

Appendix 1 – Detailed Contract Service Specifications

Notes:

- 0° degrees corresponds the “D” in the DOT number on the sidewall. “SS” refers to the Serial Side (side with DOT number). “OSS” refers to the Opposite Serial Side.
- GFE refers to Government Furnished Equipment
- The contractor shall individually label every test sample (when possible) and tire remnant. Tire test samples shall be stored in safe storage conditions in clearly labeled polyethylene or Mylar bags provided by the contractor for each test sample.

All units shall be SI unless otherwise specified in the task order. All data shall be submitted in a MS Excel format unless otherwise specified in the task order requirements.

Standards Referenced:

ASTM D 412-98a(2002) ^{ε1}	ASTM D5992-96(2001)e1
ASTM D 413-98(2002) ^{ε1}	ASTM E1131-98
ASTM D430-95(2000)	ASTM F 421-00
ASTM D 638-02a	ASTM F 538-99
ASTM D813-95(2000)	ASTM F 551-89
ASTM D 1171-99	ASTM F 1112-00
ASTM D 1434-82(1998)	SAE J1561 (February 2001)
ASTM D 2240-02b	SAE J1205-J1206

Required tests and services are specified in the following table.

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Item 1 – Tire Storage

Pricing: Price is per tire - per month. Storage costs may be prorated on a per time basis. Price includes all costs associated with this service.

Labor Costs: Included in the price.

GFE: New and used tires.

Specifications: All tires in the contractor's possession shall be stored in a secure, out-of-the-weather, storage area. The storage area does not have to be heated, but temperatures shall not exceed 32°C (90° F) at any time. The tires shall be stored in a dry, well-ventilated environment away from direct sunlight and electric motors. Untested tires shall be turned every 4-6 weeks to prevent flat spots. Tires shall be stored vertically, on racks, and in an un-mounted condition. Tires may temporarily be stored in horizontal stacks during testing and handling, but the stacks shall never exceed four tires in height.

Deliverables: Tire storage per tire per month (may be prorated) under specified conditions.

Item 2 – Wheel Storage

Pricing: Price is per wheel - per month. Storage costs may be prorated on a per time basis. Price includes all costs associated with this service.

Labor Costs: Included in the price.

GFE: New wheels.

Specifications: All wheels in the contractor's possession shall be stored in a secure, out-of-the-weather, storage area.

Deliverables: Wheel storage per wheel per month (may be prorated) under specified conditions.

Item 3 – Tire Mounting on Wheel, Dry Air Inflation, New Valve Stem

Pricing: Price is per tire mount. Price includes all costs associated with the service, including valve stem assembly, and tire lube.

Labor Costs: Included in the price.

GFE: New and used tires, new wheels.

Specifications: The tire shall be mounted on the wheel size specified by the COTR in the task order: A new tire valve assembly (stem & core), provided by the contractor, shall be installed in the wheel every time a tire is mounted. The valve stem rubber must be an EPDM compound and must be certified as meeting SAE J1205 & J1206 standard requirements. The tire shall be mounted using ready-to-use Murphy's Tire and Tube Mounting Lubricant (no mixing from

concentrate and absolutely no petroleum or water based bead lubricants). Tires shall be seated in accordance with all OSHA, RMA, tire manufacturer, and internal lab procedures. Tires shall be inflated to test specified inflation pressure with air that has had the moisture removed such that the outlet pressure dew point at rated conditions is 38°F (3°C). For tests that require inflation pressures that exceed sidewall maximum inflation pressure, tires shall be inflated in a safety cage (similar to ones used for truck tire inflation).

Deliverables: One tire mounted and inflated on wheel with a new tire valve and inflated with dry air to the specified test pressure.

Item 4 – Tire Mounting on Wheel, 50%/50% N2/O2 Inflation, New Valve Stem

Pricing: Price is per tire mount. Price includes all costs associated with the service, including valve stem assembly, and tire lube.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: The tire shall be mounted on the wheel size specified by the COTR in the task order using air to seat the bead: A new tire valve assembly (stem & core), provided by the contractor, shall be installed in the wheel every time a tire is mounted. The valve stem rubber must be an EPDM compound and must be certified as meeting SAE J1205 & J1206 standard requirements. To assist in mounting, the tire shall be mounted using ready-to-use Murphy's Tire and Tube Mounting Lubricant (no mixing from concentrate and absolutely no petroleum or water based bead lubricants). Tires shall be seated using compressed air in accordance with all OSHA, RMA, tire manufacturer, and internal lab procedures. Tires shall then be completely deflated and re-inflated to the specified test pressure with a 50%/50% N2/O2 certified blend with a certified accuracy of at least $\pm 0.5\%$. For tests that require inflation pressures that exceed sidewall maximum inflation pressure, tires shall be inflated in a safety cage (similar to ones used for truck tire inflation).

Deliverables: One tire mounted and inflated on wheel with a new tire valve and inflated with a 50%/50% N2/O2 certified blend to the specified test pressure.

Item 5 – Tire Mounting on Wheel, 100% N2 Inflation, New Valve Stem

Pricing: Price is per tire mount. Price includes all costs associated with the service, including valve stem assembly, and tire lube.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: The tire shall be mounted on the wheel size specified by the COTR in the task order: A new tire valve assembly (stem & core), provided by the contractor, shall be installed in the wheel every time a tire is mounted. The valve stem rubber must be an EPDM compound and must be certified as meeting SAE J1205 & J1206 standard requirements. The tire shall be

mounted using ready-to-use Murphy's Tire and Tube Mounting Lubricant (no mixing from concentrate and absolutely no petroleum or water based bead lubricants). Tires shall be seated using compressed air in accordance with all OSHA, RMA, tire manufacturer, and internal lab procedures. Tires shall then be completely deflated and re-inflated to the specified test pressure with a 100% N2 certified gas with a certified accuracy of at least $\pm 0.5\%$. For tests that require inflation pressures that exceed sidewall maximum inflation pressure, tires shall be inflated in a safety cage (similar to ones used for truck tire inflation).

Deliverables: One tire mounted and inflated on wheel with a new tire valve and inflated with a 100% N2 inflation gas to the specified test pressure.

Item 6 – Cut Tires into Sections

Pricing: Price is per cut. Price includes all costs associated with this service.

Labor Costs: Included in the price.

GFE: New and used tires.

Specifications: Some tires will have to be cut into sections and the sections distributed per the direction of the COTR. Pricing is per radial cut, perpendicular to the tread, from tread through the two beads. The number of cuts will be specified in the task order. This service is different from the sectioning work required for sample preparations.

Deliverables: One complete radial tire cut from the surface of the tread through the two beads.

Item 7 – Tire & Tire Section Transport: Inter-laboratory, Greater Akron Ohio Area

Pricing: Price is per tire per mile. Price includes all costs associated with this service.

Labor Costs: Included in the price.

GFE: New and used tires, new wheels.

Specifications: The contractor may be required to arrange either pickup or drop-off of tires or tire sections at multiple locations in the Greater Akron Ohio area (including Akron, Massillon, & Ravenna). Prices shall be quoted per tire, per mile. Travel without tires is not chargeable. For instance, Lab A delivers 10 tires to Lab B 20 miles away. This is 200 tire-miles. The return trip, if empty is not charged. If the truck brings back 5 tires, this is an additional 100 tire-miles. Deliveries outside of the Greater Akron area, if required, will be arranged by the government, at the government's expense.

Deliverables: One roundtrip delivery or pickup of tires or tire sections from another location in the Greater Akron Ohio area.

