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Terminology Used for Forensic Footwear and Tire Evidence

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Foreword

This document is a compilation of terms commonly used in footwear and tire examination. It was compiled from texts and publications used as common references in the field of forensic footwear and tire examination. Examiners should be familiar with these common terms and utilize them in notes, worksheets and reports. By using common terminology, the discipline will limit confusion and improve communication amongst examiners and when expressing findings to law enforcement, courts and juries.

This document was proposed by the Footwear and Tire Terminology Task Group, formed by the Footwear and Tire Examination Scientific Area Committee of the Organization of Scientific Area Committees.

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Terminology Used for Forensic Footwear and Tire Evidence

1 Scope

This technical report is targeted for forensic science professionals actively engaged in the discipline of footwear and tire examination. It is not intended to define every term potentially applicable to forensic footwear and tire evidence, but define commonly used terms in the discipline.

2 Normative References

There are no normative reference documents, Annex B, Bibliography, contains informative references.

3 Terms and Definitions

3.1
abrasion
Wearing away rubber from tires by friction due to high speed, locked wheel braking. Abrasion will be at right angles to the direction of travel, also on shoulder and sidewall.

3.2
accidental characteristic
See **randomly acquired characteristic**.

3.3
adhesive lifter
Any material coated with a tacky substance for the purpose of lifting impressions.

3.4
air bubble
A globule of air trapped within a solid material such as a footwear outsole.

3.5
alternate light source
Equipment used to produce light (or to restrict light) at various wavelengths to enhance or visualize potential items of evidence.

3.6
aspect ratio
The proportion of the tire's height to its width.

3.7
asymmetric tread design
A tire tread pattern divided circumferentially, such that one half of the tread design is not a mirror image of the other half.

3.8
bead
A hoop of steel wires within a tire that hold the tire on the rim.

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3.9
bias tire
A tire that has plies which cross over one another at an angle.

3.10
bias-belted tire
A bias tire with added reinforced belts that lie beneath the tread.

3.11
BIO-FOAM®
A commercial product comprised of collapsible foam developed for recording of three-dimensional anatomical impressions of the feet, but also used for the recording of footwear outsoles.

3.12
biscuit
Pre-formed or extruded pieces of soling compound that are placed in molds and pressed into the shape of a footwear outsole or heel.

3.13
blade
Thin pieces of metal in footwear and tire molds that result in molded sipes.

3.14
blocker
An oversized outsole made of one or more components that is later cut to size.

3.15
blunt force pattern injury
An injury to the skin by an object resulting in a pattern that may replicate the design of the object. (Also known as a **pattern contusion**.)

3.16
Brannock Device®
A foot-measuring device.

3.17
CAD/CAM
Computer Aided Design/ Computer Aided Manufacturing
Computer systems used to design and manufacture footwear and tires.

3.18
calendering
A process where raw rubber passes between a series of large steel rollers. The final roller impresses the outsole design into the rubber that is later cut into soles. Rollers are also used to help prepare raw rubber for the production of rubber biscuits for the compression molding process.

3.19
carcass
The portion of the tire that includes the liner, plies, belts, and beads which forms the foundation for the tread and sidewall.

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3.20
cast
A method of preserving and recovering an impression utilizing an appropriate casting material.

3.21
casting material
Dental stone, snow print powder, sulfur, or other suitable materials specifically used to accurately recover three-dimensional impressions. Some casting materials are also successful for lifting two-dimensional impressions.

3.22
center rib
A row of continuous rubber or disconnected tire tread blocks around the circumference of a tire and is evenly centered within the tire tread design.

3.23
chart board
A solid laminated board with a covering of white paper on at least one side (not foam core board) used to provide a firm and smooth backing when obtaining known tire impressions.

3.24
chemical etching
A process wherein a textured pattern is applied to selective areas of a mold surface. The mold is later dipped in an acid bath that etches the pattern into the mold. The details within a chemically etched pattern are specific to an original mold.

3.25
class characteristic
A feature shared by two or more items of footwear or tires. The footwear outsole or tire tread design and the physical size features of a footwear outsole or tire tread are two common manufactured class characteristics. General wear of the outsole or tire tread is also a class characteristic. Class characteristics establish membership within a specific group.

