Footwear and Tire Impressions

Proper collection and preservation of footwear and tire impression evidence is essential to capture the detail observed at the crime scene. The choice of collection technique is based on the type of impression:

- **Two-dimensional impressions are found on flat, hard surfaces such as wood, tile, or linoleum**
- **Three-dimensional impressions are found in sand, soil, snow, or other pliable materials**

**IMPORTANT NOTE:** Prior to lifting or casting any footwear or tire impression, scaled, take comparison-quality photographs. See Chapter 2, Forensic Photography, VI. Pattern Photography, for detailed instructions.

**NOTE:** As of January 1, 2016, the Wisconsin Crime Laboratory Bureau will no longer be accepting cases and evidence/standards for Tire Track Analysis. The FBI Crime Laboratory in Quantico, VA has agreed to work Tire Track Analysis cases that would normally be sent to Crime Labs in Wisconsin.

For more information on how to submit evidence to the FBI Crime Lab, please call (703)632-8444. Please note that tire tread examination with the FBI is done by the Questioned Documents Unit.

I. Two-Dimensional Impressions

Electrostatic Dust Print Lifters

Electrostatic dust print lifters (EDPL) are available from most forensic supply vendors and can be used to collect impressions composed of dust or dry, light, particulate residue from floors, walls, papers, and a variety of other surfaces.

An EDPL consists of a high voltage power supply/control unit, a nickel-plated steel ground plane, and a metalized lifting film. As high voltage is applied to the lifting film, it takes on a negative charge and the ground plane becomes positive. Any dust present under the lifting film will take on a positive charge.
and will then be attracted to the negatively charged collection film. This film retains the charge, preserving the impression, which can then be collected. The film should be taped inside a cardboard box with the IMPRESSION SIDE UP to avoid any movement or contact with any other surface. Lifts taken in this manner will be in a mirrored position and will need to be photographically reversed to return them to their proper orientation.

Consult your EDPL instruction manual and/or the online technical manuals posted by the various EDPL vendors for specific instructions on the use of their equipment.

Additionally, there are now also similar lifting devices that rely on vinyl static cling films rather than high voltage power sources which are available from forensic supply vendors.

Due to the fragile nature of dust impression(s), scaled, comparison quality photographs should be taken of all static lifts prior to packaging and submission (see Chapter 2).

**Fig. 12-1** Hand-held EDPL Kit
Gelatin Lifters

Gelatin lifters are a low adhesive lifting device which can be used on almost any visible two-dimensional dust or dirt impression. In addition, gelatin lifters can be used to lift previously wet impressions or impressions developed with fingerprint powder. Gelatin lifters are available in white, black, and transparent and are available in a variety of sizes. Choose a lifter of contrasting color to the impression for optimal results.

**NOTE:** Whenever possible, attempt to lift the impression with an EDPL prior to a gelatin lifter for best results.

Gelatin lifters are used in the following manner:

1. Use a full size lifter or cut to size for partial impressions.
2. Clip one corner of the gelatin lifter before removing the protective cover.
3. Gently place the gelatin lifter over the impression and hold in place with one hand.
4. With the free hand, lightly press or rub the gelatin lifter onto the surface without moving the lifter.
5. Peel back the gelatin lifter.
6. Align the clipped corners, replace the protective cover and label the back of the lift.

Lifts taken in this manner will be in a mirrored position and will need to be photographically reversed to return them to proper...
orientation. **Always remove the protective cover** before evaluating or photographing a gelatin lift, being careful not to damage the lift in its unprotected state. Comparison quality photographs may be completed as outlined in Chapter 2. Replace the cover before returning the lift to storage. Gelatin lifts can be packaged in a manner similar to regular latent lifts.

## II. Three-Dimensional Impressions

### What to Cast

While it is preferential to cast all three-dimensional footwear and tire impressions at a scene, it may not always be possible. If it is not feasible to cast all of the impressions, care should be taken to cast the best footwear and tire impression evidence present. Close-up visual examinations of each impression should be conducted to determine which impressions exhibit the best clarity of detail. Oblique lighting from all four sides of each impression can also assist in conducting these visual examinations. Those impressions having the best detail should be marked and preserved for future casting.