Item 8 – Move Tire-Wheel Assembly Between Oven and Roadwheel, or Vice Versa

Pricing: Price is per tire per move. Price includes all costs associated with this service.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: During the Hybrid Oven & Roadwheel Aging Method, it is anticipated that mounted tires will have to be moved from the oven to a roadwheel, or vice versa. During each move, the tire shall be:

- Uninstalled from the roadwheel or oven
- Allowed to cool if necessary
- Deflated
- A new tire valve assembly, provided by the contractor, installed (new stem & core, valve stem rubber must be an EPDM compound and must be certified as meeting SAE J1205 & J1206 standard requirements)
- If a bead unseats, reseated beads with compressed air inflation and then completely deflate tire
- Re-inflated with fresh 50%/50% N₂/O₂ gas ($\pm 0.5\%$ certified blend)
- Reinstalled in the new location

For tests that require inflation pressures above sidewall maximum inflation pressure, tires shall be inflated in a safety cage (similar to ones used for truck tire inflation).

Deliverables: One tire moved from oven to roadwheel, or vice versa, per specifications.

Item 9 – Tire & Remnants Disposal

Pricing: Price is per tire. Tire sample and remnant disposal may be prorated based on weight or volume. Price includes all costs associated with the service.

Labor Costs: Included in the price.

GFE: New and used tires.

Specifications: All tires, test samples, and tire remnants shall be preserved by the contractor in appropriate safe storage conditions until the contractor either receives written notice from the Government authorizing disposal, or the items are returned to the Government at the Government's option. Disposal of tires, test samples, and tire remnants shall comply with all applicable tire disposal regulations. Any whole tires leaving the test facility for disposal shall be made unusable by the contractor before departure to prevent possible reuse by the public (even tires sent to a third party for disposal).

Deliverables: One tire, or tire remnant on a prorated basis, properly disposed of per specifications.

Item 10 – Tire Inspection, Used Tires

Pricing: Price is per tire inspection. Price includes all costs associated with the service and data report.

Labor Costs: Included in the price.

GFE: Used tires.

Specifications: The contractor shall provide qualified personnel to inspect or measure seven used tire properties: Average tread depth¹, surface crack coding², inner liner crack coding³, inspection for number of punctures⁴, repair type coding⁵, Shore durometer readings of the tread⁶, and macro tire damage coding⁷. All data shall be submitted in an MS Excel format.

¹Average tread depth measurement shall be per ASTM F 421-00. Follow Section 9.2.1 *Preferred Method* and Section 9.3.1 or 9.3.2 (depending on the tread width). Follow Section 9.4.2 *Minimum Requirement* regarding measurements and spacing. Report raw and average values for each groove (void).

²Surface crack coding shall be per ASTM D 1171-99, Section 7.3 *Rating of Exposed Specimens*. Notes or comments may be added.

³Innerliner crack coding shall be per ASTM D 1171-99, Section 7.3 *Rating of Exposed Specimens*. Notes or comments may be added.

⁴Count the number of punctures, with the location of each puncture clearly marked on the tire and documented.

⁵Repair type coding shall follow standard industry nomenclature (plug, patch, not repaired, etc.). Notes or comments may be added.

⁶Shore durometer readings on the Shore A scale shall be completed per ASTM D 2240-02b. Measurements shall be conducted per Section 9.1.8 or 9.2.5 on the tire tread (Five determinations of hardness at least 6.0mm (0.24 in) apart at a location the corresponds to one of the tread depth measurement locations). Report raw and average values.

⁷Macro tire damage, such as belt separation, chunking, etc., shall be coded per SAE J1561 (February 2001) or ASTM F 538-99.

Data Units: mm

Deliverables: One tire inspection that produces the following measurements. All data shall be submitted in an MS Excel format:

- Six raw groove depth data points per groove
- Average groove depth on a circumferential line for each groove
- One average tread depth for the entire tire
- Surface crack coding of outer tire surfaces
- Innerliner crack coding
- Number of tire punctures with the location of each puncture marked on the tire and documented (if any)
- Repair type coding (if any)
- Five raw shore hardness numbers for the tire tread
- One average shore hardness number for the tire tread
- Documentation of macro tire damage (if any)

Item 11 – Tire Inspection, Post Test

Pricing: Price is per tire inspection. Price includes all costs associated with this service and data report.

Labor Costs: Included in the price.

GFE: New and used tires.

Specifications: Any tire tested on a roadwheel shall be inspected after each complete roadwheel sequence for tire damage. The tire shall be inspected by qualified personnel and categorized as passing the inspection or failing the inspection. [Failed tires shall not progress to further testing. The Government shall be notified of a tire that failed inspection so that a suitable replacement can be obtained. The contractor shall take three (3) digital photographs from various angles, per Item 12 specifications, of the failed tire. The cost of the photography will be charged separately under Item 12.] Data should be submitted in a MS Excel format. For failed tires, detailed descriptions of the failures shall be annotated per SAE J1561 (February 2001) and/or ASTM F 538-99. Tires purposely run to failure shall have a clearly annotated description of the failure type and location.

Deliverables: Documented tire rating of pass or fail per each inspection. For failed tires, detailed documentation of failure type and location, as well as three digital pictures of the failure are required. All data shall be submitted in a MS Excel format, pictures in a jpeg format.

Item 12 – Digital Photo

Pricing: Price is per photo. Price includes all costs associated with the service and media storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Specifications: The contractor shall take a clear, 300 dpi or better digital photograph, using sufficient lighting and focal length. The photograph shall contain the view of the object as requested by the task order. The digital camera used for the photography shall have a minimum of 3.0 megapixels. Photographs shall be saved and submitted to the Government in a digital jpg format.

Deliverables: One clearly viewable 300 dpi digital photograph per task order specifications in a digital jpg format.

Item 13 – Shearography

Pricing: Price is per bead-to-bead shearography inspection. Price includes all costs associated with the service, data report, and media storage.

Labor Costs: Included in the price.

Predecessors: Inspection for used tires.

GFE: New and used tires.

Specifications: Shearography shall be conducted per the procedure specified by the equipment manufacturer. The tires shall undergo bead-to-bead shearography, a qualified expert shall interpret the results, and suspect areas of the tire shall be clearly marked on the tire and their existence annotated in a MS Excel spreadsheet. A qualified expert for shearography interpretation is someone who has been trained by the shearography machine manufacturer on the proper shearography techniques and shearography interpretation. The expert must have billed at least 500 hours of previous shearography interpretation work to qualify as an expert. Resultant images of the individual sections recorded shall be stored in the native format of the equipment and a copy submitted to the Government. If the native format of the machine is not a pdf, also supply a copy of the images in a pdf format.

Deliverables: The complete set of digital tire section images stored in the native format of the machine as well as a digital copy of those images stored in a pdf format if pdf is not the native machine format. Results of analysis of shearography images, done by a qualified expert, shall be submitted in a MS Excel format on CD or DVD media. In addition, any accompanying notes or data shall be submitted.

Item 14 – Microscopy

Pricing: Price is per microscopy inspection. Price includes all costs associated with the service, including test sample preparation, data report, and sample, data, and media storage.

Labor Costs: Included in the price.

Replicates: Four.

Sample Regions: Radial cross sections at 0, 90, 180, and 270 degrees.

GFE: New tires.

Specifications: Section tire into appropriate test specimens. Use microscopy to measure the following component thickness:

Component gauges at center of crown:

- Innerliner
- Squeegee/gumstrips
- No. 1 body ply
- No. 2 body ply
- No. 1 belt
- No. 2 belt
- Skim rubber between belts
- Cap ply (if any)
- Undertread

- SW/Base
- Tread

Component gauges belt edge:

- Innerliner
- Wedge
- #1 Belt Width
- #2 Belt Width
- Belt Step
- Inter Belt Gauge
- Wedge Gauge/Location
- Buttress Gauge
- Base Gauge
- W7 Gauge
- Squeegee (barrier)
- Plycoat
- Shoulder wedge
- Beltcoat #1
- Beltcoat #2
- Tread base
- Tread (under lug)
- Tread (under groove)

Data Units: mm

Deliverables: A digital picture of the tire cross-section with a traceable rule and each measured component clearly identified. In addition, the following data points shall be submitted:

- Four (4) sets of raw thickness measurements, one data point for each component listed
- One (1) average thickness measurement for each component listed

All data shall be submitted in an MS Excel format on CD or DVD media.