3.26
clicker
A hydraulic machine that forces a steel die through outsole and/or midsole materials in a cookie-cutter fashion.

3.27
coaxial light
Illumination from the precise direction of the imaging lens (e.g. either through the lens or with a beam-splitter in front of the lens).

3.28
compression molding
A method for making footwear outsoles and tires where the material is placed into an open mold, which is then closed and subjected to heat, time, and pressure.

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3.29
cord
Fabrics placed under tension and covered with rubber. Used to form the plies of the tire.

3.30
correspond
Agreement of observed characteristics between two objects.

3.31
degree of wear
The extent to which the design of a footwear outsole or tire tread has been changed due to erosion.

3.32
dental stone
A generic gypsum product generally having a strength rating of 8,000 psi or higher, commonly used to cast footwear and tire impressions.

3.33
design
The manufactured pattern of a footwear outsole or tire tread. Design is a class characteristic.

3.34
design/size relationship
The tendency for a footwear outsole or tire tread design to have either more design elements, or larger design elements, or both, as the footwear or tire size increases throughout the size range produced.

3.35
die cut
Outsoles or other footwear components produced by forcing a sharpened steel die through pre-formed outsole material with the assistance of a clicker machine.

3.36
direct attach
A manufacturing process where the upper of the footwear is joined to the midsole or outsole material.

3.37
directional tread design
A tire tread pattern that is designed or intended to rotate in one direction only.

3.38
dissimilarity
A feature in an impression having the appearance of potentially originating from a different shoe or tire but lacking sufficient detail for confirmation.

3.39
distortion
An unclear or inaccurate representation of the footwear or tire in an impression due to interference in the impression-making process or its subsequent retrieval

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3.40
DOT number
Department of Transportation serial number assigned to every tire sold in the United States which gives information regarding the manufacturer, size, and date of manufacture of the tire.

3.41
dry casting
A method utilizing the layering of dry dental stone powder and misted water.

3.42
dry origin impression
An impression formed when the substrate, materials being transferred, and the outsole or tire tread are dry (e.g. footwear impressions in dust).

3.43
dual tire assembly
A pair of tires mounted side-by-side on a fixed wheel assembly.

3.44
electrical discharge machine
EDM
A machine which uses electrical discharges to produce a desired design in a footwear or tire mold.

3.45
electrostatic detection apparatus
ESDA®
electrostatic detection device
An instrument used to visualize paper fiber disturbances (e.g. indentations, erasures, typewritten material/lift off, footwear and tire impressions).

3.46
electrostatic lifting
The process of using an electrostatic charge to transfer dry origin impressions from the substrate to a film.

3.47
element
A single geometric component of a footwear outsole or tire tread design.

3.48
elimination impressions, photographs, and/or items
Footwear or tires, or recordings of footwear outsoles or tire treads, from sources such as police officers, paramedics and their vehicles for the purpose of comparing to the questioned crime scene impressions.

3.49
enhancement
Improving the visibility of an impression through physical, photographic, digital, optical, or chemical means.

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3.50
ethylene vinyl acetate
EVA
A soling compound often produced in an expanded form.

3.51
examination quality photograph
A photograph that contains sufficient quality of information for the purpose of conducting a forensic footwear and tire examination.

3.52
exclusion
This is the highest degree of non-association between a questioned impression and known source based on sufficient differences observed during the comparison of class and/or randomly acquired characteristics between the questioned impression and the known footwear or tire. In the opinion of the examiner the particular known footwear or tire was not the source of and did not make the impression.

3.53
exemplar
An item of known origin used in footwear and tire examinations.

3.54
explainable differences
Variations in appearance that can be attributed to factors such as distortion, movement and pressure. These differences do not result in an exclusion decision.

3.55
feathering (tires)
Wear pattern where tire tread ribs are worn lower/smoother on one side and higher/sharper on the other side.

3.56
fixative
A process or reagent that helps secure the blood to the substrate or secures the substrate itself (e.g. snow, sand, etc.) so that it is not destroyed or degraded during chemical enhancement.

3.57
flash
flashing
Excess material from the molding process.

3.58
footwear
Any apparel worn on the foot, such as shoes, boots, sandals, etc.

3.59
forensic light source
A filtered light source that may be fixed or tunable to a variety of spectral ranges.

