

## Standard for Terminology Used for Forensic Footwear and Tire Impression Evidence (09/2011)

### 1. Scope

1.1 This Standard provides terminology that is commonly used in the forensic recovery and examination of footwear and tire impression evidence.

Note: There may be terms not in this Standard that appear in other sources.

### 2. Terminology

*Accidental characteristics:* See *Individual characteristics*.

*Adhesive lifter:* Any material coated with a tacky substance for the purpose of lifting footwear or fingerprint impressions.

*Air bubble:* A globule of air trapped within a solid material such as a shoe sole.

*Aspect ratio:* The proportion of the tire's height to its width.

*Asymmetric tread design:* A tire tread pattern where when a tread design is divided circumferentially, one half of the tread design is not a mirror image of the other half.

*Bead:* A hoop of steel wires that hold the tire on the rim.

*Bias tire:* A tire that has plies which cross over one another at an angle.

*Bias-belted tire:* A bias tire with added reinforced belts that lie beneath the tread.

*BIO-FOAM®:* A commercial product comprised of a collapsible foam used primarily for the recording of anatomical impressions of a foot, and sometimes impressions of shoe soles.

*Biscuits:* Pre-formed or extruded pieces of soling compound that are placed in molds and pressed into the shape of a shoe sole or heel.

*Blades:* Thin pieces of metal in shoe and tire molds that result in molded sipes.

*Blocker:* An oversized outsole made of one or more components that is later cut to size.

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

*Brannock Device®:* The registered name of a foot-measuring device.

*CAD/CAM:* Computer-Aided Design / Computer-Aided Manufacture.

*Calendering:* A process where raw rubber passes between a series of large steel calender rollers. The final calendar roller impresses the sole design into the rubber that is later cut into soles. Calender rollers are also used to help prepare raw rubber for the production of rubber biscuits for the compression molding process.

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

*Cast:* The result of filling a three-dimensional impression with an appropriate material.

*Casting material:* Dental stone, sulfur, or other suitable materials specifically used to accurately recover three-dimensional impressions. Some casting materials are also successful for lifting two-dimensional impressions.

*Center rib:* A rib that runs circumferentially and is evenly centered within the tire tread design.

*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.

*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. A chemically etched pattern is unique to a specific mold.

*Chemiluminescence:* Luminescence due to chemical reaction.

*Class characteristic:* A feature that is shared by two or more shoes or tires. The shoe outsole or tire tread design and the physical size features of a shoe outsole or tire tread are two common manufactured class characteristics. General wear of the outsole or tire tread is also a class characteristic. Agreement of class characteristics alone does not provide a basis for identification however they reduce the possible number of shoes or tires that could have made an impression.

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

*Coaxial light:* Illumination from the precise direction of the imaging lens, either through the lens or with a beam-splitter in front of the lens.

*Compression molding:* A method for making outsoles where the outsole material is placed into an open mold, which is then closed and subjected to heat and pressure. Soles made with this process are referred to as “pressed soles”.

*Consistency:* The percentage of water in the water-to-powder ratio of a gypsum product such as dental stone. In this ratio, the powder will always be 100. For example, a dental stone having a water-to-powder ratio of 30/100 has a consistency of 30.

*Cord:* Fabrics placed under tension and covered with rubber. Used to form the plies of the tire.

*Degree of wear:* The extent to which a shoe outsole or tire tread has been eroded. Examples of degree of wear range from a shoe outsole or tire tread that is in a new and unworn condition to those that have considerable wear. The degree of wear continues to change as a shoe outsole or tire tread is worn.

*Dental stone:* A gypsum product generally having a pound per square inch (psi) rating of 8,000 or higher, commonly used to cast footwear and tire impressions.

*Design:* The manufactured pattern of a shoe outsole or tire tread. Design is a class characteristic.

*Design/Size relationship:* The tendency for a shoe sole or tire tread design to have either more design elements, or larger design elements, or both, as the shoe or tire size increases throughout the size range produced.

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

*Difference:* A characteristic or feature that is so strong and reliable that it, in itself, indicates non-identity. Usually a difference will be a different class characteristic, such as the specific design or specific physical size of the design. Normal variations in the impression process, the absence of cuts evident in a questioned impression that appear on the shoe or tire, or the normal advancement of wear with time do not necessarily constitute a comparative difference.