Item 15 – Tire Air Permeability per ASTM F 1112-00, 21°C (70°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test sample preparation, data report, and data storage.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: Measure whole tire air permeability per ASTM F 1112-00. Per Section 9.6 of the standard, the test period may be shorter than the commonly used 180 days depending on the precision level of the data. If a shorter test period is desired, the contractor shall obtain written authorization by the Government to use a test period less than the specified 180 days. Proof of data accuracy and precision must be submitted if the contractor recommends a reduced test duration period. The test chamber shall be controlled to provide a mean ambient temperature that is within $\pm 0.6^{\circ}\text{C}$ (1.1°F) of the 21°C (70°F) nominal test temperature and with overall variation within $\pm 3^{\circ}\text{C}$ ($\pm 5^{\circ}\text{F}$) over the course of the test.

Data Units: days, kPa, °K

Deliverables: Tire air permeability data per ASTM F 1112-00, Section 11 *Report* submitted in an MS Excel format.

Item 16 – Tire Air Permeability per ASTM F 1112-00, 70°C (158°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test sample preparation, data report, and data storage.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: Measure whole tire air permeability per ASTM F 1112-00. Per Section 9.6, the test period may be shorter than the commonly used 180 days depending on the precision level of the data. If a shorter test period is desired, the contractor shall obtain written authorization by the Government to use a test period less than the specified 180 days. Proof of data accuracy and precision must be submitted if the contractor recommends a reduced test duration period. Disregard Section 8.2 (nominal test temperatures). The test chamber shall be controlled to provide a mean ambient temperature that is within $\pm 0.6^{\circ}\text{C}$ (1.1°F) of the 70°C (158°F) nominal test temperature and with overall variation within $\pm 3^{\circ}\text{C}$ ($\pm 5^{\circ}\text{F}$) over the course of the test.

Data Units: days, kPa, °K

Deliverables: Tire air permeability data per ASTM F 1112-00, Section 11 *Report* submitted in an MS Excel format.

Item 17 – Innerliner Air Permeability per ASTM D 1434-82(1998), 21°C (70°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: Section tire into appropriate test specimens. Measure tire innerliner air Gas Transmission Rate (GTR), permeance, and permeability per ASTM D 1434-82(1998).

Data Units: °C, mm, $\text{mol}/(\text{m}^2\cdot\text{s})$, $\text{mol}/(\text{m}^2\cdot\text{s}\cdot\text{Pa})$, $\text{mol}/(\text{m}\cdot\text{s}\cdot\text{Pa})$

Deliverables: Tire innerliner air GTR, permeance, and permeability data measured per specifications and submitted in an MS Excel format.

Item 18 – Innerliner Air Permeability per ASTM D 1434-82(1998), 70°C (158°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test

sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New tires, new wheels.

Specifications: Section tire into appropriate test specimens. Measure tire innerliner air Gas Transmission Rate (GTR), permeance, and permeability per ASTM D 1434-82(1998).

Data Units: °C, mm, mol/(m²·s), mol/(m²·s·Pa), mol/(m·s·Pa)

Deliverables: Tire innerliner air GTR, permeance, and permeability data measured per specifications and submitted in an MS Excel format.

Item 19 – Intracarcass Pressure 21°C (69.8°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

Replicates: Four needles per tire.

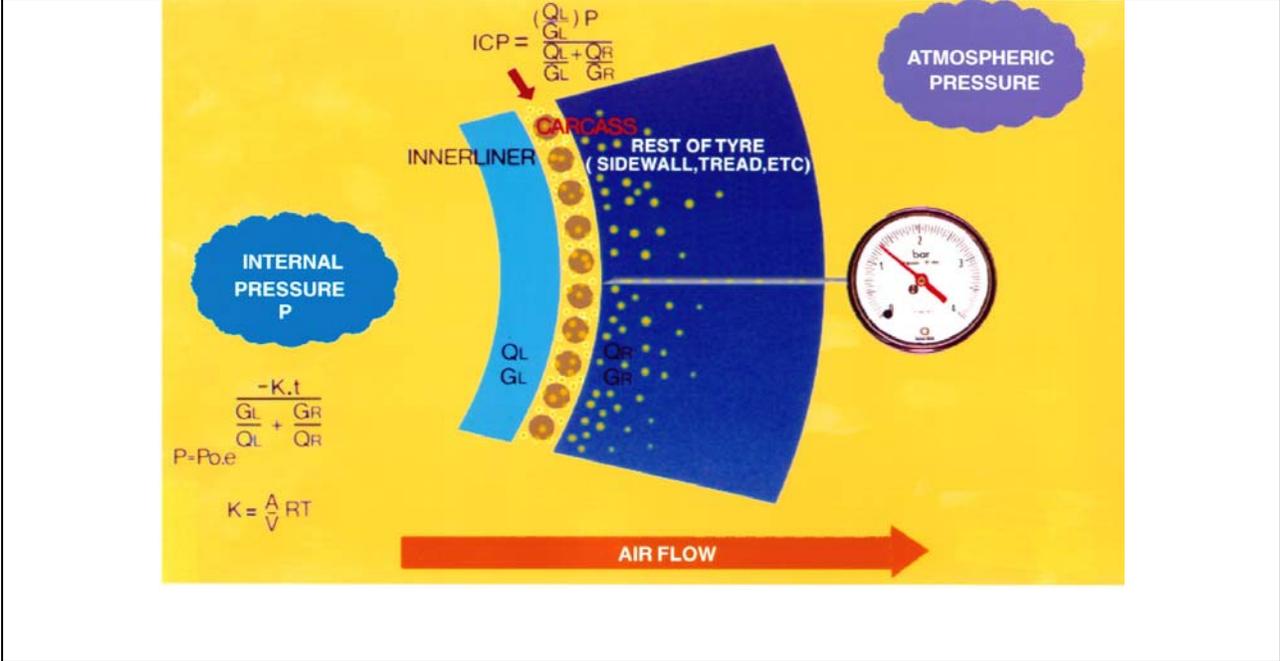
Sample Regions: Carcass, SS @ 0, 90, 180, and 270 degrees.

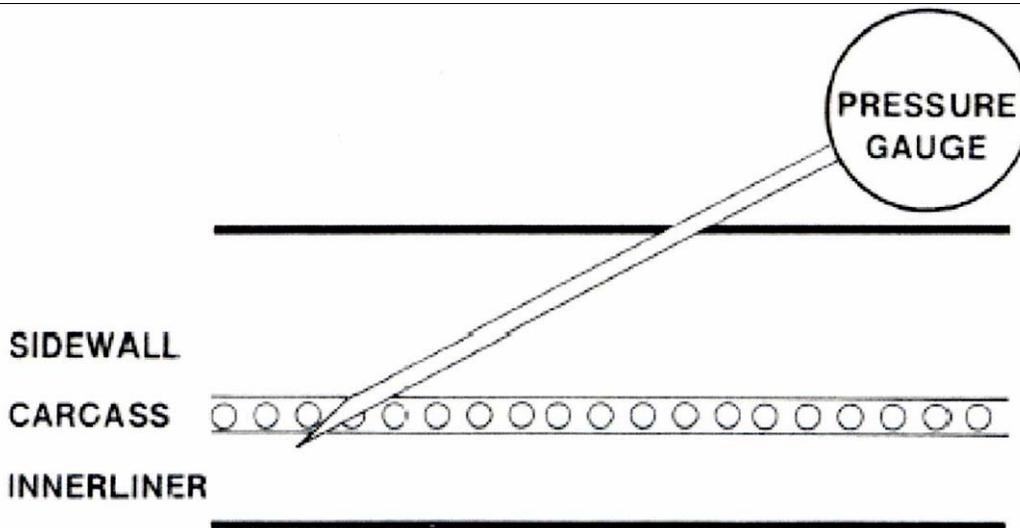
GFE: New tires, new wheels.