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3.60
foxing
foxing strip
A strip of rubber wrapped around the lower part of some footwear to cover the gap or seam between the upper and the outsole.

3.61
full impression
An impression that represents all, or nearly all, of the heel to toe portions of the outsole or the full width and circumference of the tire.

3.62
gelatin lifter
A commercial product with gelatin applied to a pliable backing used to lift impressions.

3.63
general outsole design
A general category of footwear outsole patterns (e.g. herringbone pattern, lugged outsole pattern, wave pattern, and plain soles).

3.64
general wear
The condition (degree and position of wear) of the overall footwear outsole or tire tread, ranging from new to extremely worn, related to its degree of use. General wear is a class characteristic that may be used to include or exclude footwear or tires.

3.65
grooves
The space or channels that separate the tire tread ribs and elements. Circumferential grooves run around the circumference of the tire. Transverse or lateral grooves, also known as slots, run across the tire tread design.

3.66
holes
The result of erosion of a footwear outsole or tire tread that is so extreme that it results in removal of the outer layers of the outsole or tread materials, often resulting in irregular edges. These irregular edges are randomly acquired characteristics. Random holes due to punctures are also randomly acquired characteristics.

3.67
Identicator®
An inkless method of recording footwear impressions on white chemically treated paper.

3.68
identification
The highest degree of association assigned to a questioned impression and known source based on the agreement of class and randomly acquired characteristics when there is sufficient quality and quantity of information.

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3.69
identifying characteristics
See **randomly acquired characteristics**.

3.70
impression
The product of direct or indirect physical contact between item(s) such as footwear or tire resulting in the transfer and retention of characteristics of that item.

3.71
injection molding
A manufacturing method where the outsole and/or midsole is made by forcing material into a closed mold. Outsoles can be molded individually as unit soles or directly onto the footwear upper as direct attach outsoles.

3.72
insole
A cushioned liner that occupies the inner surface of an item of footwear where the foot rests and is placed there for comfort or protection. The insole may or may not be removable.

3.73
known impression
See **test impression**.

3.74
known footwear or tire
An item of footwear or a tire of documented origin that is compared to a questioned footwear or tire impression.

3.75
label (manufacturer's sizing label)
A label placed on the tongue or other inside surface of the footwear that contains information including but not limited to the manufacturer's name, shoe size, country of manufacturer, style number, dating information, barcodes, etc.

3.76
lacks sufficient detail
Observation of features which do not allow the examination of certain class or randomly acquired characteristics.

3.77
latent impression
An impression not readily visible to the naked eye.

3.78
last
A form made of wood, metal, or synthetic material that approximates the size and shape of a foot. The upper of the footwear is stretched over the last and held in a specific shape and size throughout the manufacturing process. The size on the manufacturer's label is directly related to the size of the last.

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3.79
lift
An adhesive or other medium used to capture and preserve an impression.

3.80
liner
A thin layer of butyl rubber compound that holds the air inside the tire.

3.81
logo
A name, design, or pattern that is the trademark of the manufacturer that may appear on the footwear upper or on the outsole.

3.82
low profile
A term describing a tire that has a low aspect ratio, thus a short sidewall.

3.83
manufacturing defect
Unintended damage, defects or flaws in the footwear outsole or tire tread that occurs during manufacturing, which depending on their cause, could result in class or randomly acquired characteristics.

3.84
manufacturing variable
Features that occur during the manufacturing process that do not appear on all of the footwear/tires but may appear on more than one. Examples would be the precise positioning of foxing strips, the precise cutting of die cut or Wellman cut soles, the positioning of stitching that is added to the bottom of some soles, or a bent sipe blade in a tire mold, etc.

3.85
meaningful difference
A characteristic which demonstrates the particular known footwear or tire was not the source of the impression.

3.86
Mikrosil™
Silicone casting material used to lift footwear impressions that have been treated with fingerprint powder.

3.87
midsole
A component positioned between the upper and the outsole on some footwear to provide cushioning and support.

3.88
mold
A metal cavity containing a footwear outsole or tire tread design used to produce footwear or tires.

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3.89
mold characteristic
Those design and size features of a particular mold.

3.90
mold cure
Term used by tire manufacturers to describe the vulcanization of a tire in the molding process.

