2008 PRICE LIST

MATERIALS TESTING & RESEARCH CENTER

DESCRIPTION OF SERVICES OFFERED

The Materials Testing & Research Center is an independent research and referee-testing laboratory, specializing in refractory, glass, whiteware, and advanced ceramic materials. It is operated by The Edward Orton Jr. Ceramic Foundation, a non-profit organization providing products and services to the ceramic materials community since 1896.

The Center is staffed with engineers and technicians who understand and are responsive to the needs of our customers. Standardized procedures are employed on calibrated equipment. New and existing tests are continually under development.

For an overview of the Center operations, see page 2. For details on submitting samples, see page 3. For additional information contact Dr. Joseph Homeny, Manager of Testing Services.

ORTON
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6991 Old 3C Highway
Westerville, Ohio 43082
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THE ORTON MATERIALS TESTING & RESEARCH CENTER (MTRC)

The Orton Materials Testing and Research Center is a full service independent, non-profit research and testing laboratory that specializes in measuring the behavior of ceramic materials, performing thermal analysis measurements, and providing consulting services on ceramics and other related materials.

Initially, MTRC was known as The Refractories Fellowship Laboratory, which was established in 1917 at the Mellon Institute in Pittsburgh, Pennsylvania. It was relocated at The Ohio State University in Columbus, Ohio in 1965 and renamed the Refractory Research Center. Since 1990, the Center has been operated by the Edward Orton Jr. Ceramic Foundation.

Today, Orton manufactures and sells both test instrumentation and products used in firing ceramics. The MTRC occupies approximately 7,000 of Orton's 35,000 sq. ft. facilities located in Westerville, Ohio, a suburb of Columbus, Ohio. Both laboratory and high bay areas are used. Orton also works closely with other organizations for testing and consulting services not available in its laboratories.

Center Operation

Testing projects are reviewed for requirements and assigned to one of the MTRC engineers, who consults with the customer as needed. Qualified technicians are assigned individual testing jobs.

Results of tests are normally sent to the customer as soon as they are available, frequently by FAX or email. Once all testing is completed, a report covering the test procedures and results is prepared and sent to the customer.

Center and Support Staff

Orton maintains a diverse research and engineering staff consisting of some 7 engineers and 6 technicians experienced in the development, testing, and characterization of ceramics and other materials. Dr. Joseph Homeny, who has over 25 years of experience in research and testing of ceramic and refractory materials, manages the Center's activities. Mr. Charles Kistler is a Senior Ceramic Engineer in the Center with more than 30 years experience in research and testing of ceramic materials. Mr. Brian Rayner is also a Ceramic Engineer in the Center with over 10 years experience in testing glass and ceramic materials. Andrea Kay is a Metallurgical Engineer with 5 years experience in foundry operations.

Additionally, Orton has technicians with strong education and experience for research and testing. These include:

Ken Kovach	Senior Ceramic Technician	Over 15 Years Experience
Greg Williams	Ceramic Technician	Over 10 Years Experience
Larry Ulrey	Ceramic Technician	Over 5 Years Experience
Jim Baldwin	Electronics Technician	Over 20 Years Experience
Sergio Medina	Computer Technician	Over 15 Years Experience
Harold Taylor	Product Design Specialist	Over 15 Years Experience

PLACING AN ORDER
Please provide a purchase order and description of the materials to be tested along with identification of test work desired. Note that each test has an identifying T number (e.g. T9320), which can be used when placing an order.

A written report of the test results is provided to the customer for each completed project. Completion time for a project varies, depending upon the type of test desired and the availability of equipment and personnel. Testing is conducted on a first-come, first-serve basis with a typical turn around time of 1 to 3 weeks for most tests. Every effort is made to be responsive to the client. When required, expedited turn around can be done, normally within 1 to 3 days. If additional expenses are incurred to meet the special needs of the customer, these will be quoted separately. These may include overtime costs and special delivery charges. Results can be sent next day delivery or provided by fax or e-mail.

SPECIMENS AND CORRESPONDENCE
Send all specimens and correspondence to:

Orton Materials Testing & Research Center
Attn: Dr. Joseph Homeny
6991 Old 3C Highway
Westerville, OH 43082

Phone: 614-818-1323
Fax: 614-895-5610
E-Mail: homeny@ortonceramic.com

Freight must be PREPAID. A service charge will be assessed if sent collect.

SPECIMEN IDENTIFICATION
The identification of each specimen is essential. Whenever possible, include the chemical or generic name(s) for the material(s).

SPECIMEN SIZING AND PREPARATION
Most tests do not include any time for special cutting or preparation that may be necessary if the specimens are not provided in standard size or form. Specimen preparation is billed as technician time at $90 per hour.

HAZARDOUS OR DESTRUCTIVE MATERIALS
To protect the health and safety of our personnel, we must be advised of toxic or hazardous materials present in the specimens submitted for testing. Please provide appropriate Material Safety Data Sheets. We must also be advised of any possible toxic or hazardous reactions that may occur as a result of preparing the specimen for testing or during testing. When hazardous conditions or reactions that may be destructive to test instrument parts are known or anticipated, please advise us, so we can make provisions during testing to eliminate injury and minimize damage to testing equipment.

If any damages occur as a result of negligence by the customer to inform Orton of possible hazardous or destructive materials, all costs of repair or replacement of instrument parts will be included in the invoice.

RETURN OF MATERIALS
All test requests should include instructions for return of specimens if desired. Specimens, which are not returned, will be held for six months, then discarded. When specimens are returned, they will be shipped prepaid and the cost added to the invoice.

PRICING
Pricing is effective March 1, 2008. Discounts may be available where the same test is conducted on multiple specimens. Call with your requirements to determine if a discount is available.

All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials, and all other causes beyond our control.

BILLING
Invoices for test work completed are sent following shipment of the test results. Terms are net 30 days, FOB Westerville, OH. No minimum order is required. Arrangements for payment in U.S. funds need to be made for orders originating outside the United States before work begins.

TEST RESULTS
Testing is conducted by qualified test personnel. ASTM or other published test procedures are used. Best efforts are made to assure that equipment is properly calibrated and maintained and proper procedures are followed. Results should be considered advisory and/or experimental in nature. Neither Orton, nor its employees, assumes any obligation or liability for damages, including, but not limited to, consequential damages arising out of or in conjunction with the use, or inability to use, the resulting information.

ADVANCED CERAMIC TEST METHODS

ASTM C-1161 FLEXURAL STRENGTH OF ADVANCED CERAMICS AT AMBIENT TEMPERATURE-T9763

Flexural strength is determined in three-point or four-point bending on bars of rectangular cross-section. Testing of ten specimens per type/brand is recommended by ASTM.