Specifications: A detailed test procedure is available upon request.

General Process:

- Measure tire intracarcass pressure at 21°C ±3°C (69.8°F ±5°F) with the following method:
 - Equilibrate tires at 21°C
 - Inflate tires to 2.2 bar and maintain pressure with a pressure manifold system
 - Fill hypodermic needle / pressure gauge with water
 - Insert 4 needles into tire sidewall until carcass cords are touched
 - Rest gauge on inclined support tray
 - Monitor ICP
 - Equilibrium is usually reached within 20 days





Data Units: °C, bar

Deliverables: Tire intracarcass pressure, in bar, measured per specifications and submitted in an MS Excel format.

**Pictures courtesy of Exxon-Mobil Chemical (EMC) Company. Full test procedure available from EMC.*

Item 20 – Peel Strength per ASTM D 413-98(2002)@1 23°C (73.4°F)

Pricing: Price is per test. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

Predecessors: Inspection and shearography for used tires.

GFE: New and used tires.

Replicates: Four (4) repeated measurements per tire sample region

Sample Regions: Skim & wedge rubber, 0° & 180°.

Specifications: General - Section tire into appropriate test specimens. Measure peel strength of the tire skim rubber between the steel belts as well as the wedge rubber (belt edge) per ASTM D 413-98(2002)^{e1} *Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate*.

For used tires, the contractor shall use previously conducted tire shearography images to locate two regions approximately 180 degrees from one another around the circumference of the tire that are not damaged or separated. For new tires, the first region shall be located at the DOT number (0°), with the second region located 180 degrees around the circumference of the tire (180°). Prepare the sample according to the following guidelines:

- For each of the two chosen tire regions, cut one 63.5 mm (2½") wide radial section bead to bead. The section should resemble the following photo:



- Trim off the sidewall portion of each section approximately 31.75 mm (1¼") down the sidewall from the end of the 1st (bottom) belt. Discard sidewall portions.
- Buff the tread flat on each radial tread sections.
- Bisect each radial tread section into two 31.75 mm (1¼") wide radial strips.
- Bisect the radial strips, circumferential to the tire at the centerline of the tread, to produce two test specimens (1-SS and 1-OSS) per strip. This will produce a total of eight 31.75 mm (1¼") wide test specimens in total (4-SS and 4-OSS) from the two original radial sections.
- Mark each sample for identification e.g. SS0a, SS0b, OSS0a, OSS0b, SS180a...
- Buff the edges of all samples until smooth, paying close attention to minimizing heat generation.
- Cut each sample with a razor knife from the skim end of the test strip, midway between the belts, for a length of 25.4 mm (1") to facilitate gripping the ends in the stress/strain tester jaws.
- Score the sides of each specimen at a point midway between the belts to a depth of 3.175 mm (1/8"). The scoring will extend from the end of the gripping surface to the end of belt #2 in the shoulder area, providing a final 25.4 mm (1") wide peel section. The final section should look like this:



- Testing is conducted per ASTM D 413 “Type A 180° peel”. Testing is restricted to the Section 3.1.2 *Machine Method*, in which the force required to cause separation between adhered surfaces is applied by means of a tension machine. A mark shall be made on the side of the sample where the wedge material begins and a separate result shall be recorded for the wedge region to the end of the belts. The peel test shall be performed at 0.8 mm/s (2 in/min). Test shall be conducted under the following environmental conditions: $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test. Peel strength values shall be submitted in units of both N/m and lbf/in.

Data Units: N/m, lbf/in, °C, %

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- SS, 4 average & 4 peak peel strengths for skim and wedge compounds in both N/m & lbf/in units.
- OSS, 4 average & 4 peak peel strengths for skim and wedge compounds in both N/m & lbf/in units.
- Temperature and relative humidity readings for each test.

Item 21 – Peel Strength per ASTM D 413-98(2002)@1, 100°C (212°F)

Peel strength per Item 20 specifications at 100°C (212°F) instead of 23°C (73.4°F).

Item 22 – Variable Speed Peel Strength

Peel strength per Item 20 specifications using variable peel speeds ranging from 0.00001 m / sec

to 5 m /sec. Sample preparation and dimensions may be modified to accommodate test procedure.

Item 23 – Total Crosslink Density

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

GFE: New and used tires.

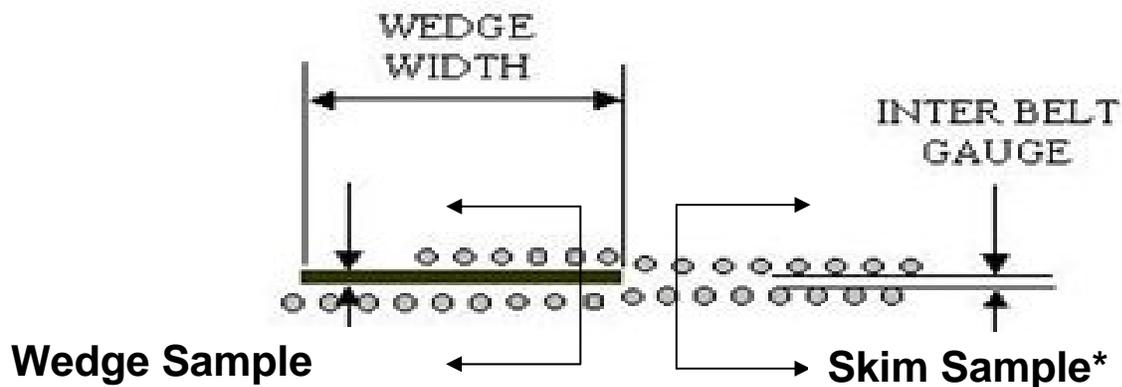
Labor Costs: Included in the price.

Replicates: Five (5) repeated measurements in each sample region.

Sample Regions: Skim Rubber 0° SS, Skim Rubber 180° OSS, Wedge Rubber 0° SS, Wedge Rubber 180° OSS, Tread Rubber 0° SS, Tread Rubber 180° OSS.

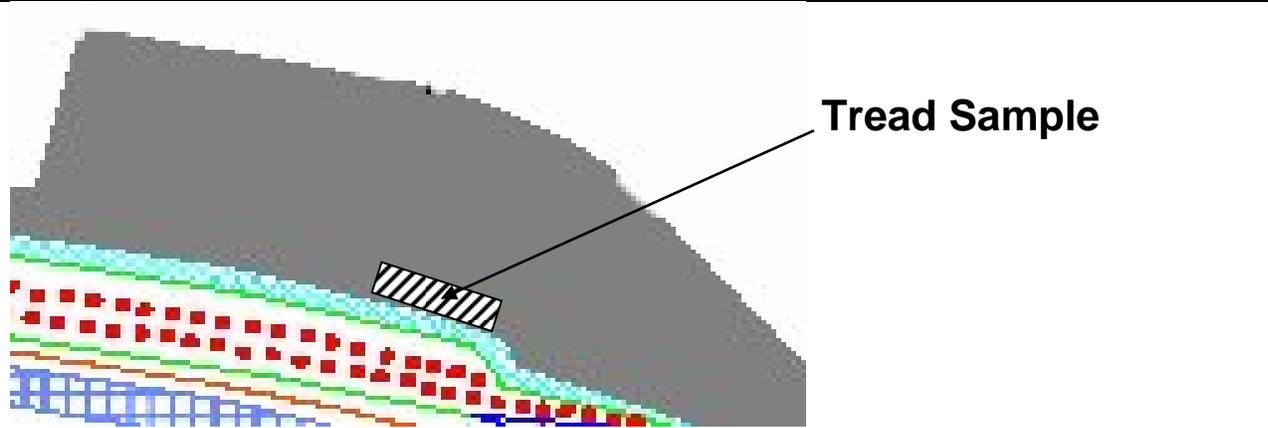
Specifications: General - Section tire into appropriate test specimens. Measure total crosslink density in six regions, with five repeated measurements on a sample taken from each region. Remove a large enough sample from each section to accommodate the skim, wedge, and tread rubber excisions, accounting for replicates.