3.91
mold parting line
The dividing line between two halves of a shell mold, or between the segments of a segmented mold.

3.92
natural crepe rubber
A crude form of coagulated natural rubber having a crinkled or knobby texture.

3.93
natural rubber
A natural product derived from latex tapped from rubber trees.

3.94
negative impression
An impression that has resulted from the removal of a substance from a substrate by a footwear outsole or tire tread.

3.95
noise treatment
The mixed arrangement of tread block sizes used by the tire industry to reduce noise generated by tires.

3.96
notches
Small void areas that extend off of grooves or slots of a tire design but don't fully cross the rib or tread block.

3.97
oblique lighting
Illumination from a light source that is at a low angle of incidence, or even parallel, to the surface of the item. (Also known as **side lighting**.)

3.98
offset
The distance from the wheel's centerline to the wheel's mounting surface. Offset is measured as positive or negative.

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3.99
open pour molding
The manufacturing process for the outsoles in which the polyurethane (PU) is poured directly into the mold cavity. Single unit soles are made by pouring the PU into the mold and allowing the outsole to harden. Direct attached soles can be made utilizing this process. (See **direct attach**.)

3.100
outsole
The bottom portion of the footwear that comes into contact with the substrate.

3.101
outsole design
A specific pattern or arrangement of elements on an outsole typically associated with a manufacturer and having a name and/or style number.

3.102
partial or fragmented impression
An impression that does not represent the entire footwear outsole or tire tread.

3.103
patent impression
An impression visible to the naked eye.

3.104
pattern
See **design**.

3.105
pattern contusion
(See **blunt force pattern injury**)

3.106
physical size
The dimensions, shapes, spacing and relative positions of the footwear outsole design components and tire tread blocks (not the same as the manufacturer's footwear or tire size). Physical size is a class characteristic.

3.107
pitch length
The circumferential length allotted for a single tire tread element, as designated on the blue print drawing for each tire design and size.

3.108
pitch sequence
The full arrangement of pitch lengths around the full circumference of a tire, specific to a certain design and size.

3.109
plane polarized light
Illumination consisting of light rays with a single vibration direction.

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3.110
ply
Rubber-coated parallel cord fabric placed over the liner forming the tire carcass.

3.111
pneumatic tire
A tire filled with air under pressure.

3.112
Polyurethane
PU
A polyester or polyether-based polymer used in both the outsoles and midsoles of footwear.

3.113
Polyvinylsiloxane
Dental casting material formulated to render fine detail.

3.114
polyvinyl chloride
PVC
A thermoplastic polymer used in footwear outsoles.

3.115
position and orientation of wear
The location and direction of an area of erosion on a footwear outsole or tire tread. Examples of location of wear include wear along the medial edge of the footwear outsole and wear along the outer edge of a tire tread. The position and orientation of wear can change as a footwear outsole or tire tread is worn.

3.116
positive impression
See **transfer impression**.

3.117
pressed outsole
An outsole made in the compression mold.

3.118
printer's ink
A highly toned oil-based black ink. Printer's inks that set up in two to four hours are often used in the production of full circumference known tire impressions.

3.119
proficiency test
An exam that tests a person's and/or an organization's ability to meet a certain level of skill in a particular activity, field of study, etc.

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3.120
questioned
An item of unknown source (impression or otherwise).

3.121
radial ply tire
A tire whose plies run from bead to bead at right angles to the centerline of the tread.

3.122
randomly acquired characteristic
A feature on a footwear outsole or tire tread resulting from interaction with an object(s) including, but not limited to: cuts, scratches, tears, holes, stone holds, abrasions and the acquisition of debris. The position, orientation, size and shape of these characteristics differentiate a footwear outsole or tire tread from other footwear outsoles or tire tread with similar class characteristics. Randomly acquired characteristics are essential for an identification of a particular item of footwear or tire as the source of an impression.

3.123
release agent
Any product that prevents substrate material from adhering to the cast.

3.124
residue impression
Formed by the deposition of a substance from the footwear or tire onto another surface.

3.125
retreaded tire
A used tire to which a new tread has been added.

3.126
rib
Row of continuous rubber or disconnected tire tread blocks that run circumferentially around a tire to form the tread pattern, further distinguished as center, intermediate, or shoulder ribs.