$40 per specimen

ASTM C-1259 DYNAMIC YOUNG'S MODULUS, SHEAR MODULUS, AND POISSON'S RATIO FOR ADVANCED CERAMICS BY IMPULSE EXCITATION OF VIBRATION-T9767

A non-destructive sonic method is used to determine the modulus of elasticity and modulus of rigidity for calculation of Poisson's Ratio. Bars of rectangular cross-section are used for the measurements.

$200 per test of 5 specimens (Young’s modulus only)
$230 per test of 5 specimens (Young’s modulus, shear modulus, and Poisson’s ratio)

ASTM C-1341 FLEXURAL PROPERTIES OF CONTINUOUS FIBER-REINFORCED ADVANCED CERAMIC COMPOSITES-T9764

Flexural strength is determined in three-point or four-point bending on bars of rectangular cross-section. Testing of ten specimens per type/brand is recommended by ASTM.

$40 per specimens

ASTM C-1421 FRACTURE TOUGHNESS OF ADVANCED CERAMICS AT AMBIENT TEMPERATURE-T9768

Fracture toughness is determined in three-point or four-point bending on chevron-notched bars of rectangular cross-section. Testing of four specimens per type/brand is recommended by ASTM.

$50 per specimen

CARBON TEST METHODS

ASTM C-454 DISINTEGRATION OF CARBON REFRACTORIES BY ALKALI-T9540

Ten 2" cube specimens are required by ASTM. A 1" hole is drilled into the face of each specimen and filled with 8 gm of Potassium Carbonate. The effects of being fired at 1750°F for 5 hours are determined visually.

$660 per test of 10 specimens

ASTM C-559 BULK DENSITY BY PHYSICAL MEASUREMENTS OF MANUFACTURED CARBON AND GRAPHITE ARTICLES-T9556

The bulk density is determined using the specimen weight and dimensions.

$20 per specimen

ASTM C-561 ASH IN A GRAPHITE SAMPLE-T9558

Ash content of graphite materials is determined by oxidation at 950°C. The ash content for two representative specimens per type/brand is determined.

$290 per test of 2 specimens

ASTM C-611 ELECTRICAL RESISTIVITY OF MANUFACTURED CARBON AND GRAPHITE ARTICLES AT ROOM TEMPERATURE-T9585

Electrical resistivity of carbon and graphite materials is determined by DC, as well as AC, methods. Specimens may be in the form of plates, rods, bars, or tubes.

$400 per specimen

ASTM C-651 FLEXURAL STRENGTH OF MANUFACTURED CARBON AND GRAPHITE ARTICLES USING FOUR-POINT LOADING AT ROOM TEMPERATURE-T9587

Flexural strength is determined in four-point bending on specimens of rectangular cross-section.

$40 per specimen

ASTM C-695 COMPRESSIVE STRENGTH OF CARBON AND GRAPHITE-T9588

The compressive strength is determined on a right cylinder. The diameter of the specimen must be ten times the maximum particle size and the ratio of height to diameter must be between 1.9 and 2.1.

$40 per specimen

ASTM C-747 MODULUS OF ELASTICITY AND FUNDAMENTAL FREQUENCIES OF CARBON AND GRAPHITE MATERIALS BY SONIC RESONANCE-T9600

Resonant frequencies are determined by a non-destructive sonic method in the flexural and torsional modes on prism or rod specimens. Moduli are calculated from the resonant frequency, mass, and dimensions.

$200 per test of 5 specimens (Young's modulus only)
$230 per test of 5 specimens (Young's modulus, shear modulus, and Poisson's ratio)

ASTM C-767 **THERMAL CONDUCTIVITY OF CARBON REFRACTORIES-T9610**
Same as ASTM C-182

ASTM C-769 **SONIC VELOCITY IN MANUFACTURED CARBON AND GRAPHITE MATERIALS FOR USE IN OBTAINING AN APPROXIMATE YOUNG'S MODULUS-T9620**

Approximation of Young's Modulus is calculated through sonic velocity measurements in 3 directions. The velocity of sound waves is measured using a James V-meter.

$230 per test of 5 specimens

ASTM C-838 **BULK DENSITY OF AS-MANUFACTURED CARBON AND GRAPHITE SHAPES-T9660**

Bulk density is calculated from weight and volume measurements.

$180 per test of 10 specimens

ASTM C-1025 **MODULUS OF RUPTURE IN BENDING OF ELECTRODE GRAPHITE-T9747**

Flexural strength is determined in four-point bending on 6" x 1 1/2" x 1 1/2" specimens.

$40 per specimen

ASTM C-1039 **APPARENT POROSITY, APPARENT SPECIFIC GRAVITY, AND BULK DENSITY OF GRAPHITE ELECTRODES-T9748**

A vacuum is used to determine the apparent porosity, bulk density, liquid absorption, and apparent specific gravity. Testing of five specimens (2" diameter x 7 1/2" high) per type/brand is suggested by ASTM.

$240 per test of 5 specimens

FIBROUS INSULATION TEST METHODS

ASTM C-165 COMPRESSIVE PROPERTIES OF THERMAL INSULATIONS-T9404

The compressive resistance is determined on either rigid board or blanket insulation. Specimens can be square or circular with a preferred width or diameter of 6". Testing of four specimens per type/brand is recommended by ASTM.

$180 per test of 4 specimens

ASTM C-167 THICKNESS AND DENSITY OF BLANKET OR BATT THERMAL INSULATIONS-T9405

One representative roll or bundle of insulation is required. Density is calculated from weight and dimensional measurements.

$180 per specimen

ASTM C-203 BREAKING LOAD AND FLEXURAL PROPERTIES OF BLOCK-TYPE THERMAL INSULATIONS-T9403

Flexural strength is determined on 1" x 4" x 12" specimens. Testing of four specimens per type/brand is recommended by ASTM.

$160 per test of 4 specimens

ASTM C-303 DENSITY OF PREFORMED BLOCK-TYPE THERMAL INSULATION-T9406

Minimum specimen size is 4" x 8" in cross-section. Density is calculated from weight and dimensional measurements.

$20 per specimen

ASTM C-356 LINEAR SHRINKAGE OF PREFORMED HIGH-TEMPERATURE THERMAL INSULATION SUBJECTED TO SOAKING HEAT-T9505

Linear shrinkage is determined after a thermal insulating material is exposed to soaking heat for 24 hours. Four 6" x 2 1/2" x 1" or 2" specimens are required by ASTM.

TEMPERATURE	PER TEST OF 4
2000°F or Less	$550
2000°F to 2500°F	$640
2500°F to 3000°F	$795

ASTM C-892 UNFIBERIZED SHOT CONTENT OF INORGANIC FIBROUS BLANKETS-T9715

A 10 gm. specimen is fired to 2300°F and forced consecutively through No. 30, 50, and 70 screens. Shot content is determined by percent retained on each screen.

