U.S. DEPARTMENT OF THE TREASURY
BUREAU OF ALCOHOL, TOBACCO AND FIREARMS

A FIELD GUIDE TO RECOVERING EXPLOSIVES IDENTIFICATION TAGGANTS

Prepared by
Explosives Technology Branch
Bureau of Alcohol, Tobacco and Firearms
Washington, D.C.

FOR LAW ENFORCEMENT USE

ATF P 7555.1 (1/78)

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- For Technical Assistance in Investigating the Illegal Use of Explosives

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FOREWORD

The illegal use of explosives is a widespread problem that is growing in severity. Used as weapons, explosives have become an easy and available tool for those with unstable minds, as well as for calculating criminals. Perhaps the most psychologically effective and physically dangerous use of explosives is accomplished by the indiscriminate bomber; innocent citizens are potential victims for no apparent reason. These bombings present a great threat to society; the societal effect can be greatly out of proportion to the actual danger presented—commerce can be slowed; human values are degraded; and the confidence of a society in itself eroded. It is imperative that the utmost degree of concentrated effort be implemented toward bombing investigations so that we may prevent these types of explosives incidents from happening.

"A Field Guide to Recovering Explosives Identification Taggants" is designed to serve as a convenient source of information on recovering explosives identification taggants from bomb scenes by law enforcement officials. It is the belief of the Bureau of Alcohol, Tobacco and Firearms (ATF) that the use of explosives identification tagging will provide the means for tracing explosives to a point that will assist the investigator in apprehending the criminal.

ATF has prepared this field guide, primarily for law enforcement agencies, in the hope that it will provide meaningful information to assist all involved in explosives investigations. If you have any questions concerning explosives identification tagging, please do not hesitate to contact us. We hope this publication will prove helpful to you in discharging your responsibilities under the Federal, State and local statutes.