- Skim rubber sample: Locate the region between the 2 steel belts, inboard of the end of the 2nd (top) belt. Come inboard to the 2nd cable of the top belt beyond the wedge ending (beyond the flare) and excise the rubber sample.
- Wedge rubber sample: Samples shall be taken from the belt wedge rubber outboard of the flare in the inter-belt rubber to a thicker gauge (under the edge of the 2nd (top) belt). Care should be taken to excise only the belt wedge compound, as tires occasionally have a belt



wedge compound that differs from the skim coat.

- Tread rubber sample: Samples shall be taken from the tread rubber above the edge of the 2nd (top) belt at the innermost depth of the tread rubber compound (above any skim, under-tread, or cap-ply layers). The sample is excised from under a tread block (not in a void or groove).



Measure total crosslink density on samples swollen to equilibrium in toluene after 24 hours. If Coefficient Of Variation (COV) between 5 replicates is above 4%, remove outlier and recalculate. Repeat if COV is above 4% for 4 samples. If COV is above 4% for 3 samples, repeat test. Results shall be reported as mol/cc³ using the Flory-Rehner equation.

Data Units: mol/cc³

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average (adjusted per COV) total crosslink density

**Picture sampled from Summary Root Cause Analysis Bridgestone/Firestone, Inc., Slide 1*

Item 24 – Crosslink Density Distribution (S1-S8)

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Five (5) repeated measurements in each sample region.

Sample Regions: Skim Rubber 0° SS, Skim Rubber 180° OSS, Wedge Rubber 0° SS, Wedge Rubber 180° OSS, Tread Rubber 0° SS, Tread Rubber 180° OSS.

Specifications: General - Section tire into appropriate test specimens (see Item 23 for sample region description). Measure crosslink density distribution (S1-S8) in six (6) regions, with five (5) repeated measurements on a sample taken from each region.

Test Procedure Adapted from Akron Rubber Development Lab (ARDL) Procedure:

1. **SCOPE:** This work instruction covers the necessary steps to measure the crosslink density and percent S1-S8 of a vulcanized rubber specimen.

2. **PURPOSE:** This procedure describes the testing procedure and the calculation procedure to measure the crosslink density of a sample.
3. **EQUIPMENT:** Chemical solvents A (37.6 ml of propane-2-thio and 39.5 ml of piperidine to toluene diluted with 1 liter of toluene.), solvent B (118 ml of hexane-1-thio to piperidine and diluted with 1 liter of piperidine), Toluene, precision scale.
4. **PROCEDURE:**
 - 4.1. A new sample is treated with the Toluene solution to produce a swollen rubber network.
 - 4.2. The density of unswollen and swollen network yields q , the swelling ratio.
 - 4.3. Using the correct interaction parameter x_1 and the molar volume of the solvent V_1 , we go to step 4.4
 - 4.4. Use the Flory-Rehner's equation $V_e = (0.5-x_1) / (V_1) / (q^{5/3})$ to calculate total crosslink density.
 - 4.5. Repeat procedure 4.1 through 4.4 on a new sample using a solution of solvent A. The solvent A solution will cleave only the poly-sulfidics from the rubber sample to yield the crosslink density of the remaining mono and di-sulfidics.
 - 4.6. Repeat procedure 4.1 through 4.4 on a new sample using a solution of solvent B. The solvent B solution will cleave both the poly-sulfidics and di-sulfidics to yield the crosslink density of the remaining mono-sulfidics.
 - 4.7. Calculate the % poly-sulfidics, di-sulphidics, and mono-sulphidics based on the numbers obtained from 4.1 through 4.3

If Coefficient Of Variation (COV) between 5 replicates is above 4%, remove outlier and recalculate. Repeat if COV is above 4% for 4 samples. If COV is above 4% for 3 samples, repeat test.

Data Units: mol/cc³, %

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average swelling ratio (q)
- 5 raw & 1 average total crosslink density with Toluene
- 5 raw & 1 average S1 crosslink density
- 5 raw & 1 average S2 crosslink density
- 5 raw & 1 average S8 crosslink density
- 5 raw & 1 average % Monosulfidic crosslinks
- 5 raw & 1 average % Disulfidic crosslinks
- 5 raw & 1 average % Polysulfidic crosslinks
- 5 raw & 1 average total crosslink density from sum of S1-S8 components

Item 25 – Fixed Oxygen by Weight

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Five (5) repeated measurements in each sample region.

Sample Regions: Skim Rubber 0° SS, Skim Rubber 180° OSS, Wedge Rubber 0° SS, Wedge Rubber 180° OSS, Tread Rubber 0° SS, Tread Rubber 180° OSS.

Specifications: General - Section tire into appropriate test specimens. Measure percent oxygen by weight of skim, wedge, and tread rubber (see Item 23 for sample region descriptions). Once the sample is removed, care shall be taken that sample is placed in an inert atmosphere so that further oxidation does not occur. If Coefficient Of Variation (COV) between 5 replicates is above 4%, remove outlier and recalculate. Repeat if COV is above 4% for 4 samples. If COV is above 4% for 3 samples, repeat test. Results shall be reported as percent oxygen by weight.

Data Units: %O₂ by weight

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average percent oxygen by weight

Item 26 – Tensile Properties per ASTM D 412-98a(2002)€1

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, data report, and sample & data storage.

Labor Costs: Included in the price.

Predecessors: Inspection and shearography for used tires.

GFE: New and used tires.

Replicates: Five repeated measurements in each sample region.

Sample Regions: Skim Rubber 0° SS, Skim Rubber 180° OSS, Wedge Rubber 0° SS, Wedge Rubber 180° OSS

Specifications: General - Section tire into appropriate test specimens. Perform tensile & elongation measurements of the skim and wedge material per D 412-98a(2002)^{€1} *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension*.

Under D412, certain test parameters require additional specifications:

- Samples of at least 100 mm (4 in) in length and 25 mm (1 in) in width shall be removed from the skim and wedge rubber (see Item 23 for sample region details) for each test. Samples shall be buffed to uniform thickness of 0.5 to 1.0 mm (0.02 to 0.04"). Care must be taken to minimize heat generation during buffing.
- Since the test specimen sizes available in D 412 are too large for tire sample purposes, specimens shall be die-cut using an ASTM D 638-02a Type V dumbbell die (see following photo):



- Test shall be conducted per D 412-98a(2002)^{e1}, Section 9.1 environmental conditions: $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being at conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test.
- The rate of jaw separation is 500 ± 50 mm/min (20 ± 2 in/min).
- The 5 samples from each area shall be evaluated and 1 or 2 outliers may be removed. If less than 3 good samples remain, test must be repeated.
- Record the modulus in MPa @ 50%, 100%, 200%, 300%; ultimate elongation and tensile strength, and provide the raw data curves.