$395 per specimen

ASTM C-892 THERMAL CONDUCTIVITY OF FIBROUS INSULATING MATERIAL-T9716
Same as ASTM C-182

GLASS TEST METHODS

ASTM C-158 STRENGTH OF GLASS BY FLEXURE-T9501

Flexural strength is determined in three-point or four-point bending on bars of rectangular or circular cross-section. Between ten to thirty specimens per type/brand is recommended by ASTM.

$40 per specimen

ASTM C-336 ANNEALING POINT AND STRAIN POINT OF GLASS BY FIBER ELONGATION-T9502

The annealing point of a glass is defined as the temperature at which a round fiber, nominally 0.65 mm in diameter, elongates under a load of 1.0 kg at a rate of 0.14 mm/min when it is cooled at a rate of 4°C/min. The strain point is determined by extrapolation of the annealing point data as the temperature at which the elongation rate is 0.0316 times that at the annealing temperature. A representative sample of 50 gm or more of flame workable glass in pieces a minimum of 5 mm in diameter is required. Fritted or ground samples must be remelted to obtain a piece large enough from which fibers can be drawn.

$210 per glass to 800°C
$160 per glass for fiber preparation

ASTM C-338 SOFTENING POINT OF GLASS BY FIBER ELONGATION-T9503

The softening point of a glass is defined as the temperature at which a round fiber, nominally 0.65 mm in diameter and 235 mm long, elongates under its own weight at a rate of 1 mm/min when the upper 100 mm of its length is heated at a rate of 5°C/min. A representative sample of 50 gm or more of flame workable glass in pieces a minimum of 5 mm in diameter is required. Fritted or ground samples must be remelted to obtain a piece large enough from which fibers can be drawn.

$160 per glass to 1000°C
$160 per glass for fiber preparation

ASTM C-598 ANNEALING POINT AND STRAIN POINT OF GLASS BY BEAM BENDING-T9575

The annealing point of a glass is defined as the temperature at which a 3-point loaded beam, nominally 3 to 4 mm in cross section on a 50 mm span, elongates under a load of between 0.2 kg and 1.0 kg at a rate determined by the span, load, and moment of inertia when it is cooled at a rate of 4°C/min. The strain point is determined by extrapolation of the annealing point data as the temperature at which the elongation rate is 0.0316 times that at the annealing temperature. Representative specimens, nominally 3 to 4 mm in cross section and 75 mm in length, are required.

$235 per glass to 1000°C
$90 per glass for beam preparation

ASTM C-657 DC VOLUME RESISTIVITY OF GLASS-T9577

Same as D-257.

SOFTENING POINT OF GLASS BY PENETROMETER (LABINO METHOD)-T9160

A 3/16” cube specimen is supported on a horizontal platform inside a furnace. A probe rod is lowered to contact the glass specimen. As the furnace is heated at a rate of 25°C/min, the probe penetrates the glass specimen. The temperature at which the probe penetrates a certain distance is correlated to the softening point. Three representative specimens, approximately 3/16” by 3/16” by 3/16”, are required.

$160 per glass to 1000°C
$90 per glass for cube preparation

ASTM C-829 LIQUIDUS TEMPERATURE OF GLASS BY THE GRADIENT FURNACE METHOD-T9576

The liquidus temperature is the maximum temperature where equilibrium exists between the amorphous glass and its primary crystalline phase. A sample of about 30 gm is crushed to -20 mesh and placed in a platinum boat with dimensions of 0.5" x 0.5" x 6.0". The glass specimen is held at a specified temperature gradient over its entire length for a period of time necessary to obtain thermal equilibrium between the crystalline and glassy phases. The specimen is quenched and viewed with a microscope to determine the glass / crystalline interface location and corresponding temperature.

$620 per glass

ASTM C-965 VISCOSITY OF GLASS ABOVE THE SOFTENING POINT-T9578

The viscosity of glass above the softening point is determined using a platinum alloy spindle immersed in a platinum crucible of molten glass. The crucible is placed in a vertical tube furnace capable of 1600°C. The viscometer is mounted above the tube furnace and is capable of measuring from 1.5 to 5.0 Poise. About 400 gm of glass is necessary for the test. After the data is collected, it is fit to a Fulcher equation to describe the viscosity / temperature relationship.

$620 first temperature specified
$205 each additional temperature specified

REFRACTORY TEST METHODS

ASTM C-16 LOAD TESTING REFRACTORY BRICK AT HIGH TEMPERATURES-T9300

A 25 psi load is applied to 9" x 4 1/2" x 2 1/2" or 3" bricks during a specified heating schedule. A minimum of two specimens per type/brand is suggested by ASTM. The percent deformation is measured on each brick after testing simultaneously in a gas-fired kiln up to 3100°F.

		PER TEST OF 2	PER TEST OF 4	EA ADD'L 24 HR HOLD
Misc. Products	Less than 2000°F	$530	$740	$225
Medium Duty Fireclay	Schedule 1 2370°F	$565	$790	$225
High Duty Fireclay	Schedule 2 2460°F	$600	$815	$225
Misc. Products	2550°F	$610	$835	$255
Super Duty Products	Schedule 3 2640°F	$615	$840	$255
Misc. Products	2750°F	$645	$870	$255
Mullite, High Alumina	Schedule 6 2900°F	$685	$920	$285
Mullite, High Alumina	Schedule 7 3000°F	$755	$980	$285
Silica Brick to Failure	Schedule 4	$845	$1070	$285
Mag-Chrome Brick to Failure	Schedule 5	$870	$1095	$285
Other Temperatures and Conditions		Quote	Quote	Quote

ASTM C-20 APPARENT POROSITY, WATER ABSORPTION, APPARENT SPECIFIC GRAVITY, AND BULK DENSITY OF BURNED REFRACTORY BRICK AND SHAPES BY BOILING WATER-T9310

The apparent porosity, bulk density, apparent specific gravity, and water absorption are determined by the boiling method. Testing of five specimens (1/4 brick or a 25 to 30 in^3 piece) per type/brand is suggested by ASTM.

$170 per test of 5 specimens

ASTM C-24 PYROMETRIC CONE EQUIVALENT OF FIRECLAY AND HIGH ALUMINA REFRACTORY MATERIALS-T9320

Compares the deformation of prepared cone specimens with Orton PCE test cones. Indicate approximate cone value anticipated or describe material. A representative sample of 150 gm or more of granular material to pass a No. 70 ASTM Sieve (No. 65 Tyler) should be submitted.

	PER TEST
One specimen up to cone 36	$295
Two specimens in one firing, within 3 Cone numbers, up to cone 36	$380
One specimen up to cone 38	$350
Two specimens in one firing, within 3 Cone numbers, up to cone 38	$435

ASTM C-92 SIEVE ANALYSIS AND WATER CONTENT OF REFRACTORY MATERIALS-T9350

Water Content: A 2 to 5 lb. representative sample of material should be submitted.

