Introduction to Gun Shot Residue

Chemical particles which are frequently referred to as Firearm Discharge Residues are also represented as Gun Shot Residues (GSR). GSR is produced due to burning of powder, rubbing of bullet with barrel parts and explosion of priming compounds. GSR particles may be found as inorganic elements, organic compounds or gases. GSR particular may be found on the target and when the target is a human being, they may exist on the body of the victim and on his clothes depending on the range of firing and other factors.

GSR particle may be found on the hands of the shooter, inside the body of the victim as well as at some distance from the place of firing depending on firing range. In cases of suicide, GSR particles can be found on the body of the shooter as well on his clothes.
GSR particles may be found in the barrel and chamber of the weapon as well as on the outside of barrel. GSR particles may be found in the air. Presence of GSR particles has even been reported in the excreta of the shooter. In India, the new primer composition being used is -

- Lead Styphnate : 32.42%
- Antimony Sulphide : 13.17%
- Barium nitrate: 27- 37%
- PETN: 4 - 6%
- Tetracene : 3-5%
- Aluminum: 6-8%

Thus, the elements present in the GSR would be Lead, Antimony, Barium and Aluminum. In addition to above elements produced from the primer, we may have contribution from other sources. Some particles of plain lead which has vaporized form the base of the bullet, copper and zinc particles from the inside surface of the cartridge case.

Collection of samples for GSR analysis

The practice for sample collection for GSR analysis is easy. Generally, a 1 × l cm strip of double - sided adhesive tape fixed against a thin acetate band. The acetate band allows the adhesive surface to be conveniently operated. During the sample collection, the skin must be stretched as much as possible to ensure that any GSR particles which may be hidden within the folds of the skin or inside the hair follicles are exposed. It is important to cover the sampled area at least three times even if the adhesive has lost its tackiness. The adhesive is quite soft and particles can still be pressed into the surface even if there is no apparent adhesiveness left. It is also important to be consistent in the number of times the area is covered to ensure consistency, for interpretation of the results.

Chemical test for GSR identification-

In cases where a SEM is not available, the tests described below can still be used. Excessive caution should be used with the interpretation of any results obtained from these tests as none of them are specific. At best, the results could be presumptive and at worst, only indicative.

1. SODIUM RHODIZONATE TEST:

The test is carried out by firmly pressing a clean filter paper, lightly moistened with 0.1N Hydrochloric Acid (HCl), over the bullet hole. The filter paper is then dried using a hot air blower and carefully spotted with a saturated solution of Sodium Rhodizonate in water. The filter paper will eventually take on an orange colour from the Sodium Rhodizonate.

The filter paper is then warmed once again with the air blower, but not dried. The solution of 0.1 N HCl is then lightly spotted, or preferably sprayed, onto the paper until the orange colour disappears. If there are any lead particles present, they will remain as a purple coloration.

After spotting with the 0.1N HCl solution and noting or photographing any purple - colored spots; a filter paper is held over a solution of 880 ammonia solution. A filter paper is placed into a mildly alkaline condition (preferably about pH 8). This will remove the purple coloration due to lead and then placed it in a condition where the Sodium Rhodizonate will react with any barium present to give a red/brown coloration. Alternatively, the filter paper can be spotted with dilute ammonia solution, but this tends to dilute the result, leading to difficulties in identifying the colour change.

The Sodium Rhodizonate test can also be used for the detection of barium, although it is not as sensitive as when used for lead. This test can be used in conjunction with the test for lead, giving a more specific identifier of GSR.

2. WALKER TEST FOR NITRITES:

This is used for the detection of nitrites in the partially burnt and unburnt propellants. In this technique, a photographic paper is desensitized in hypo fixer. After that the paper is immersed in a solution of 5% 2 - naphthylamine - 4, 8 - disulphonic acid. Then it is air dried. A cloth, wetted with 20% Acetic Acid, is placed under the clothing under test. The photographic paper is placed on top and covered with a piece of dry cloth. Pressure is applied with a hot iron set at ‘warm’ for 5 min. Any bright red spot which appears indicates the presence of nitrite compounds.

It should be noted that many compounds other than nitrocellulose propellants can give a positive reaction, e.g., urine, face powder, fertilizers.

3. GREISS TEST:

This is identical to the Walker test except for the main reagent which is naphthylamine instead of 2 - naphthylamine - 4, 8 - disulphonic acid. This reagent gives orange spots. Once again, this test is mainly used for detection of propellant particles in range of firing estimations.