**Note:** *All of the impressions should be photographed properly with a scale prior to any casting that may be done. Refer to Chapter 2 for photographic instructions.*

If there are a large number of impressions at a scene, at minimum, the following should be cast:

- One full footwear impression for each outsole design (*left & right shoe*).
- All full or partial footwear impressions with good detail and clarity.
- One full tire impression for each tire track present (*left front, left rear, right front, and right rear in segments*).
- All partial tire impressions of good detail and clarity.
Dental Stone Casting Procedures

Dental stone can be used to cast footwear/tire impressions in sand, dirt, or snow. In order to properly cast a footwear/tire impression using dental stone, thoroughly evaluate the substrate, the condition of the substrate, and the environmental conditions. The following are examples of scenarios that may require special considerations:

- Impressions in loose sand or soil may benefit from the use of a hardening agent such as hair spray before casting
- Impressions in snow or ice should be considered a high priority due to the possibility of melting
- A snow or ice impression may benefit from the use of Snow Print Wax™ or gray primer spray prior to casting
- Forms can be used to frame an impression on a steep angle
- A box or shield can be used to protect an impression from rain, snow, sun, wind, etc.

The following materials are needed to cast an impression with dental stone:

- Dental Stone inside a zip top-type bag
  - 2 pounds for an average footwear impression
  - 3 – 4 pounds for one segment of an average tire impression (complete tire rotation is ~ 3 segments)
- Extra Dental Stone
- Approx. 4-6 oz. of water per pound of powder, more may be needed
- Extra zip top plastic bags to protect from leakage when mixing
- Scissors to cut open the bag
- Object to deflect the casting material when pouring into the impression (paint stir stick, fingerprint lift card, etc.)
- Material to help fix the impression before casting (Snow Print Wax™, gray primer spray, hairspray, or hardener)
- Form (cardboard or metal landscape edging) to frame the impression if it is on a steep angle
• Box or cover to protect impression from weather
• Permanent marker to “mark” cast
• Cardboard box for packaging
• Bowl or bucket if using bulk dental stone
• Stick or spoon for mixing bulk dental stone

Dental stone material can be purchased in premeasured zip-top plastic bags or in bulk amounts. While premeasured bags will be sufficient to cast most footwear impressions, bulk dental stone is often more convenient for casting tire impressions.

**Premeasured Dental Stone**
Bags of premeasured dental stone (generally 2 pounds) are available from most forensic suppliers. The primary benefit of the premeasured dental stone is the ability to mix the dental stone in the bag. Premeasured bags of dental stone are easily stored in a scene processing kit along with spare gallon size plastic zip-top bags in the event that a premeasured bag of dental stone leaks during the mixing process.

**Bulk Dental Stone**
Bulk dental stone can be measured into gallon size zip-top plastic bags, bowls, or buckets. The size of the bowl or mixing container used can be determined by the size of the impression being cast. One large batch may be used to cast several smaller impressions if done in quick succession. The disadvantages of using bulk dental stone are the space required to maintain the additional equipment and the clean up after use.

**Procedure for Mixing Dental Stone**
Dental stone typically requires 4-6 ounces of water per pound of powder to make a mixture the consistency of a **thick paint** or **pancake batter**. While these are the recommended amounts, the actual amount of water needed can vary based on the temperature of both the water and the environment. Dental stone should flow freely when poured but should not be watery or runny.
• **Mixing dental stone in a 2-pound premeasured bag:**
  - Add a little less than 9 ounces of water to start
  - Squish the bag gently to mix the contents; most have colored dyes in them that will dissipate as the contents mix
  - Make sure that all of the dry material is thoroughly mixed, paying specific attention to the corners of the bag
  - If the consistency is too thick, add more water; If too thin, add more powder
  - **Thinner is generally better!**

![Fig. 12-3 Mixing dental stone in a zip-top bag](image)

• **Mixing bulk dental stone in a bucket or bowl:**
  - Add water to bucket or bowl (always start with a smaller amount of water than necessary)
  - Slowly add the dental stone to the water, stirring continuously to ensure that it is thoroughly mixed & all of the dry material is incorporated into the mixture
  - If the consistency is too thick, add more water; If too thin, add more powder
  - **Thinner is generally better!**

In order to properly cast a footwear/tire impression using dental
stone, thoroughly evaluate the substrate, the condition of the substrate, and the environmental conditions. The following are examples of scenarios that may require special considerations:

- Impressions in loose sand or soil may benefit from the use of a hardening agent such as hair spray before casting
- Impressions in snow or ice should be considered a high priority due to the possibility of melting
- A snow or ice impression may benefit from the use of Snow Print Wax™ or gray primer spray prior to casting
- Forms can be used to frame an impression on a steep angle
- A box or shield can be used to protect an impression from rain, snow, sun, wind, etc.

**NEVER POUR THE MIXTURE DIRECTLY INTO THE IMPRESSION!**

Use a deflector when pouring casting materials into an impression to avoid damaging the impression. Start the pour on the outside of the impression and worked carefully into the impression. If the mixture is too thick or too thin, stop the pour immediately while still outside of the impression and make a new mixture to cast the impression.