$90 per specimen

Sieve Analysis: Tyler Standard series sieves are used. A 2 to 5 lb. representative sample of material should be submitted.

1 to 4 Sieves	$90
Each Additional Sieve	$5
Full Analysis: 3, 4, 6, 8, 10, 14, 20, 28, 35, 48, 65, 100, 150, 200 mesh	$140

ASTM C-93 **COLD CRUSHING STRENGTH AND MODULUS OF RUPTURE OF INSULATING FIREBRICK-T9360**

Crushing Strength: The crushing load is applied to the 4 1/2" x 4 1/2" face of half bricks. Testing of 10 specimens per type/brand is suggested by ASTM.

$320 per test of 10 specimens

MOR: Flexural strength is determined in three-point bending on 9" x 4 1/2" x 2 1/2" or 3" bricks. Testing of ten specimens per type/brand is suggested by ASTM.

$300 per test of 10 specimens

ASTM C-113 **REHEAT CHANGE OF REFRACTORY BRICK-T9370**

Three 9" x 4 1/2" x 2 1/2" or 3" bricks are heated on a specified heating schedule and the percent linear change is reported. At least three 9" bricks per brand/type are suggested by ASTM. For volume change, add $10 per specimen.

		PER TEST OF 3	EA ADD'L SPECIMEN
Misc. Products	2000°F or Less	$410	$20
Low Duty Fireclay	Schedule A, 2190°F	$440	$20
Ladle Brick	Schedule E, 2350°F	$465	$20
Fireclay Nozzles	Schedule D, 2460°F	$495	$20
High Duty Fireclay	Schedule B, 2550°F	$505	$20
Misc. Products	Schedule F, 2730°F	$545	$20
Super Duty Fireclay	Schedule C, 2910°F	$630	$30
High Alumina	Schedule G, 3000°F	$775	$30
Misc. Products	Schedule H, 3090°F	$785	$30

ASTM C-133 **COLD CRUSHING STRENGTH AND MODULUS OF RUPTURE OF REFRACTORIES-T9380**

Crushing Strength: The crushing load is applied to the 2" x 2" face of a 2" cube or the 2" diameter face of a 2" diameter x 2" high cylinder. Testing of five specimens per type/brand is recommended by ASTM.

$160 per test of 5 specimens

MOR: Flexural strength is determined in three-point bending on 9" x 4 1/2" x 2 1/2" or 3" bricks. Other sizes can be used depending on the material. Testing of five specimens per type/brand is recommended by ASTM.

$150 per test of 5 specimens

ASTM C-134 **SIZE AND BULK DENSITY OF REFRACTORY BRICK AND INSULATING FIREBRICK-T9390**

The weight per volume is determined using the specimen weight and dimensions. Warpage is measured with the use of warpage wedges. Testing of ten specimens of each type/brand is suggested by ASTM.

Size and Bulk Density	$180 per test of 10 specimens
Warpage	$140 per test of 10 specimens

ASTM C-135 TRUE SPECIFIC GRAVITY OF REFRACTORY MATERIALS BY WATER IMMERSION-T9400

A water immersion technique is used to determine the true specific gravity of a ground specimen. A completely representative sample is required for the analysis.

$135 per specimen

ASTM C-179 DRYING AND LINEAR CHANGE OF REFRACTORY PLASTIC AND RAMMING MIX SPECIMENS-T9410

Three 9" bricks are molded in a press at 1000 psi and the linear drying and firing shrinkage is determined. A 50 lb. representative sample should be submitted, including a specification of the type/class of the material.

Specimen Preparation and Drying Shrinkage	$180 per test of 5 specimens
Firing Shrinkage	Same as ASTM C-113

ASTM C-181 WORKABILITY INDEX OF FIRECLAY AND HIGH-ALUMINA PLASTIC REFRACTORIES-T9420

The workability/consistency of as-received material is determined. Cylindrical specimens are impacted under a 14-lb. load and the percent deformation is reported. The testing of five specimens is recommended by ASTM. A 10 lb. representative sample should be submitted, including the production date for the material.

$180 per test of 5 specimens

ASTM C-182 THERMAL CONDUCTIVITY OF INSULATING FIREBRICK-T9430

The heat flow through a refractory is determined with a water-cooled copper calorimeter. The temperature limit of refractory must be specified, as well as the hot face or mean test temperatures desired. The maximum hot face temperature for testing is 2700°F. The specimens required are six 9" bricks or an 18" x 13.5" x 2.5" slab.

		EA ADD'L TEST TEMP
First Hot Face Temperature Specified	$950	$260
First Mean Temperature Specified	$1150	$260

ASTM C-198 COLD BONDING STRENGTH OF REFRACTORY MORTAR-T9440

Fireclay brick halves are bonded with a 1/16" thick joint. After air and oven drying, the MOR is determined for the brick/joint assembly. Testing of 5 specimens is suggested by ASTM. At least 10 lbs. of mortar should be submitted for analysis.

$375 per test of 5 specimens

ASTM C-199 PIER TEST OF REFRACTORY MORTARS-T9450

A multiple brick pier is made with 1/8" thick vertical and horizontal joints. The assembly is air and oven dried, and then fired for 5 hours at the specified temperature. If the mortar flows from the joints during firing, it fails the test. At least 10 lbs. of mortar should be submitted of analysis.

	FIRING TEMPERATURE	PER TEST
Medium Duty	2550°F	$530
High Duty	2730°F	$580
Super Duty	2910°F	$700
High Alumina	3100°F	$755

ASTM C-201 THERMAL CONDUCTIVITY OF REFRACTORIES-T9460
Same as ASTM C-182

ASTM C-202 THERMAL CONDUCTIVITY OF REFRACTORY BRICK-T9470
Same as ASTM C-182

ASTM C-210 REHEAT CHANGE OF INSULATING FIREBRICK-T9480

Three 9" x 4 1/2" x 2 1/2" or 3" bricks are fired for 24 hours after which the percent linear and volume changes are measured.

IFB CLASS	TEMPERATURE	PER TEST OF 3	EA ADD'L SPECIMEN
Group 16	1550°F	$515	$20
Group 20	1950°F	$550	$20
Group 23	2250°F	$590	$20
Group 26	2550°F	$635	$20
Group 28	2750°F	$670	$20
Group 30	2950°F	$780	$30
Group 32	3150°F	$925	$30
Group 33	3250°F	$1020	$30

ASTM D-257 D-C RESISTANCE OR CONDUCTANCE OF INSULATING MATERIALS-T9485

Surface and volume electrical resistivity of insulating materials are determined by DC, as well as by AC methods. Specimen dimensions and electrode configuration are determined on an individual basis.