3.127
rim diameter
The diameter of the rim that supports the tire bead and is expressed in inches, such as 13”, 16”, 16.5” etc.

3.128
Ritz Stick®
A commercial device for measuring foot length and width.

3.129
roller transport film
A seven-mil Estar film base material designed to wet rollers and pick up loose particles on all types of roller transport photo-processing machines used along with fingerprint powder to produce known impressions of footwear and tires.

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3.130
rolling circumference
The linear distance traveled by a tire in one revolution under load.

3.131
Schallamach pattern
Patterns that develop as ridges on rubber material as a result of repeated abrasive forces. These patterns are highly individual and randomly acquired characteristics. They continue to change rapidly as affected by continued abrasion.

3.132
section height
The distance from the rim to the tread surface of an unloaded tire.

3.133
section width
The distance between the sidewalls of an inflated tire, exclusive of any lettering or designs.

3.134
segmented tire mold
A mold consisting of several segments that open and close around the tire. The sidewall plates are mounted separately.

3.135
shell tire mold
Also known as a two-piece mold, it consists of a top and bottom, each containing a sidewall ring and half of the full-circle tread design.

3.136
shoe perimeter
The outer border or edge of the footwear outsole that defines its overall physical size and shape. Some perimeters may be comprised of a border such as a molded border or a foxing strip.

3.137
shoe size
The size a manufacturer designates for an item of footwear and places on a label in the footwear and/or footwear outsole, and shoe box. There is not a strict dimensional relationship between a manufacturer's shoe size and the length and width of the outsole.

3.138
shoe size grading
The gradual increase or decrease in physical size and content that a manufacturer uses for each half size. In general, each half size will result in an approximate measurement change of 4.2 mm in length of the outsole.

3.139
shoulder
The portion of the tire where the sidewall and tread meet.

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3.140
side-by-side
A comparison method performed by placing objects next to one another.

3.141
sidewall
The portion of the tire between the shoulder and the bead that contains the tire information.

3.142
similar
An observation that an impression shares a general likeness with a known footwear or tire. (Similar should not be confused with correspond.)

3.143
sipes
Thin slits in a footwear outsole or tire tread to create better traction. True sipes in footwear are those that are cut into an outsole during manufacture. True sipes in tire treads are cut in the tread only after market. True sipes must be flexed to open. Imitation sipes are molded and remain open.

3.144
slot
A lateral groove on a tire tread separating tread blocks.

3.145
snow print powder
An accelerated plaster that is applied in a prescribed way and is capable of casting all forms of snow impressions.

3.146
Snow Print Wax™
Snow impression wax
Aerosol waxes used to coat the surface of snow impressions prior to casting.

3.147
specific location of wear
A defined area of erosion on a footwear outsole or tire tread. Examples of a specific location of wear are a worn tire sipe or a small area of worn stippling on a footwear outsole. Specific locations of wear may allow for a greater level of discrimination or association between questioned impressions and known footwear or tires.

3.148
specific outsole design
The precise arrangement of design elements of part or all of a footwear outsole. The precise size/shape and arrangement of design elements in an outsole of one style and manufacturer's size are normally distinguishable from other sizes of the same manufacturer's style. See **design/size relationship**.

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3.149
sprue
The piece of material that represents the passageway where the molding material was injected into the mold to form an outsole and remains attached to the outsole at that point. The sprue is removed before sale.

3.150
sprue mark
A small circular mark typically left on the surface of the back of the heel of the outsole after the sprue has been removed.

3.151
standard
See **test impression**.

3.152
stippling
A pattern hand struck onto the surface of a mold using a steel die containing a selected design. The tip of the die is small and requires numerous, often overlapping, strikes. These multiple strikes result in a fine pattern on the surface of the mold, and subsequent outsoles that come from that mold. Because of the highly variable manner in which hand stippling is applied, it is specific to a given mold.

3.153
stone hold
A stone held in a recessed area of a footwear outsole or tire that may or may not be replicated in an impression.

3.154
sulfur
A substance used for casting snow impressions.

3.155
sulfur cement
A reinforced modified sulfur material, available in flake form that is a safer, stronger alternative to using pure sulfur in casting snow impressions.

3.156
superimposition
A visual comparison performed by placing one object over the other.