Data Units: MPa, mol/cc³, °C, %

Deliverables:

For each tensile test, provide the raw data curves. From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average modulus at 50%
- 5 raw & 1 average modulus at 100%
- 5 raw & 1 average modulus at 200%
- 5 raw & 1 average modulus at 300%
- 5 raw & 1 average tensile strength
- 5 raw & 1 average ultimate elongation
- Temperature and relative humidity for each test

Item 27 – Shore A Hardness per ASTM D2240-02b

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Five (5) repeated measurements in each sample region.

Sample Regions: Innerliner 0° SS, Innerliner 180° SS, wedge rubber 0° SS, wedge rubber 180° SS.

Specifications: Section tire into appropriate test specimens. Measure tire innerliner hardness at the centerline of the crown. Wedge rubber samples shall be per Item 23 sample descriptions. Measure inner liner and wedge rubber hardness using the Shore A scale per D2240-02b *Standard Test Method for Rubber Property—Durometer Hardness*. Measurements shall be conducted per Section 9.1.8 or 9.2.5 (Five determinations of hardness at least 6.0mm (0.24 in) apart). Test shall be conducted under the following environmental conditions: $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test. Report raw and average values.

Data Units: Shore A Hardness #.

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average shore hardness numbers

Item 28 – Micro Hardness per ASTM 1415-88 (Reapproved 1999)

Pricing: Price is per tire. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Five (5) repeated measurements in each sample region.

Sample Regions: Skim Rubber 0° SS, Skim Rubber 180° OSS

Specifications: Section tire into appropriate test specimens per Item 23. Measure skim rubber micro hardness per 1415-88 (99) *Standard Test Method for Rubber Property—International Hardness*. Test specimens shall be per Section 6.3 *Micro Tester*. Test shall be conducted under the following environmental conditions: $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test. Report raw and average values.

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- 5 raw & 1 average micro hardness numbers

Item 29 – Indentation Modulus Profiling

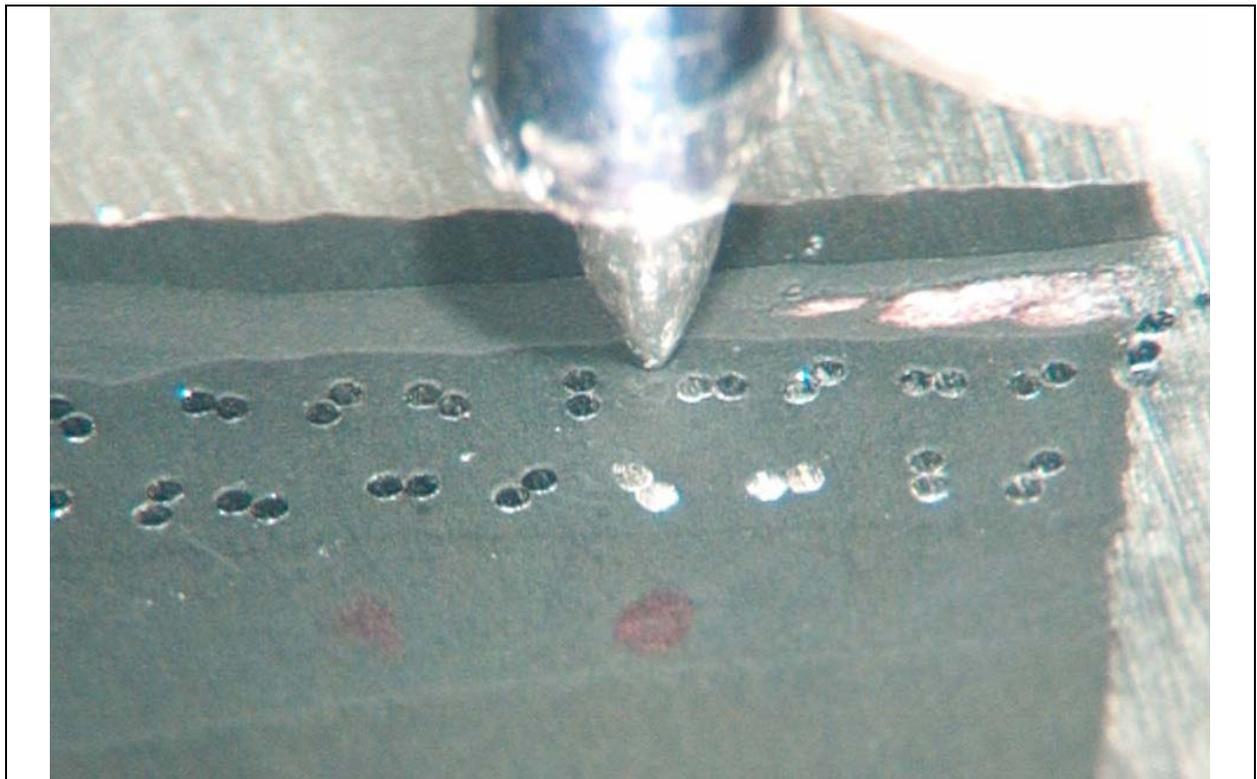
Pricing: Price is per tire per sample region, either shoulder or bead region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: One (1) complete radial scan per sample region.

Sample Regions: Specified by COTR in task order.



Specifications: Section tire into appropriate test specimens. A nano-indenter in accordance with the methodology contained in RC&T, 74, No.3, pp. 428ff (2001) shall be utilized to acquire indentation modulus measurements of the rubber components in 0.1mm increments from interior to exterior surfaces (innerliner to tread surface of the sample). Test specimens shall be prepared with minimal heat input in an embedment medium suitable for grinding/polishing in order to obtain a flat surface for measurement. A single radial scan shall performed on each specimen. Test shall be conducted under the following environmental conditions: $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test. Data shall be submitted to the Government in a MS Excel format.

Deliverables: A chart containing the modulus profile trace with accompanying data in a MS

Excel format.

Item 30 – Roadwheel Time ≤ 120 km/h (75 mph), per ASTM F 551-89

Pricing: Quotes for road wheel testing may be quoted in two (2) forms: hourly use/yearly rental

- Per tire-hour of road wheel time. Fractional hours may be prorated.
- Per year rental of a road wheel. The per year quote shall be on the basis that the road wheel is available for NHTSA testing at least 80 percent of time (i.e., at least 7,000 hours per year). Price reductions, in the event that the 80 percent availability goal cannot be met should be clearly indicated in the yearly rental quotation.

All prices quoted for road wheel tests shall include all costs of operating and maintaining the road wheel. Tire mounting and inflation with air or enriched inflation mixtures will be charged separately.

Labor Costs: Labor for general road wheel testing is included in the hourly price. The yearly rental price should indicate if labor will be charged separately.

GFE: New and used tires, new wheels.

Specifications: General – Test tires on a tire dynamometer per ASTM F 551-89(2000) *Standard Practice for Using a 67.23-in. (1.707-m) Diameter Laboratory Test Roadwheel in Testing Tires.*

All tests shall be performed according to standard commercial tire road wheel testing practice. The following test parameters will be provided to the contractor when tests are ordered:

- Mark the direction of rotation on the test tires
- Tire Inflation Pressure – an initial cold inflation pressure will be specified by the COTR in writing for each test. Dynamic pressure regulation is not required.
- Tire Load – will be specified by the COTR in writing for each test, but will not exceed the 200% of passenger car or LT tire rated loads (no medium or heavy truck tires).
- Test Speed – will be specified by the COTR in writing for each test, but will not exceed 120 km/h (75 mph) for any test.
- Duration – will be specified by the COTR in writing for each test.

Deliverables: Tire road wheel testing per task order specifications.

Item 31 – Roadwheel Time ≤ 120 km/h (75 mph), Dynamic Press. Maintenance

Same specifications as Item 30, but with dynamic tire pressure maintenance (rotary air union).