![Fig. 12-4 Pouring dental stone using a deflector](image)

Methods and procedures for casting below are provided as guidelines:
Dry Sand/Soil Conditions:

1. Place scale on the same plane as the detail to be photographed. **Note:** Avoid disturbing the impression!
2. Take comparison quality photographs. See Chapter 2.
3. Carefully remove debris not imbedded in the impression.
4. Re-photograph as indicated above.
5. Stabilize impression with hairspray/hardener if necessary. **Note:** Avoid spraying hairspray directly onto the impression; lightly mist it into the impression. A fine mist pump spray works well. Allow time to dry between applications.
6. Place a form around the impression if on a steep angle.
7. Pour dental stone mixture on the ground next to the impression or onto a deflector, allowing it to flow into all areas of the impression. In the event that the casting material does not flow completely into the impression, the top surface of the casting material can gently agitated to help it flow. The cast should be of sufficient thickness to avoid breakage (at least 1” thick).
8. Let the impression dry thoroughly (~30-45 minutes, longer in colder weather) before carefully removing it. *Handle the cast very carefully because it is fragile and will break easily.*
9. Mark the cast & package properly.

Wet Soil Conditions (Submerged or Partially Submerged):

1. Place scale on the same plane as the detail to be photographed. **Note:** Avoid disturbing the impression!
2. Take comparison quality photographs. See Chapter 2.
3. Carefully remove debris not imbedded in the impression.
4. Re-photograph as indicated above.
5. Sift dry dental stone into standing water until absorbed, the water will wick to the top of the dental stone; re-
apply sifted dental stone until all standing water is absorbed.

6. Pour a dental stone mixture over the sifted dental stone to complete the cast.

7. Let the impression dry thoroughly (~30-45 minutes, longer in colder weather) before carefully removing it. *Handle the cast very carefully because it is fragile and will break easily.*

8. Mark cast & package properly.

III. Casting in Snow and Ice

Dental stone and melted sulfur are the two traditional methods for casting footwear and tire impressions in ice and snow. Because heat is generated by the dental stone as it sets up, it is strongly recommended that one or more layers of Snow Print Wax™ or gray primer spray be added to the impression first to act as a buffer. Do not spray directly onto the impression, but mist over the impression at an oblique angle and allow the spray to fall over it. Apply the spray in light layers, letting each layer dry completely before adding additional layers.

Dental Stone/Pour Method

1. Place scale on the same plane as the detail to be photographed. **Note: Avoid disturbing the impression!**

2. Take comparison quality photographs. See Chapter 2.

3. Carefully remove debris not imbedded in the impression.

4. Re-photograph as indicated above.

5. Lightly spray Snow Print Wax™ or gray primer spray to improve contrast (see Figure 10-6).

6. Re-photograph.

7. Spray additional Snow Print Wax™ or primer spray if necessary.

8. Pour the dental stone mixture on the ground next to the impression or onto a deflector, allowing it to flow into all areas of the impression. In the event that the casting
material does not flow completely into the impression, the top surface of the casting material can be gently agitated to help it flow. The cast should be of sufficient thickness to avoid breakage (~ 1” thick).

9. Dry the impression thoroughly (~30-45 minutes, longer in colder weather) before carefully removing it. *Handle the cast very carefully as it is fragile and will break easily.*

10. Mark cast & package properly

Fig. 12-5 Impression in snow.

Fig. 12-6 Impression sprayed with Snow Print Wax™ which enhances the detail of impression and creates a buffer for the dental stone.
Sulfur Casting

Sulfur is another technique that can be used to cast footwear/tire impressions in snow.

CAUTION: This technique requires the user be familiar with safety issues regarding the use of sulfur (see sulfur MSDS). The melting of sulfur should be done outside in a well-ventilated area while wearing a dust/mist respiratory mask to prevent the inhalation of sulfur fumes. Adequate ventilation and proper temperature control can also reduce the risk of igniting melting sulfur.

- the melting point of sulfur is 119°C
- the flash point of sulfur is 207°C
- the ignition point of sulfur is 232°C

The following materials are needed to cast an impression with sulfur:

- Sulfur – powder or prill (pellets)
  ▪ ~ 3 cups for an average footwear impression
- Electric heating mantle or propane stove
- One-gallon unlined paint can
- Large metal spoon
- Material to help fix the impression before casting (Snow Print Wax™, gray primer spray, hairspray, or hardener)
- Form (cardboard or metal landscape edging) to frame the impression if it is on a steep angle
- Box or cover to protect impression from weather
- Permanent marker to “mark” cast
- Cardboard box for packaging

Heating the Sulfur

Place the sulfur in the paint can and turn the heat to medium to begin melting the sulfur (see Figure 10-7). The sulfur should slowly turn from a yellow solid to a translucent amber liquid. If the temperature of melted sulfur exceeds 160°C, it will become
a dark, thick syrup at the bottom of the can. This is a sign that that sulfur has become too hot and that the temperature should be lowered immediately. Melt until all solids have liquefied. With an effective heating mantle or stove, the sulfur should melt within 10 minutes.