3.157
synthetic rubber
Any artificial elastomer that simulates the qualities of natural rubber.

3.158
tandem
Tires set immediately one behind the other.

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3.159
tears
Fractures that have occurred in footwear outsoles or tire treads that reflect irregular edges. Tears are randomly acquired characteristics.

3.160
test impression
An impression made from a footwear or tire used as an aid for comparison purposes.

3.161
texture
A rough surface or shallow design added to surfaces of a mold through the process of chemical etching or hand struck stippling that is transferred to the footwear during the molding process. Texture is unique to specific molds.

3.162
three-dimensional impression
An impression made on surfaces such as soil, sand, snow or mud with dimensions of length, width, and depth.

3.163
tire footprint
The contact area of a tire tread against a flat surface when under load, also known as a contact patch.

3.164
tire profile
See **aspect ratio**.

3.165
toe bumper guard
A thick strip of rubber that, in some footwear designs, is placed around the front perimeter of the footwear surrounding the toe area.

3.166
track width
The distance between the center points of the tires from one side of the vehicle to the other (e.g. from the center point of the right front tire to the center point of the left front tire). On a dual axle vehicle, this is the distance from the center points between the dual tires from one side of the vehicle to the other.

3.167
transfer impression
An impression made on a two dimensional surface by a footwear or tire as a result of coming in contact with and acquiring dust, residue, blood, mud, or other materials that the footwear or tire subsequently deposits or transfers to a substrate in the form of an impression.

3.168
tread
The designed part of the tire that comes into contact with the road.

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3.169
tread block
A single geometric component of a tire tread design.

3.170
tread depth
A vertical measurement between the top of the tread to the bottom of the tire's deepest groove, measured in 32nds of an inch.

3.171
tread depth gauge
A device used to measure the depth of the tire tread.

3.172
tread design
A specific pattern or arrangement of design elements on a tire tread typically associated with a manufacturer and having a name and/or style number. (Also used to describe footwear outsoles.)

3.173
TreadPrint™ [1]
A commercial product used to make inkless tire test impressions.

3.174
tread wear indicator
Bands of raised rubber, sometimes called "wear bars", that are 2/32 of an inch above the bottom of the main grooves of a tire.

3.175
tread width
The width of the tire tread from one edge to the other in an impression. Not to be confused with section width.

3.176
turning diameter
The diameter of the smallest circle produced during a vehicle's tightest turn, as measured from the outer edge of the outmost front tire in that turn.

3.177
two-dimensional impression
An impression with dimensions of length and width.

3.178
unit outsole
An individual heel or outsole that must be glued and/or stitched to the upper.

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[1] This term is used as an example only, and does not constitute an endorsement of this product by the AAFS Standards Board.

3.179
upper
The top portion of the footwear excluding the outsole or midsole.

3.180
unvulcanized/raw rubber
Rubber not subjected to the process of vulcanization. The handling of this material may result in randomly acquired characteristics.

3.181
variations
Imprecise duplication and deviations among repetitions of the same process.

3.182
vent
Drilled hole or gap between tire mold components allowing for the release of air during mold cure.

3.183
vulcanization
A process in which a rubber compound is heated under pressure causing a chemical change which transforms the rubber from a soft, tacky substance to tough, hard rubber.

3.184
wear
Erosion of the surfaces of a footwear outsole or tire tread during use.

3.185
Wellman outsole cutting machine
A machine used to cut outsoles from unvulcanized calendered outsole material.

3.186
wet media film
A clear drafting film, preferably with a minimum thickness of 4 mils, capable of accepting ink, which is used to obtain inked impressions of tires.

3.187
wet origin impression
An impression formed under wet conditions including impressions consisting of residues of blood, grease, mud and other wet substances.

3.188
wheel base
The distance between the front and rear axles of a vehicle. An approximation of this dimension can be obtained by measuring the distance from the leading edge of the rear tire track to the leading edge of the front tire track on the same side of the vehicle.

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Annex A
(informative)

Bibliography

This is not meant to be an all-inclusive list as the group recognizes other publications on this subject may exist. At the time this document was drafted, these were the publications available to the working group members for reference. Additionally, any mention of a particular software tool or vendor as part of this bibliography is purely incidental, and any inclusion does not imply endorsement by the authors of this document.

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