Item 32 – Oven Aging, Contractor’s Ovens

Pricing: Quotes for oven aging time shall be quoted in two forms: hourly use/yearly rental

- Per tire-hour of oven aging. Fractional hours may be prorated.
- Per year rental of an oven . The per year quote shall be on the basis that the oven is available

for NHTSA use at least 80 percent of time (i.e., at least 7,000 hours per year). Price reductions, in the event that the 80 percent availability goal cannot be met should be clearly indicated in the yearly rental quotation.

Prices quoted for tire oven aging shall include all costs of operating and maintaining the oven.

Tire mounting and inflation with air or enriched inflation mixtures will be charged separately.

Labor Costs: Labor for general oven aging is included in the price. The yearly rental price should indicate if labor will be charged separately.

GFE: New and used tires, new wheels.

Specifications: General – Tire oven aging under task order specified conditions.

- Oven Temperature – $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($158^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) unless otherwise specified in the task order.
- Tire Inflation Pressure – an initial cold inflation pressure will be specified by the COTR in writing for each test. Dynamic pressure regulation is not required.
- Duration – will be specified by the COTR in writing for each test.

Deliverables: Tire oven aging per task order specifications.

Item 33 – Oven Aging, Government’s Ovens

Pricing: Quotes for oven aging time shall be quoted in two forms: hourly use/year use

- Per tire-hour of oven aging. Fractional hours may be prorated.
- Per year operation of aging oven.

All prices quoted for oven aging shall include all costs of operating ovens, including energy costs, in a safe in-door test space.

Tire mounting and inflation with air or enriched inflation mixtures will be charged separately.

GFE (ovens) will be shipped to and from the contractor’s location, and installed and uninstalled by VRTC at no cost to the contractor. The VRTC will be responsible for the preventative maintenance, calibration, and repair of the ovens.

The contractor will be responsible for the correct operation and day-to-day maintenance of the GFE while in its possession. The government will be responsible for shipping the GFE back to VRTC at no cost to the contractor.

Labor Costs: Labor for general oven aging is included in the price. The yearly operation price should indicate if any labor will be charged separately.

GFE: New and used tires, new wheels, ovens.

Specifications: General – Tire oven aging under task order specified conditions.

- Oven Details (total of two ovens available):
 - o Thermcraft Oven:
 - Model 48-48-60-REC-0V, Serial # 83439
 - 480 V, 3 phase, 24000 watts, 29 amps (oven)
 - Controller – Model 1Z3-480-50, Serial # 84080-C
 - Interior dimensions – 4' wide, 4' deep, 5' tall (80 ft³)
 - Exterior dimensions – 7' wide, 5'3" deep, 8'4" tall
 - o GS Blue M Electric Oven:
 - Model 806 Batch Oven, Serial #15X-402-90
 - 480V, 3 phase, 52 amps (oven), 60 Hz
 - Interior dimensions – 4' wide, 4' deep, 5' tall (80 ft³)
 - Exterior dimensions – 7'9" wide, 5'2" deep, 7'10" tall
- Oven Test Temperature – 70°C ± 2°C (158°F ± 3.6°F) unless otherwise specified in the task order.
- Tire Inflation Pressure – an initial cold inflation pressure will be specified by the COTR in writing for each test. Dynamic pressure regulation is not required.
- Duration – will be specified by the COTR in writing for each test.

Deliverables: Tire oven use per task order specifications.

Item 34 – Analysis of Innerliner Compound by FTIR

Pricing: Price is per analysis. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New tires.

Replicates: One (1) measurement per tire.

Sample Regions: Innerliner 0° SS.

Specifications: Section tire into appropriate test specimens. Identify innerliner compound polymer composition by pyrolysis Fourier Transform InfraRed (FTIR) technique in accordance with ASTM D 367700, *Standard Test Methods for Rubber – Identification by Infrared Spectrophotometry*. The vendor shall estimate the relative percentage of the polymer composition based on control curves run at vendor's expense.

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- Innerliner polymer type
- % Halo-butyl rubber
- % Natural rubber
- % other rubber polymer (specify polymer)

The vendor shall retain and shall archive copies of sample spectra and reference spectra in pdf

format and shall provide them to the Government upon request.

Item 35 – Inflation Gas Oxygen Concentration

Pricing: Price is per measurement.

Labor Costs: Included in the price.

GFE: New and used tires, new wheels.

Replicates: One (1) measurement per tire.

Sample Regions: Tire inflation gas.

Specifications: Non-dynamic, pre or post-test; measure the percent oxygen concentration in the tire's inflation gas mixture with a gas analyzer accurate to within $\pm 0.1\%$.

Data Units: %

Deliverables: Percent oxygen concentration in tire inflation mixture in an MS Excel format.

Item 36 – Tire Aging Simulations with Finite Element Software

Pricing: Price is per simulation per region.

Labor Costs: Included in the price.

Sample Regions: Specified by COTR in the task order.

Specifications: Use tire component temperatures, gauges (see **Item 14 – Microscopy**), oxygen partial pressures (inside tire and outside tire), effect of partial pressure on oxygen consumption rate, density, diffusion limited oxygen rates, and known polymer properties to simulate the effects of different aging tests on the tire by finite element simulation. Simulations should attempt to quantify changes in the modulus, crosslink density, and fixed oxygen for the sample region. Methodology should follow that described in Tire Technology International, Annual Review, 46 (2001). Vendor shall provide diffusion parameters, solubility constants and other necessary measures in order to quantify the simulation constituents. Controls shall be run as necessary in order to obtain FEA convergent models.

Deliverables: A finite element simulation of tire aging per specified conditions. Simulations should quantify oxygen consumption rate with about 0.2 mm resolution performed at specified location along with input parameters. A chart containing the oxygen consumption rate profile with accompanying data in a MS Excel format.

Item 37 – Micro Demattia

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Eight (8) repeated measurements per sample region.



Sample Regions: Specified by COTR in the task order.

Specifications: Prepare the necessary test samples to conduct Demattia rate of crack growth testing. Use a test machine scaled down from the ASTM specifications D813-95(2000) *Standard Test Method for Rubber Deterioration-Crack Growth* and ASTM D430-95(2000) *Standard Test Methods for Rubber Deterioration-Dynamic Fatigue* to give less variation in testing. This is otherwise referred to as “Micro Demattia” testing.

Data Units: Rate of crack growth in SI units.

Deliverables: Eight (8) rates of crack growth and one (1) average rate of crack growth for each region tested.

Item 38 – Torsional Test on Belt Ply

Pricing: Price is test. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

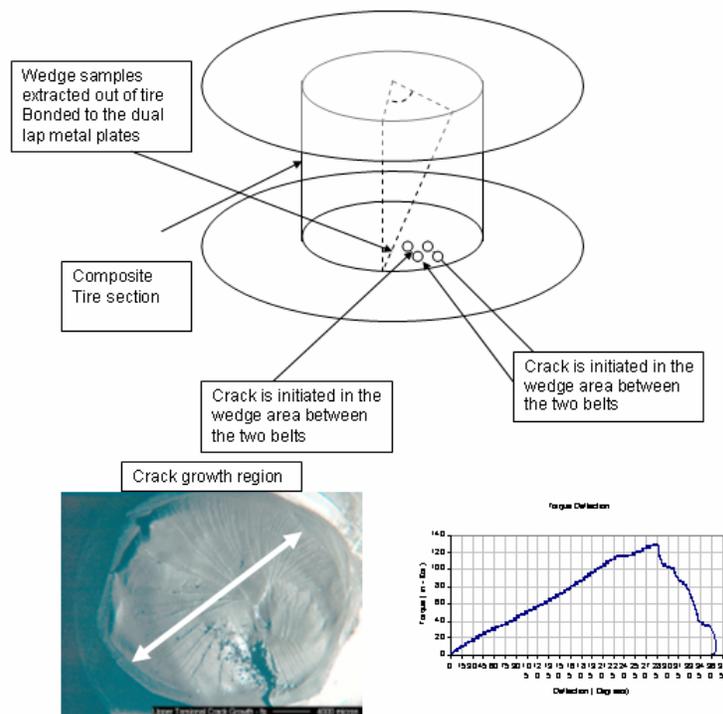
Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Three (3) repeated measurements.