**Cooling the Sulfur**

Cool the melted sulfur by stirring it continuously with a large spoon until the sulfur becomes grainy. The sulfur should be a liquid, inelastic gruel, and its color will have lightened. Stir the sulfur constantly as it cools. Do not put the pot in the snow, water, or any place where it will begin to cool quickly. Doing this will cause the sulfur to harden too quickly and you may not have enough time to pour it into the impression. If this occurs, it will require the sulfur to be melted again.

![Image](image.png) Fig. 12-7 Heating mantle with one-gallon unlined paint can.

Impressions being cast with liquid sulfur do not require a buffer layer of Snow Print Wax™ to protect them from the heat. However, a light application of Snow Print Wax™ or gray primer spray can be used to enhance the detail in the impression for photography.

Framing of the impression should be considered as liquid sulfur is thin and free flowing. Sulfur does tend to solidify on contact with ice and snow, which will help restrict its movement. The liquid should be poured onto a deflector (spoon) and directed into the impression.
Procedure:

1. Place scale on the same plane as the detail to be photographed. **Note: Avoid disturbing the impression!**
2. Take comparison quality photographs. See Chapter 2.
3. Carefully remove debris not imbedded in the impression.
4. Re-photograph as indicated above.
5. Lightly spray Snow Print Wax™ or gray primer spray to improve contrast (see Figure 12-6).
6. Re-photograph.
7. Place a form around the impression, if necessary.
8. Heat paint can with sulfur until melted. (See Fig. 12-8)
9. Reduce heat to cool allowing crystals to begin forming

![Fig. 12-8 Cooling sulfur.](image)

10. Pour cooled sulfur fairly quickly from a low height onto a deflector, allowing it to flow into all areas of the impression. (see Figure 12-9). The cast should be of sufficient thickness to avoid breakage (~ 1” thick).
11. Let the cast cool until it is warm (not hot) to the touch (at least 30 minutes) and then carefully lift up the cast from the snow. Do not leave the sulfur cast in the impression for a long time because it can freeze to the ground. Place the cast on a firm surface and handle the cast very carefully because it is fragile and will break easily. A layer of dental stone can be added to the back of the cast to prevent breakage. This can be done before or after the sulfur cast is lifted from the impression (see Figure 12-11).
CAUTION: Sulfur casts remain hot for a period of time after they are poured. Use caution when checking these casts. Do not attempt to lift until the casts have hardened and cooled.

Fig. 12-9  Sulfur mixture is poured into the footwear impression using a deflector (metal spoon).

Fig. 12-10  Sulfur cast which has begun to harden.

Fig. 12-11  Sulfur cast with dental stone reinforcement.
IV. Marking and Packaging Casts

Once the cast hardens, mark the necessary identifying data on the back of the cast. At a minimum, this should include:

- case number
- exhibit number or location collected (when multiple casts are made)
- date
- initials of the person making the cast
- arrow pointing north to orientate the cast

Allow the cast to remain undisturbed for a sufficient amount of time to harden. Under dry conditions this may take from 30 minutes to an hour. Drying times will be affected by the consistency of the casting material, the humidity, the moisture content of the ground surface and the air temperature. Casts poured in wet sand and soil should not be removed immediately after the exposed portion of the cast has hardened.

Casts should be removed using a gentle rocking motion to avoid breaking the cast. Casts that do not release readily may require the loosening of the dirt underneath the cast. A knife or other bladed object should be inserted into the dirt at an angle allowing the dirt 1” below the cast to be loosened. At no time should the bladed object come into contact with the cast.

**Do not attempt to clean off the cast after removal.** Sand or soil adhering to the cast should not be removed before the cast is completely dry as this may damage the fine details in the cast. Allow the cast to air dry for at least 48 hours before packaging.

To package casts, wrap each separately in paper, **never use plastic.** Seal the cast in an appropriately sized box with enough packaging material to protect it from damage. Each cast should be sealed in a separate box.

Moisture may exude from a dental stone cast for several days thereby weakening bags and boxes used as packaging. Check the integrity of the packaging at the end of the drying stage. Repackaging may be necessary once the cast is completely dry.