*Direct attach:* A manufacturing process where the upper of the shoe is lowered onto a sole plate in a mold cavity and the midsole or outsole material is injected directly onto the upper. This term also applies to open pour polyurethane molding where the lasted shoe upper is lowered into a mold containing poured polyurethane and an outsole, directly attaching both to the upper.

*Directional tread design:* A tire tread pattern that is optimized to work best when rotating in one direction only.

*Distortion:* An unclear or inaccurate representation of the shoe or tire in an impression due to interference in the impression-making process or its subsequent retrieval.

*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.

*Dry casting:* A casting method utilizing the layering of dry dental stone powder and misted water.

*Dry origin impressions:* Impressions formed under dry conditions such as dry dust and dry residue impressions.

*Dual tire assembly:* A pair of tires mounted side-by-side on a fixed wheel assembly.

*Electrical discharge machine (EDM):* A machine used to produce molds by electrically burning away the undesired metal portions.

*Electrostatic detection apparatus (ESDA) or Electrostatic detection device:* An instrument used primarily to detect indented writing on documents, which can also be used to detect footwear and tire tread impressions on paper items.

*Electrostatic dust lifter:* An instrument that utilizes an electrostatic charge as a means of transferring dry origin impressions from a substrate to a film.

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

*Electrostatic lifting device:* An instrument that utilizes electrostatic charges as a means of transferring dry origin impressions from a surface to a film.

*Element/Design Element:* A single component (lug, herringbone, wave, circle, etc.) of a shoe sole distinguished by its shape that, by itself or with other design elements, comprises the tread design on that sole. (see Tread block)

*Elimination impressions and/or photographs:* Impressions and/or photographs taken of shoes and tires from known sources (police officers, paramedics, and their vehicles, etc.) for the purpose of discerning them from the questioned crime scene impressions.

*Enhancement:* Improving the ability to visualize an impression through physical, photographic, digital or chemical means or through the use of alternate light sources.

*Ethylene vinyl acetate (EVA):* A soling compound often produced in an expanded form.

*Examination quality photographs:* High quality photographs taken with a scale specifically for use in the physical comparison of footwear and tire impressions with known footwear and tires.

*Exemplar:* See *Test impression*.

*Feathering:* See *Schallamach pattern*.

*Fixative:* Substance that stabilizes blood prior to enhancement. Also refers to any product that will stabilize the substrate prior to casting.

*Flash:* Small amounts of rubber and shoe soling compounds that have seeped between mold components during the footwear and tire molding process.

*Fluorescence:* Luminescence that is caused by the absorption of radiation at one wavelength followed by nearly immediate re-radiation usually at a different wavelength and that ceases almost at once when the incident radiation stops.

*Footwear:* Any apparel worn on the foot, such as shoes, boots, sandals, etc.

*Forensic light source:* A filtered light source that may be fixed or tunable to a variety of spectral ranges.

*Foxing/Foxing strip:* A strip of rubber wrapped around the lower part of some shoes to cover the gap or seam between the upper and the outsole.

*Full circumference tire impression:* An impression of a tire that represents a full rotation of that tire under load and thus represents its entire tread surface.

*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.

*Gelatin lifter:* Gelatin applied to a pliable backing that can be used to lift impressions

*General sole design:* A very general category of footwear sole patterns, i.e. herringbone pattern, lugged sole pattern, wave pattern, plain soles, etc.

*General wear:* The overall condition of a shoe outsole or tire tread related to its degree of use. General wear is a class characteristics that may be used to include or exclude shoe outsoles and tire treads based on similar or different degrees and positions of wear.

*Grooves:* The space or channels that separate the 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.

*Holes:* The result of erosion of a shoe outsole or tire tread that is so extreme that it results in removal of the outer layers of sole or tread materials, often resulting in

irregular edges. These irregular edges are individual characteristics. Random holes due to punctures are also individual characteristics.

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

*Identification*: The positive association of an impression as having been made by a single shoe or tire to the exclusion of all others.

*Identifying characteristics*: See *Individual characteristics*.

*Impression*: The product of direct physical contact of an item such as a shoe or tire resulting in the transfer and retention of characteristics of that item.

*Individual characteristics*: Features that have occurred randomly on a footwear outsole or tire tread. Examples of individual characteristics include cuts, scratches, tears, holes, stone holds, abrasions and the acquisition of debris from random events. The position, orientation, size and shape of individual characteristics contribute to the uniqueness of a shoe outsole or tire tread. Individual characteristics are essential for an identification of a particular shoe or tire as the source of an impression.