Room Temperature	$400 per specimen (call for feasibility)
200°C to 1200°C	$560 per specimen plus $125 per high temperature point
800°C to 1600°C	$690 per specimen plus $125 per high temperature point

ASTM C-288 DISINTEGRATION OF REFRACTORIES IN AN ATMOSPHERE OF CARBON MONOXIDE-T9500

Shows the comparative behavior of refractory products with accelerated exposure to nearly pure CO at 940°F. The sample performance is rated based on the ASTM visual criteria. Specimens shall be 9" x 2 1/2" or 3" square in cross section. Maximum capacity of the test furnace is 50 specimens.

Basic Test Cost	$740
Hourly Charge for Test Duration	$2 per hour
Sample Inspection During Test	$180

ASTM C-357 BULK DENSITY OF GRANULAR REFRACTORY MATERIALS-T9510

A 3 mesh by 8 mesh specimen of about 70 gm is weighed, boiled in water, and its volume measured using a buret. A sample of at least 5.5 lbs. should be submitted as recommended by ASTM.

$130 per specimen

ASTM C-403 TIME OF SETTING OF CONCRETE MIXTURES BY PENETRATION RESISTANCE-T9511

The resistance of the concrete mixture to penetration by standard needles is measured. The initial and final setting times are determined from a plot of penetration resistance versus time. A sample of at least 25 lbs. should be submitted

$180 per specimen

ASTM C-417 **THERMAL CONDUCTIVITY OF UNFIRED MONOLITHIC REFRACTORIES-T9520**
Same as ASTM C-182

ASTM C-491 **MODULUS OF RUPTURE OF AIR-SETTING PLASTIC REFRACTORIES-T9550**

Five 9" x 4 1/2" x 2 1/2" or 3" bricks are prepared in a hydraulic press at 1000 psi. MOR is determined after drying and firing the specimens.

Specimen Preparation and Drying Shrinkage	$180 per test of 5 specimens
Firing Shrinkage	Same as ASTM C-113
MOR	Same as ASTM C-133

ASTM C-577 **PERMEABILITY OF REFRACTORIES-T9560**

Air or nitrogen is used to determine permeability. The direction of flow should be indicated by arrows on the specimens. Testing of four 2" cube specimens of each type/brand is recommended by ASTM.

$200 per test of 4 specimens

ASTM C-583 **MODULUS OF RUPTURE OF REFRACTORY MATERIALS AT ELEVATED TEMPERATURES-T9570**

Flexural strength is determined for 1" x 1" x 7" bars at temperature in three-point bending. Price includes a 12 hour hold at the test temperature. Testing of five specimens per type/brand is recommended by ASTM.

TEMPERATURE	1-5 SPECIMENS	6-25 SPECIMENS
2000°F or Less	$340	$15 each
2000°F to 2300°F	$380	$15 each
2300°F to 2500°F	$410	$15 each
2500°F to 2750°F	$515	$20 each
Additional Hold Time at Temperature	Quote	Quote

ASTM C-605 **REHEAT CHANGE OF FIRECLAY NOZZLES AND SLEEVES-T9580**

Specimens (25 to 26 in^3) are taken from four different sleeves or nozzles and fired per Schedule D of ASTM C-113 (2460°F reheat). The percent linear and volume changes are measured.

$495 per test of 4 specimens

ASTM C-704 **ABRASION RESISTANCE OF REFRACTORY MATERIALS AT ROOM TEMPERATURE-T9590**

The volume of materials abraded by a specified exposure to SiC grit blast is measured. Specimens are typically 4 1/2" square and 3" thick.

$375 per test of 5 specimens

ASTM C-830 **APPARENT POROSITY, LIQUID ABSORPTION, APPARENT SPECIFIC GRAVITY, AND BULK DENSITY OF REFRACTORY SHAPES BY VACUUM PRESSURE-T9630**

A vacuum is used to determine the apparent porosity, bulk density, liquid absorption, and apparent specific gravity. Testing of five specimens (1/4 brick or 25 to 30 in^3 piece) per type/brand is suggested by ASTM.

$240 per test of 5 specimens

ASTM C-831 **RESIDUAL CARBON, APPARENT RESIDUAL CARBON, AND APPARENT CARBON YIELD IN COKED CARBON CONTAINING BRICKS AND SHAPES-T9640**

Used for characterization and comparison of carbon containing brick and shapes. A 1" x 3" x 6" specimen is suggested by ASTM.

1800°F Coking (up to 12 specimens)	$325
2200°F Ignition Firing (12 hour hold)	$380
Residual Carbon, Loss on Ignition, And Carbon Yield Determinations	$20 per specimen

ASTM C-832 **MEASURING THE THERMAL EXPANSION AND CREEP OF REFRACTORIES UNDER LOAD-T9650**

Two specimens, as suggested by ASTM, are tested simultaneously under a 25 psi compressive stress for 50 hours. Other compressive stresses, up to 100 psi can be specified. The percent linear change is recorded continuously during the heat up and creep period under load. Specimen size is 1 1/2" square by 4 1/2" long.

TEMPERATURE	PER TEST OF 1 (50 hr hold)	PER TEST OF 1 (100 hr hold)	PER TEST OF 1 (EUL only)
1400°C (2552°F) or less	$560	$730	$310
1400°C to 1500°C (2732°F)	$640	$810	$395
1500°C to 1600°C (2912°F)	$730	$900	$450
1600°C to 1650°C (3002°F)	$835	$1000	$505
Alcoa Modified (2600°F)	$2140		
Other Test Conditions	Quote	Quote	Quote

ASTM C-860 **DETERMINING AND MEASURING CONSISTENCY OF REFRACTORY CONCRETE-T9670**

This method determines the optimum water content and consistency of castable products. Consistency is judged with the Ball-in-Hand method or measured with the Flow Table method.

$180 per specimen

ASTM C-862 **PREPARING REFRACTORY CONCRETE SPECIMENS BY CASTING-T9680**

Five brick specimens are prepared using the water content determined in ASTM C-860. This procedure assures the preparation of uniform samples for testing purposes. At least 50 lbs. of each material for testing should be submitted. Mixing is performed in a Hobart mixer and casting is performed either by spading or by vibration.

$180 per test of 5 specimens

ASTM C-863 EVALUATING OXIDATION RESISTANCE OF SILICON CARBIDE REFRACTORIES AT ELEVATED TEMPERATURES-T9690

Steam is used to accelerate the oxidation of SiC refractories at elevated temperatures. ASTM specifies a 500 hour test duration at a temperature between 800°C and 1200°C. The average volume and bulk density changes are measured on three specimens per material.

	PER TEST OF 1 MATERIAL	PER TEST OF 3 MATERIALS	PER TEST OF 6 MATERIALS
Measurements	$170	$500	$1000
Basic Test Cost	$1265	$1265	$1265
	$1435	$1765	$2265

ASTM C-865 FIRING REFRACTORY CONCRETE SPECIMEN-T9700

Firing schedules are for five refractory concrete specimens made in accordance with ASTM C-862 and classified by ASTM C-401. Price includes linear change measurement.