Sample Regions: Wedge region - 0°, 120°, 240°.

Specifications: Prepare the necessary test samples to conduct a torsional belt ply test to failure. The torsional test is conducted on the entire tire composite structure by bonding the 1-inch diameter section, cut through the wedge region, and obtaining the torque versus the deflection curve till the precut crack introduced circumferentially grows to fail the sample through the wedge after propagating through the wedge. In this method the actual torque and its effect on the crack growth in the wedge transmitted through the composite for different tires can be evaluated.



Data Units: N-m, mm.

Deliverables: Three (3) raw and one (1) average set of torsion and deflection curves.

Item 39 – DMA: Dynamic Testing, Micro Dumbbell Samples per ASTM D5992-96(2001)e1

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Three (3) repeated measurements.

Sample Regions: Specified by COTR in task order.

Specifications: Dynamic material properties are evaluated at fixed strains % of 5, 10, 15, and 20% in tension for 4 frequencies of 5, 10, 15, 20 Hz and 4 temperatures of 70, 80, 90, and 100°C.

Data Units: Tan delta, MPa

Deliverables: Three (3) raw and one (1) average tan delta and dynamic modulus at 5, 10, 15, and 20% in tension for 4 frequencies of 5, 10, 15, 20 Hz and 4 temperatures of 70, 80, 90, and 100°C for a sample region.

Item 40 – Two-ply Laminate Fatigue Test

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Predecessors: Inspection and shearography for used tires.

Replicates: Three (3) repeated measurements per region.

Sample Regions: Specified by COTR in task order.

Specifications: Section tire into appropriate test specimens. Measure fatigue life in number of cycles to failure by cycling under load control at specified minimum and maximum load at a specified temperature. For used tires, the contractor shall use previously conducted tire shearography images to locate two regions approximately 120 degrees from one another around the circumference of the tire that are not damaged or separated. For new tires, the first region shall be located at the DOT number (0°), with the second region located 120 degrees around the circumference of the tire (120°). The third region located 240 degrees around the circumference of the tire (240°). Prepare the sample according to the following guidelines:

- Cut one (10") wide circumferential section from each location.
- Cut (2½") wide circumferential section from the sample region.
- Buff tread flat on each section.
- Buff edge of sample until smooth, minimizing heat generation.
- Score the sides of each specimen at a point midway between the belts to a depth of 3.175 mm (1/8"). The scoring will extend from the end of the gripping surface to the other end of the gripping surface.
- Place in test equipment with 6" separation between jaws.
- Testing is conducted by fatigue to failure under cyclic deformation MTS servo-hydraulic instrument. Three loading conditions will be used, designed to reflect tire unload and load conditions (see Interlaminar Shear Test)
- Test shall be conducted under the following environmental conditions: $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and a relative humidity of $50 \pm 5\%$, with the specimens being conditioned at these conditions for a minimum of 24 hrs. The temperature and relative humidity shall be recorded for each test.

Data Units: Number of cycles to failure as a function of load expressed in Mpa.

Deliverables: From the measurements, provide the following data for a sample region in an MS Excel format:

- Number of cycles to failure as a function of loading conditions expressed in Mpa.
- Temperature and relative humidity reading per test.

Item 41 – Bulk Modulus of Belt Edge: Hopkinson Bar Testing

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Five (5) repeated measurements per region.

Sample Regions: Specified by COTR in task order.

Specifications: Measure bulk modulus versus strain rate with the Hopkinson Bar test of 2-3 mm thick and ½" diameter buttons excised from the specified sample region.

Data Units: GPa

Deliverables: Table of bulk modulus and strain rates for a sample region.

Item 42 – Pure Shear Crack Growth Test

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Three (3) repeated measurements per region.

Sample Regions: Specified by COTR in task order.

Specifications: Skim region extracted and buffed on both sides to give parallel and uniform surface. Dynamic cycling is performed and the coordinates of the tip of the crack continuously monitored.

Data Units: Rate of crack growth, SI units.

Deliverables: Three (3) raw and one (1) average rate of dynamic crack growth for a sample region.

Item 43 – Thermo-Gravimetric Analysis (TGA) for % Carbon Black & % Ash

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Three (3) repeated measurements per sample region.

Sample Region(s): Specified by COTR in task order.

Specifications: Excise test samples and perform a Thermo-Gravimetric Analysis (TGA) to determine % carbon black and % ash content per ASTM E1131-98 *Standard Test Method for Compositional Analysis by Thermogravimetry*.

Data Units: %

Deliverables: Three (3) raw and one (1) average % carbon black & % ash numbers for a sample region.

Item 44 – Interlaminar Shear Test

Pricing: Price is per sample region. Price includes all costs associated with the service, including test sample preparation, repeated measurements, data report, and sample & data storage.

Labor Costs: Included in the price.

GFE: New and used tires.

Replicates: Four (4) repeated measurements per sample region.

Specifications:

- Tire is notched at four locations to expose the rubber between bets at the edge of the belt #2.
- A vertical (radial position) mark is made.
- The tire is inflated. The positions of the marks are measured.
- The tire is loaded and the position of the notch is measured under static (unloaded) and loaded conditions.
- Calculate strain energy density at unload and strain energy density at maximum rated load. Calculate R-ratio, ratio of minimum strain (unloaded conditions) to maximum strain (at maximum rated load). To calculate strain energy density and R-ratio, produce a stress/strain curve (generated by tensile test).
- Note – same testing can be used for an underinflated tire, if specified.

Data Units: MPa

Deliverables: From the measurements, provide the following data points for each sample region in an MS Excel format:

- Interlaminar shear strain, strain energy density, and R-ratio as a function of load expressed in Mpa
- Temperature and relative humidity reading per test

Item 45 – Labor, Program Manager

Pricing: Price is per hour. Provide both regular and overtime rates.

Specifications: Loaded hourly regular and overtime labor rates for a program manager.

Deliverables: One hour of program manager labor.

Item 46 – Labor, Project Engineer

Pricing: Price is per hour. Provide both regular and overtime rates.

Specifications: Loaded hourly regular and overtime labor rates for a project engineer.

Deliverables: One hour of project engineer labor.

Item 47 – Labor, Instrumentation Engineer / Technician

Pricing: Price is per hour. Provide both regular and overtime rates.

Specifications: Loaded hourly regular and overtime labor rates for an instrumentation engineer/technician.

Deliverables: One hour of instrumentation engineer/technician labor.

Item 48 – Labor, Test Equipment Operator

Pricing: Price is per hour. Provide both regular and overtime rates.

Specifications: Loaded hourly regular and overtime labor rates for a test equipment operator.

Deliverables: One hour of test equipment operator labor.

Item 49 – Labor, Administrative Assistant

Pricing: Price is per hour. Provide both regular and overtime rates.

Specifications: Loaded hourly regular and overtime labor rates for an administrative assistant.

Deliverables: One hour of administrative assistant labor.

Item 50 – Metal Valve Stem Surcharge

Item 51 – High Speed Surcharge on Item 30

Item 52 – Bundle of Items 14, 20, 23, 25, 26, 27 and 28

Item 53 – Bundle of Items 17 and 18