*Injection molding*: A manufacturing method where the sole and/or midsole is made by forcing material into a closed mold. Outsoles can be molded individually as unit soles or directly onto the shoe upper as direct attach soles.

*Insole*: A cushioned liner that occupies the inner surface of a shoe where the foot rests and is placed there for comfort or protection. The insole may or may not be removable.

*Known impression*: See *Test impression*.

*Known shoe or tire*: A shoe or tire that is compared to a questioned shoe or tire impression.

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

*Latent impression*: An impression not readily visible to the naked eye.

*Last*: A form made of wood, metal, or synthetic material that approximates the size and shape of a foot. The upper of the shoe 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.

*Liner*: A thin layer of butyl rubber compound that holds the air inside the tire.

*Logo:* A name, design, or pattern that is the trademark of the manufacturer that may appear on the shoe or on the outsole.

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

*Manufacturing defect:* Unintended damage, defects or flaws in the shoe outsole or tire tread that occurs during manufacturing, which depending on their cause, could result in individual or class characteristics.

*Manufacturing variable:* Variations that occur during the manufacturing process that do not appear on all of the shoes/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.

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

*Midsole:* A component positioned between the upper and the outsole on some shoes to provide cushioning and support.

*Mold:* A metal cavity containing a footwear sole or tire tread design used to produce footwear or tires.

*Mold characteristics:* Those design and size features of a particular mold.

*Mold cure:* Term used by tire manufacturers to describe the vulcanization of a tire in the molding process.

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

*Natural crepe rubber:* A crude form of coagulated natural rubber having a crinkled or knobby texture.

*Natural rubber:* A natural product derived from latex tapped from rubber trees.

*Negative impression:* An impression that has resulted from the removal of a substance from a substrate by a shoe outsole or tire tread.

*Negative control:* Confirmation of no color change in the absence of blood.

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

*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.

*Oblique angle*: Angle between 0 and 90 degrees.

*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)

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

*Open pour molding*: A method of making outsoles utilizing polyurethane (PU). The mold is filled by pouring the PU into the mold cavity and then closing the mold. Single unit soles are made by pouring the PU into the mold and allowing the sole to harden. Direct attached soles can be made utilizing this process. (See *Direct attach*.)

*Outsole/sole*: The bottom portion of the shoe that comes into contact with the ground.

*Outsole/sole design*: A term used to describe a specific pattern or arrangement of design elements on an outsole typically associated with a manufacturer and having a name and/or style number. (also referred to as tread design)

*Partial or fragmented impression*: An impression that does not represent the entire shoe outsole or tire tread.

*Patent impression*: An impression visible to the naked eye.

*Pattern*: See *Design*.

*Photo log*: A written record of photographs taken at the crime scene.

*Physical size and shape (of design)*: The size, shape, spacing and relative positions of the outsole design components and tire tread blocks (not the same as the manufacturer's shoe or tire size). Physical size and shape are class characteristics.

*Pitch length*: Circumferential length allotted for a tire tread block.

*Pitch sequence*: The arrangement of tire tread blocks of varied pitch lengths to reduce tire noise.

*Ply*: Rubber-coated parallel cord fabric placed over the liner forming the tire carcass.

*Pneumatic tire*: A tire filled with air under pressure.

*Polarized lighting*: Illumination consisting of light rays with a single propagation direction and a single vibration direction. Polarized light is produced by the use of a polarizing filter.

*Polyurethane (PU)*: A polyester or polyether-based polymer used in both the outsoles and midsoles of shoes.

*Polyvinylsiloxane*: Dental casting material formulated to render fine detail.



*Polyvinyl chloride (PVC):* A thermoplastic polymer used in shoe outsoles.

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

*Positive impression:* See *Transfer impression*.

*Positive control:* Confirmation of a color change in the presence of blood.

*Pressed sole:* A sole made in the compression mold.

*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.

*Questioned impression:* An impression of an unknown shoe or tire located and recovered from a crime scene.

*Radial ply tire:* A tire whose plies run from bead to bead at right angles to the centerline of the tread.

*Release agent:* Any product that prevents soil from adhering to the cast.

*Residue impression:* Formed by the deposition of a substance from the shoe or tire onto another surface.