REGULAR TYPE	INSULATING TYPE	PER TEST OF 5
	Class N, 1700°F	$380
	Class O, 1900°F	$395
Class A, 2000°F		$410
Class B, 2300°F		$445
	Class P, 2100°F	$470
Class C, 2500°F	Class Q, 2300°F	$500
Class D, 2700°F	Class R, 2500°F	$535
Class E, 2900°F	Class S, 2700°F	$615
	Class T, 2900°F	$755
Class F, 3100°F	Class U, 3000°F	$765
Class G, 3200°F	Class V, 3200°F	$790

NOTE: Many of the tests listed for castables are also used for gunning refractories. Gunned specimens prepared by the supplier according to ASTM C-903 can be tested upon request.

ASTM C-885 YOUNG'S MODULUS OF REFRACTORY SHAPES BY SONIC RESONANCE-T9710

Resonant Frequency is determined by a non-destructive sonic method in the flexural mode on prism or rod specimens. Young's Modulus is calculated from the resonant frequency, mass, and dimensions.

$200 per test of 5 specimens (Young’s modulus only)
$230 per test of 5 specimens (Young’s modulus, shear modulus, and Poisson’s ratio)

ASTM C-914 BULK DENSITY AND VOLUME OF SOLID REFRACTORIES BY WAX IMMERSION-T9720

This method is used to determine volume and bulk density of a refractory of any shape providing it has sufficient structural integrity to permit handling. At least five representative specimens, as suggested by ASTM, should be supplied.

$250 per test of 5 specimens

ASTM C-973 **PREPARING TEST SPECIMENS FROM BASIC REFRACTORY GUNNING PRODUCTS BY PRESSING-T9730**

Five brick specimens are prepared using the water content specified by the manufacturer. This procedure assures the preparation of uniform specimens for testing purposes. At least 50 lbs. of each material for testing should be submitted. Mixing is performed in a Hobart mixer and specimens are formed at 1800 psi.

$180 per test of 5 specimens

ASTM C-974 **PREPARING TEST SPECIMENS FROM BASIC REFRACTORY CASTABLE PRODUCTS BY CASTING-T9740**

Five brick specimens are prepared using the water content specified by the manufacturer. This procedure assures the preparation of uniform specimens for testing purposes. At least 50 lbs. of each material for testing should be submitted. Mixing is performed in a Hobart mixer and casting is either performed by spading or by vibration.

$180 per test of 5 specimens

ASTM C-975 **PREPARING TEST SPECIMENS FROM BASIC REFRACTORY RAMMING PRODUCTS BY PRESSING-T9745**

Five brick specimens are prepared using the water content specified by the manufacturer. This procedure assures the preparation of uniform specimens for testing purposes. At least 50 lbs. of each material for testing should be submitted. Mixing is performed in a Hobart mixer and specimens are pressed at 10,000 psi.

$180 per test of 5 specimens

ASTM C-1054 **PRESSING AND DRYING REFRACTORY PLASTIC AND RAMMING MIX SPECIMENS-T9750**

Five brick specimens are prepared at 1000 psi. This procedure assures the preparation of uniform specimens for testing purposes. At least 50 lbs. of each material for testing should be submitted.

$180 per test of 5 specimens

ASTM C-1099 **MODULUS OF RUPTURE OF CARBON-CONTAINING REFRACTORY MATERIALS AT ELEVATED TEMPERATURES-T9758**

Flexural strength is determined for 1" x 1" x 6" bars at 2550°F in three-point bending. Testing of five specimens per type/brand is recommended by ASTM.

$410 per test of 5 specimens ($20 for each additional specimen)

ASTM C-1100 **RIBBON THERMAL SHOCK TESTING OF REFRACTORY MATERIALS-T9760**

Specimens receive alternating 15 minute heating at 1800°F and cooling in air cycles. The before and after shock strength and sonic properties are measured and both the actual and percent change in properties are reported. Five 9" bricks per type/brand are suggested by ASTM.

$720 per test of 5 specimens

ASTM C-1113 THERMAL CONDUCTIVITY OF REFRACTORIES BY HOT WIRE-T9855

The hot wire technique is a transient, intermittent isothermal method for measuring thermal conductivity. A thin platinum wire is placed between two appropriately prepared 9" bricks of same density. Heat generated by current applied to the wire is conducted away from the wire at a rate dependent on the thermal conductivity of the material. Minimum of two bricks required.

Room Temperature (1 data point)	$515
Room Temperature, 400, 800, and 1200°C	$955
Extra Temperature Points	$160

ASTM C-1171 QUANTITATIVELY MEASURING THE EFFECT OF THERMAL CYCLING ON REFRACTORIES-T9765

Determination of the relative thermal shock resistance of refractories using 5 alternating 10 minute heating at 2190°F and cooling in air cycles. Ten specimens 1" x 1" x 6" per type/brand are required by ASTM, and both the actual and percent change in strength and ultrasonic properties are reported.

$845 per test of 10 specimens

ASTM C-1419 SONIC VELOCITY IN REFRACTORY MATERIALS AT ROOM TEMPERATURE AND ITS USE IN OBTAINING AN APPROXIMATE YOUNG'S MODULUS-T9766

Approximation of Young's Modulus is calculated through sonic velocity measurements in 3 directions. The velocity of sound waves is measured using a James V-meter.

$230 per test of 5 specimens

ASTM C-1548 DYNAMIC YOUNG'S MODULUS, SHEAR MODULUS, AND POISSON'S RATIO FOR REFRACTORY MATERIALS BY IMPULSE EXCITATION OF VIBRATION-T9767

A non-destructive sonic method is used to determine the modulus of elasticity and modulus of rigidity for calculation of Poisson's Ratio. Bars of rectangular cross-section are used for the measurements.

$200 per test of 5 specimens (Young's modulus only)
$230 per test of 5 specimens (Young's modulus, shear modulus, and Poisson's ratio

DIN 51053 DETERMINATION OF CREEP OR REFRACTORINESS UNDER LOAD-T9900
ISO 3187

One cylindrical specimen (50 mm diameter x 50 mm high) is tested per firing. The percent linear change is recorded continuously during the heat-up and creep period under load. The minimum size required is a half brick. Standard conditions are 0.2 N/mm^2 (29 psi) load and 50 hour hold.