4. MARSHALL TEST:

The desensitized photographic paper is soaked it in 0.5% solution Sulphanillic Acid for 10 min, then dried. This is then soaked in a 0.5% solution of N – α naphthyl – ethylenediamine hydrochloride in methanol for 2 min then again dried. A cloth, wetted with 20% acetic acid, is placed under the clothing under test. The photographic paper is placed on top and covered with a piece of dry cloth. Pressure is applied with a hot iron set at ‘warm’ for 5 min. A positive indication for nitrites will appear as purple spots on a purple background. It is rinsed in warm water to remove background colour. If then rinsed in methanol, the spots will turn orange.

This test is mainly used for detection of propellant particles in range of firing estimations.

5. TEWARI TEST:

1 gm. of Antazoline Hydrochloride (2 – N- benzyl aniline methyliminazoline hydrochloride) is dissolved in 50 mL of water. 45 mL of concentrated HCl is added and stirred until the white precipitate dissolved. A filter paper soaked in acetone and pressed on target. It is then air dried and sprayed heavily with the prepared Antazoline solution.
Nitrite compounds will register a positive reaction as deep yellow spots.

This test is mainly used for range of firing estimations by visualization of propellant particles.

6. LUNGE REAGENT:

This was the original ‘Dermal Nitrite Test’ used for the proof of firing a weapon. Originally, the reagent consisted of a 0.25% solution of Diphenybenzidine in concentrated Sulphuric Acid. This reagent was sprayed onto paraffin casts of the suspect’s hands, and any nitrite particles present, which include nitrocellulose, would give a deep blue coloration. Diphenybenzidine is, however, carcinogenic and has been replaced with diphenylamine, which also gives a deep blue coloration to nitrites.
The problem with this test is that so many everyday chemicals, for example, fertilizer, urine, make - up, etc., can give a positive reaction with this reagent that it is no longer used for the identification of GSRs on hands.

7. HARRISON AND GILROY REAGENT:

Whereas this reagent is really intended for the identification of GSR on hand swabs, it can be used just as well for range of firing estimations once the particles have been removed from the garment.

The photographic paper method of lifting the residues from the clothing is used, but dilute HCl must be used instead of acetic acid. It is then air dried, then sprayed with a 10% solution of Triphenylmethylarsonium Iodide in alcohol. An orange coloration is positive for antimony. Then it is dried and sprayed with a saturated solution of Sodium Rhodizonate. Red spots are positive for barium or lead. When dried and sprayed with dilute HCl, Purple spots are positive for lead. If the spots are then exposed to a 35% ammonia solution, any particles containing barium will give a red coloration.

8. DI- THIO- OXAMIDE (DTO) TEST:

This test detects copper and nickel, and can be utilized for the determination of bullet entry and exit holes for fully jacketed gilding metal (Cu/Zn) and cupro nickel (Cu/Ni) bullets. It can also detect the presence of cobalt, although this is currently of no significance in forensic firearms examination. With DTO, copper produces a very dark - green coloration, nickel a pink to violet coloration and cobalt a brown coloration. The presence of blood can, however, give a false negative result.

The reagent must be freshly prepared from 0.2 g of DTO in 100 mL of ethanol. The ammonium hydroxide is 20 mL of ammonium hydroxide in 50 mL of distilled water. A filter paper moistened with the ammonium hydroxide is pressed onto the bullet hole. Gentle heat via a hair dryer can be applied, which will enhance the transfer. Place three drops of the DTO solution to the area in contact with the bullet hole.

A dark greenish/gray reaction constitutes a positive reaction for copper. A blue/violet coloration constitutes a positive reaction for nickel.

Precautions to be taken duing GSR Examination-

- Plastic gloves should be worn by the evidence technician when taking the handwiping.

- The cotton swab is moistened with two or three drops of acid solution.

- About 20 seconds of swabbing is recommended and important per swab. Each area should be swabbed twice.

- The four areas to be swabbed are the backs of both hands and the palms of both hands.

- On the back of the hand the radial aspect of the forefinger, the dorsal aspect of the thumb and the skin web between must be swabbed.

- On the palm of the hand the palmar aspect of the forefinger and thumb together with the base of the forefinger and thumb and the skin web between is swabbed.

- Clothing submitted for gunshot residue examination should be carefully handled, air dried, and wrapped separately in paper.

- Clothing with blood must be air dried and labeled BIOHAZARD on the inner and outer containers. The date, time, location, collector's name, case number, and evidence number should be on the container.