*Retreaded tire:* A used tire to which a new tread has been added. *Release agent:* Any product that prevents soil from adhering to a cast. *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.

*Rim diameter:* The diameter of the rim that supports the tire bead and is expressed in inches, such as 13", 16", 16.5" etc.

*Ritz Stick®:* Device for measuring foot length and width.

*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 shoes and tires.

*Rolling circumference:* The linear distance traveled by a tire in one revolution under load.

*Schallamach pattern:* Microscopic patterns that develop as ridges on rubber material as a result of repeated abrasive forces. These patterns are very similar in their size and appearance to skin friction ridges and are highly individual. They

continue to change rapidly as affected by continued abrasion. Schallamach patterns are individual characteristics. The term gets its name from a researcher of the same name.

*Section height:* The distance from the rim to the tread surface of an unloaded tire.

*Section width:* The distance between the sidewalls of an inflated tire, exclusive of any lettering or designs.

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

*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.

*Shoe perimeter:* The outer border or edge of the shoe sole 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.

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

*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.

*Shoulder:* The portion of the tire where the sidewall and tread meet.

*Side-by-side:* A comparison method performed by placing two or more objects adjacent to one another.

*Sidewall:* The portion of the tire between the shoulder and the bead that contains the tire information.

*Sipes:* Thin slits in a shoe outsole or tire tread to create better traction. True sipes are those that are cut into a shoe outsole during manufacture. True sipes are cut in a tire tread only after market. True sipes must be flexed to open. Imitation sipes are molded and remain open.

*Slot:* A lateral groove on a tire tread separating tread blocks.

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

*Specific location of wear:* A defined area of erosion on a shoe 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 shoe outsole. Specific locations of wear may allow for a greater level of discrimination or association between questioned impressions and known shoes or tires.

*Specific sole design:* The precise arrangement of design elements of part or all of a shoe 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

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

*Sprue mark:* A small circular mark left on the surface of the back of the heel of the outsole after the sprue has been removed.

*Standard:* See *Test impression*.

*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 random manner in which hand stippling is applied, it is unique to that specific mold.

*Stone hold:* A stone held in a recessed area of a shoe or tire that may or may not be replicated in an impression.

*Sulfur:* A substance used for casting snow impressions.

*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.

*Superimposition:* A comparison method performed by placing one object over the other.

*Synthetic rubber:* Any artificial elastomer that simulates the qualities of natural rubber.

*Tandem:* Tires set immediately one behind the other.

*Tears:* Fractures that have occurred in shoe outsoles or tire treads that reflect irregular edges. Tears are individual characteristics.

*Test impression:* An impression made from a shoe or tire used as an aid for comparison purposes.

**Texture:** A rough surface or shallow design added to surfaces of a mold through the process of chemical etching or stippling that is transferred to the shoe during the molding process. Texture is unique to specific molds.

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

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

**Tire profile:** See *Aspect ratio*.

**Toe bumper guard:** A thick strip of rubber that, in some shoe designs, is placed around the front perimeter of the shoe surrounding the toe area.

**Track width:** The distance between the center points of the tires from one side of the vehicle to the other (i.e., 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.

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

**Tread:** The designed part of the tire that comes into contact with the road.

**Tread block:** A shape arranged circumferentially around a tire tread that together form the tread design. (See *Element/Design Element*.)

**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.

**Tread depth gauge:** A device used to measure the depth of the tire tread.

**Tread design:** A term used to describe 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 shoe outsoles).

**TreadPrint™:** An inkless method for making tire test impressions.

**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.

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

*Turning diameter:* The diameter of the smallest circle that is measured from the outer edge of the outermost front tire in a turn.

*Two-dimensional impression:* An impression with dimensions of length and width.

*Unit sole:* An individual heel or sole that must be glued and/or stitched to the upper.

*Upper:* The top portion of the shoe excluding the outsole or midsole.

*Variations:* Minor variables that normally exist between repetitive impressions of the same shoe or tire.

*Vent:* Drilled hole or gap between tire mold components allowing for the release of air during mold cure.

*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.

*Wear:* Erosion of the surfaces of a footwear outsole or tire tread during use.

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

*Wet media film:* A clear drafting film, preferably with a minimum thickness of 4 mil, capable of accepting ink, which is used to obtain inked impressions of tires.

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

*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.