TEMPERATURE	PER TEST OF 1 (50 hr hold)	PER TEST OF 1 (100 hr hold)	PER TEST OF 1 (RUL only)
1400°C or Less	$560	$730	$310
1400°C to 1500°C	$640	$810	$395
1500°C to 1600°C	$730	$900	$450
1600°C to 1650°C	$835	$1000	$505
Other Test Conditions	Quote	Quote	Quote

ALCOA MODIFIED ALUMINUM CUP PENETRATION-T9810

The comparative resistance of refractory brick, mortars, or monolithics can be determined using this cup test, with 7075 aluminum alloy at 1500°F for 72 hours. Two 9" bricks are required. Before and after metal analysis is available at an additional cost of $120 per analysis.

$580 per test of 1 specimen
$765 per test of 2 specimens

ALCOA MODIFIED DISINTEGRATION OF REFRACTORIES BY ALKALI-T9540

Nine 2" cube specimens are required. A 1" hole is drilled into the face of each specimen and filled with either 8 gm of Potassium Carbonate, 8 gm of Sodium Carbonate, or a mixture of 4 gm of Potassium Carbonate and 4 gm of Sodium Carbonate. The effects of firing three cubes each at 900°C, 1000°C, or 1100°C for 5 hours are determined visually.

$810 per test of 9 specimens

ALKALI RESISTANCE-T9800

Test specimens are fired to 1700°F in two cycles in the presence of Potassium Carbonate. MOR, MOE, and visual observations are taken before and after exposure to alkali. Ten 1" x 1" x 6" bars are required.

$780 per test of 10 specimens

BONDING STRENGTH AFTER FIRING-T9820

Fireclay brick halves are bonded with a 1/16" thick joint. After air and oven drying and a 5 hour hold at the specified firing temperature, the MOR is determined for the brick/joint assembly. Five 9" bricks are required. At least 10 lbs. of mortar should be submitted for analysis.

Specimen Preparation and MOR	Same as ASTM C-198
Specimen Firing	Same as Periodic Kiln Firing

CHEMICAL ANALYSIS-T9830

Full service analytical capabilities are offered. All analyses are performed by a subcontractor. MTRC prefers to prepare the needed representative powder from the bulk sample(s) submitted. The analyses listed below show the main services provided by MTRC. Other species can be analyzed if requested.

MATERIAL	ANALYSIS	PRICE PER SPECIMEN
Fireclay	A	$360
Mullite	A	$360
Bauxite	A	$360
Feldspar	A	$360
High Alumina	A	$360
Magnesite, Dolomite	B	$360
Silica	A	$360
Zircon	C	$360
Alumina-Zirconia-Silica	D	$360
Special Analyses		Quote

Analyses:

A SiO_2, AI_2O_3, Fe_2O_3, TiO_2, CaO, MgO, Na_2O, K_2O, L.O.I

B SiO_2, AI_2O_3, Fe_2O_3, TiO_2, CaO, MgO by diff., Na_2O, K_2O, L.O.I

C SiO_2, AI_2O_3, Fe_2O_3, TiO_2, CaO, MgO, ZrO_2, L.O.I

D SiO_2, AI_2O_3, Fe_2O_3, TiO_2, CaO, MgO, ZrO_2, Na_2O, K_2O, L.O.I

Emission Spectrographic Analysis - A qualitative method, which identifies the presence of major, minor, and trace elements in a sample. $210 per specimen

CURING OR DRYING CHANGE-T9840

For refractory concretes the percent linear or volume change can be calculated after curing based on mold dimensions and after drying based on cured dimensions. At least 50 lbs. of each material for testing should be submitted.

$180 per test of 5 specimens

MICROSCOPIC ANALYSIS-T9775

Optical Microscope: Reflected light techniques are used to characterize the microstructure of materials submitted. Photomicrographs can be provided, if requested. Quote.
Scanning Electron Microscope: Electron beam techniques are used to characterize the microstructure of materials submitted. Photomicrographs can be provided, if requested. Quote.

PERIODIC KILN FIRINGS-T9200

Periodic kiln firing can be performed within all commercial ranges of temperatures and atmospheres, using almost any schedule used by commercial equipment. The prices apply to one firing with 1 cubic foot setting space up to a 5 hour cycle. Longer soak times are $50 to $175 per additional 24 hours and are quoted depending on firing conditions.

TEMPERATURE RANGE	FIRING CONDITIONS	PRICES
25°C-1000°C	Electric firing with normal air atmosphere	$190 per firing
25°C-1500°C	Electric firing with normal air atmosphere	$380 per firing
25°C-1500°C	Gas firing with normal combustion gas	$565 per firing
25°C-1700°C	Gas firing with normal combustion gas	$635 per firing
Other Test Conditions		Quote

ULTRASONIC VELOCITY -T9780

The speed of sound is measured non-destructively for brick through 3 dimensions. Testing of 5 specimens per type/brand is recommended.

$230 per test of 5 specimens

WORKABILITY- T9785

A practical test used in industry to determine the approximate working time for placement of a castable in the field.

$90 per test

X-RAY DIFFRACTION ANALYSIS-T9790

The major and minor crystalline phases present in a sample are determined on a qualitative basis. All analyses are performed by subcontractor. MTRC prefers to prepare the needed representative powder from the bulk sample(s) submitted.

Qualitative Determination	$275 per specimen
Quantitative Determination	$375 per specimen

THERMAL ANALYSIS METHODS

DIFFERENTIAL THERMAL ANALYSIS (DTA)-T9140

Differential Thermal Analysis is a determination (multigram samples) of the temperature difference between the sample and a known reference as a function of the reference temperature. It is a sensitive qualitative test for determining the temperature at which chemical and physical changes occur in the sample. DTA is especially useful in control and analysis and for indicating temperature regions for closer study or evaluation by other thermal analytical techniques.

TEMPERATURE RANGE	RUN IN AIR ATMOSPHERE	RUN IN SPECIAL ATMOSPHERE (Ar, O_2, N_2, CO_2)
25-1600°C	$190	$240

Sample Required: 10 gm minimum, 60 mesh
Heating and Cooling Rate: 10°C/minute (standard)

THERMAL GRAVIMETRIC ANALYSIS (TGA)-T9170

Thermogravimetric Analysis provides the change (multigram samples) in weight of a sample as function of temperature. It is a precise quantitative method of determining combustibles, loss of volatiles, curing times, decomposition of hydrates and carbonates, and weight loss changes. Rates of weight loss or gain are easily determined from the curve. The use of controlled atmospheres allows for the study of solid-gas reactions.

TEMPERATURE RANGE	RUN IN AIR ATMOSPHERE	RUN IN SPECIAL ATMOSPHERE (Ar, O_2, N_2, CO_2)
25-1600°C	$190	$240

Sample Required: 10 gm minimum, 60 mesh
Heating and Cooling Rate: 2°C/minute (standard)

SIMULTANEOUS DIFFERENTIAL THERMAL ANALYSIS / THERMAL GRAVIMETRIC ANALYSIS (DTA / TGA)-T9150

Simultaneous DTA / TGA Analysis combines the two thermal analysis techniques, Differential Thermal Analysis and Thermogravimetric Analysis, in one measurement. The instrument is configured with the differential thermocouple assembly mounted on the balance, which allows monitoring the weight change and temperature differential simultaneously as a function of temperature.

