aluminum, copper, & magnesium base-alloy specimens B: carbon, low-alloy, & stainless-steel specimens C: cobalt, nickel, & titanium base-alloy specimens, and alloys above 40 HRC	Standard size specimen 0.500" to 0.250" reduced section: \$50.00 (A), \$60.00 (B), \$85.00 (C)

1. Specimen is machined on two sides only and derived from a strip that measures approximately 0.750 inches by 8 inches.
2. Machining of sub-size tensile specimens will be subject to an additional \$25.00 charge (per specimen). Threading of round tensile specimens will be subject to an additional \$35.00 charge (per specimen).
3. The machining and sectioning prices listed in this price schedule reflect *average* charges. Prices may vary depending upon the size, hardness, and/or conditions of the component material from which the specimen(s) will be derived.
4. Machining services not listed will be quoted upon request. These quoted prices are *not* inclusive of charges for sectioning, special grinding, polishing, notching, and threading, or charges associated with difficulty in specimen machining (encountered due to condition, size, and/or configuration of component material). Pre-machined or cast specimens that do not conform to ASTM E8 specifications will be machined to conformance prior to testing; if conformance to ASTM E8 cannot be achieved, specimen size non-conformance will be noted in the CMS-issued testing certification.

**PLATING & CORROSION ANALYSIS**

SERVICES	PRICE (USD)
Chemical Passivation Screening for Stainless Steel Parts (per ASTM A967) <sup>1</sup> A. water immersion test C. salt spray test D. copper sulfate test	\$150.00 (A) \$75.00 (C) \$100.00 (D)
Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels (per ASTM A262) <sup>1</sup> A. oxalic acid etch test (includes mount, polish and etch) B. ferric sulfate-H <sub>2</sub> SO <sub>4</sub> acid test <sup>2</sup> C. HNO <sub>3</sub> acid test <sup>3</sup> D. HNO <sub>3</sub> - HF acid test <sup>4</sup> E. copper-copper sulfate-H <sub>2</sub> SO <sub>4</sub> acid test F. copper-copper sulfate-50% H <sub>2</sub> SO <sub>4</sub> acid test <sup>5</sup>	\$175.00 (A) \$300.00 (B) \$300.00 (C) \$300.00 (D) \$250.00 (E) \$250.00 (F)
Hydrogen Embrittlement Evaluation (per ASTM F519) <sup>1</sup> A. pre-machined, notched 4340 test specimens to be tested at CMS (set of 5 specimens) B. 200-hour test (up to <i>four</i> specimens per test)	\$150.00 (A) \$175.00 (B)
Heat Treating <sup>6</sup>	\$60.00 per hour
Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution (per ASTM G48) <sup>1</sup> A. method A or (A923 Method C for Duplex Stainless Steel) B. method B	\$300.00 (A) \$375.00 (B)
Salt Spray (Fog) Test (per ASTM B117) <sup>7</sup>	Test to 168 hours: \$30.00 Test to 335 hours: \$40.00 Test to 500 hours: \$65.00 Test to 1,000 hours: \$130.00
Specimen Preparation for Corrosion Analyses <sup>8</sup>	\$75.00
Susceptibility to Intergranular Corrosion in Wrought, Ni-Rich, Cr-Bearing Alloys (per ASTM G28) A. method A B. method B	\$300.00 (A) \$375.00 (B)

1. Price is inclusive of hazardous material disposal and set-up configuration charges.
2. The specimen mass *required* for this analysis is between 5-20 grams. The *submitted* specimen mass must be larger (preferably double) than the *required* specimen mass.
3. The specimen mass *required* for this analysis is 100 grams. The *submitted* specimen mass must be larger (preferably double) than the *required* specimen mass.
4. The specimen mass *required* for this analysis is between 5-20 grams. The *submitted* specimen mass must be larger (preferably double) than the *required* specimen mass. Two different specimens are required for this analysis to be conducted.
5. The specimen mass *required* for this analysis is 0.4 grams. The *submitted* specimen mass must be larger (preferably double) than the *required* specimen mass.
6. The minimum time required for furnace use is 2 hours, due to the time required for furnace ramping; furnace temperature cannot exceed 2200 °F.
7. Standard specimen sizes include 4" by 6" or 3" by 10" sheets. Specimens that do not meet standard specimen size requirements are subject to surcharges.
8. Price is *not* inclusive of sectioning & specimen machining charges, if required.

**MISCELLANEOUS SERVICES**

SERVICES	PRICE (USD)
Density Analysis (governing internal standard operating procedure)	\$100.00
Ferrite Content Analysis (Ferrite Scope MP-30)	\$150.00
Heat Treating <sup>1</sup>	\$60.00 per hour
Hardenability Analysis (Jominy bar end-quench method, per ASTM A255) <sup>2</sup>	\$300.00
Oven Certification (per AMS H-6088) <sup>3</sup>	\$275.00
Oven Certification (per AMS H-6875) <sup>3</sup>	\$175.00
Tape/Wet Tape Adhesion Test (ASTM D3359)	\$50.00
Welding Certifications (per governing codes)	Quote Upon Request
External Technical Services A: Vehicle Charge <sup>6</sup> B: Vehicle Mileage Charge C: Conducting applicable tests outside of laboratory <sup>5,6</sup> D: Certified welding inspector (CWI) Visual Field Inspections <sup>5,6</sup> E: Certified Welding Inspector (CWI) Report	\$40.00 (A) Current IRS Standard Mileage Rates (B) \$175.00 per hour + travel expenses, from portal to portal (C) \$100.00 per hour + travel expenses, from portal to portal (D) \$150.00 per hour (E)
Shipping / Sample Return	TBD <sup>4</sup>
Onsite Witness Testing <sup>7</sup>	\$100.00 per hour

1. The minimum time required for furnace use is 2 hours, due to the time required for furnace ramping; furnace temperature cannot exceed 2200 °F.

2. Price is inclusive of set-up configuration and hardness tests that are required for this service.

3. Price is inclusive of machining, tensile tests, corrosion tests, specimen preparation, microstructural analysis, and report that are required for this service.

4. TBD – Based on USPS, UPS or FedEx pricing. Upon request billing directly to customer shipping account is available.

5. Offsite testing is billed at a 4-hour minimum charge. 24-hour advanced notice of cancelation is required to avoid 4-hour minimum charge.

6. Offsite testing or inspecting requires a flat rate vehicle charge and round-trip mileage.

7. Additional cost for use of equipment or consumables.