TEMPERATURE RANGE	RUN IN AIR ATMOSPHERE	RUN IN SPECIAL ATMOSPHERE (Ar, O_2, N_2, CO_2)
25-1600°C	$275	$325

Sample Required: 10 gm minimum, 60 mesh
Heating and Cooling Rate: 10°C/minute (standard)

THERMAL LINEAR ANALYSIS (THERMAL EXPANSION/CONTRACTION) -T9110

Thermal Linear Analysis determines the expansion and/or contraction characteristic of a specimen as a function of temperature. Numerical and graphical results show the percent of linear thermal change (expansion or shrinkage) versus temperature using an Orton dilatometer. Tests on larger refractory specimens can also be made using a vertical thermal expansion furnace (see ASTM C-832).

TEST DESCRIPTION	**CRYOGENIC -175 to 300°C**	**25 to 1000°C**	**25 to 1500°C**	**25 to 1600°C**
Heating Only Air Atmosphere	N/A	$110	$160	$190
Heating and Cooling Air Atmosphere	N/A	$150	$210	$250
Heating Only Special Atmosphere (Ar, O_2, N_2, CO_2)	$160	$180	$240	$260
Heating and Cooling Special Atmosphere (Ar, O_2, N_2, CO_2)	N/A	$220	$280	$320

Sample Sizing -T9100 $90 per specimen

Sample Required: For specimens run to 1000°C, the maximum diameter is 1/2" and the standard lengths are 1/2", or 1", or 2". For specimens greater than 1000°C, the maximum diameter is 5/8" and the standard length is 1". Length can vary by 0.1". Specimen ends need to be flat and parallel and within ± 0.001". Tests can be made on specimens of non-standard length and unusual shapes (foils, wafers, or stacking small pieces).
Heating and Cooling Rates: 3°C/minute (standard)
ASTM Standard Conditions: Thermal linear analysis can be performed according to other standard conditions, such as outlined in C-372, C-824, E-228, and E-831.

WHITEWARE TEST METHODS

ASTM C-67 BRICK AND STRUCTURAL CLAY TILE TESTING-T9340

A minimum of five full size brick or tile units per type/brand is suggested by ASTM for determination of modulus of rupture, compressive strength, absorption, and saturation coefficient.

TEST DESCRIPTION	PER TEST OF 5
Modulus of Rupture	$150
Compressive Strength (includes capping)	$280
Absorption: 5 or 24 hour submersion test	$100
Absorption: 1, 2, or 5 hour boil test	$170
Saturation Coefficient	$220

ASTM C-279 CHEMICAL RESISTANT MASONRY UNITS-T9490

Granular specimens are boiled in a sulfuric acid solution for a specified time period. The percent weight loss for two representative specimens per type/brand is determined.

$340 per test of 2 specimens

ASTM C-373 WATER ABSORPTION, BULK DENSITY, APPARENT POROSITY, AND APPARENT SPECIFIC GRAVITY OF FIRED WHITEWARE PRODUCTS -T9515

The water absorption, bulk density, apparent porosity, and apparent specific gravity are determined by the boiling method. Testing of five unglazed specimens (of at least 50 gm/piece) is suggested by ASTM.

$170 per test of 5 specimens

ASTM C-554 CRAZING RESISTANCE OF FIRED GLAZED CERAMIC WHITEWARES BY A THERMAL SHOCK METHOD-T9516

The resistance to crazing of fired glazed whitewares is determined when subjected to thermal stresses. Specimens are initially heated at 250°F and water quenched. This cycle is repeated three times. If crazing dos not take place, then the three cycles are repeated in 25°F increments up to 450°F. Failure is defined as the temperature at which crazing is observed. Testing of five specimens is suggested by ASTM.

$180 per test of 5 specimens

ASTM C-674 FLEXURAL PROPERTIES OF CERAMIC WHITEWARE MATERIALS-T9517

Flexural strength is determined in three-point bending on bars of circular or rectangular cross-section. Testing of ten specimens per type/brand is recommended by ASTM.

$40 per specimen (strength)
$80 per specimen (strength and elastic modulus)

ASTM C-773 COMPRESSIVE (CRUSHING) STRENGTH OF FIRED WHITEWARE MATERIALS-T9518

The compressive strength is determined on a right cylinder. Testing of at least ten specimens per type/brand is recommended by ASTM.

$40 per specimen

LABOR AND CONSULTING CHARGES

LABOR CHARGES

Technician Time and Sample Preparation-T8200	$90 per hour
Engineer Time-T8100	$140 per hour

ON-SITE INSPECTION OR SAMPLING-T9870

Arrangements can be made to offer needed services in-plant or on-site. Examples are quality control sampling, product inspection (including non-destructive sonic testing), failure analysis, and sampling of a failure.

$1200 per day plus expenses

NOTARIZED REPORTS-T9875

Because some specifications, bids or orders require a notarized certificate of test results, such a documented report can be provided for an additional charge. If a notarized report is needed, please indicate at the start of the testing program.

Notarized Report	$20
Copies of Notarized Report	$15

SPECIAL PROJECTS-T9880

For special projects, a proposal is submitted covering work to be done along with time and costs. Most projects are done on a cost-incurred basis. Orton makes every effort to provide high quality technical services on a responsive basis.

Quote

RESEARCH & CONSULTANT SERVICES

CENTER staff are actively involved in the development of new test methods and the evaluation of existing tests. We can do comparative evaluations on specific materials. Capabilities exist to evaluate sensors, design or apply electronics, write specialized software, and design and build test equipment.

THE CENTER also undertakes proprietary research and testing projects for clients on a contract basis. These may include ceramic/refractory materials evaluation, development/characterization of new test procedures or evaluation of firing behavior. Following discussion of the project with a client, a proposal is prepared outlining the work to be performed, project schedule, and estimated cost. The Center utilizes the services of private consultants, University faculty, and others to complement its own professional staff and testing capabilities.

SUBJECT INDEX

Request for Testing Services

The Edward Orton Jr. Ceramic Foundation
Materials Testing and Research Center
6991 Old 3C Highway
Westerville, OH 43082
Phone (614) 895-2663 Fax (614) 895-5610

Contact			
Company Name			
Address			
City	**State**	**Zip**	
Phone	**Fax**	**E-mail**	**PO #**

Sample Identification	Sample Description, Dimensions	Testing Requested
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Special Instructions	
Hazardous Material Information (Please attach MSDS)	

Samples	**Discard [ ] Retain (1 yr) [ ]** **Return [ ] Acct. # [ ]** **Special:**
Date Received	

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