Rex D. Davis

Director

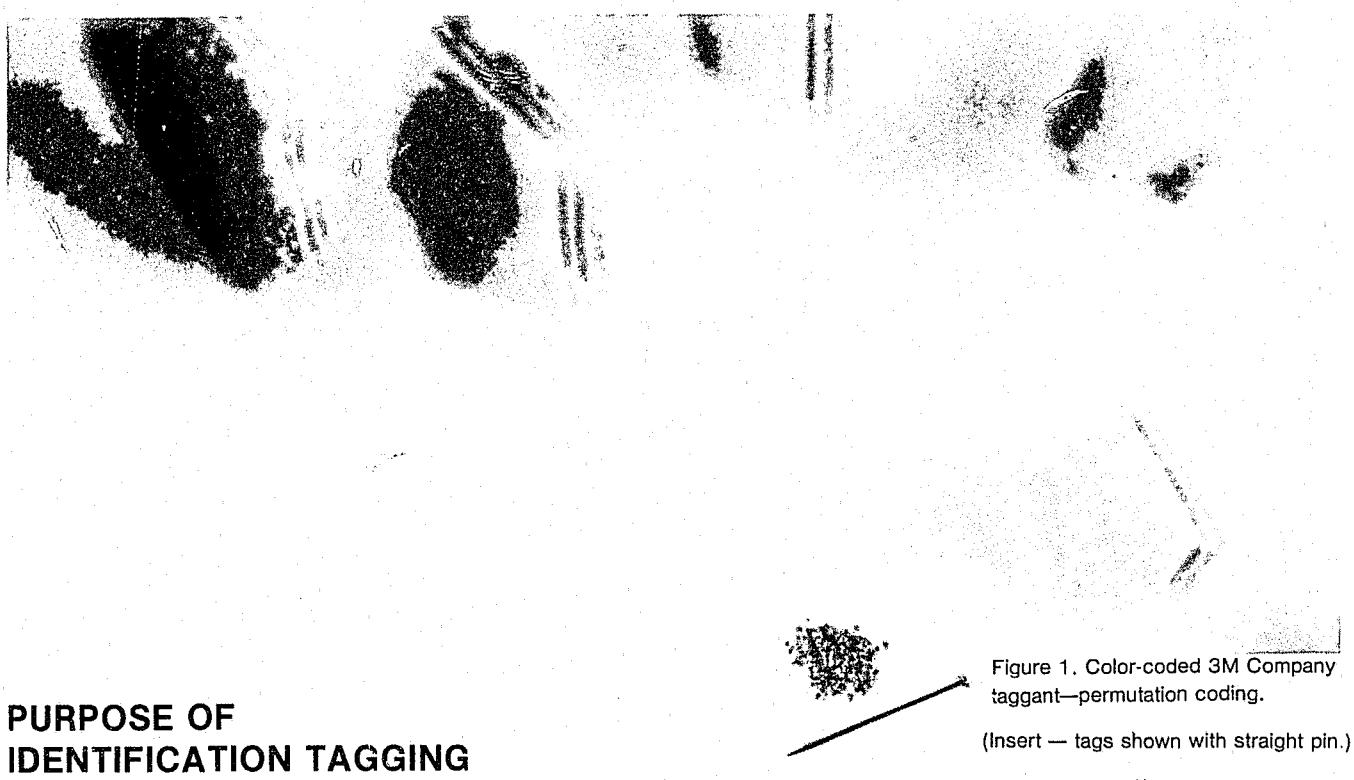


Figure 1. Color-coded 3M Company taggant—permutation coding.

(Insert — tags shown with straight pin.)

PURPOSE OF IDENTIFICATION TAGGING

Identification tagging is designed not to replace existing bomb-scene investigation techniques but to augment them. While they may often reveal the type of explosive used, existing investigative techniques will, in a few rare cases, provide the investigator with the name of the plant of manufacture. With the recovery, decoding, and subsequent tracing of identification taggants, the investigator can determine the plant of manufacture, the date and shift of manufacture, the name and grade of the explosive material, the size of explosive package, the particular 20,000-pound lot of production of the explosive material, and finally, the name and address of the distributors and final legal users of the explosive material.

GENERAL DESCRIPTION OF COLOR-CODED TAGGANT

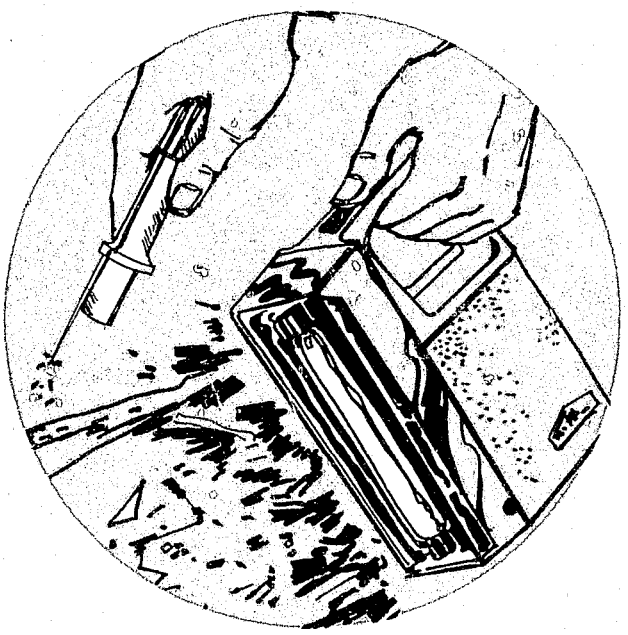
The color-coded taggant developed by the 3M Company is a plastic chip that is manufactured in pigmented layers providing a combination/permutation coding, as shown in Figure 1. One of the layers is magnet-sensitive to aid in retrieval, and one of the outer layers (called the spotting layer) is fluorescent to aid in visual detection. The taggant is coated with polyethylene and has a polyethylene-to-chip weight ratio of 1:1. The purposes of this coating are to provide an ablative shield and to minimize the absorption of explosive ingredients.

The selection and sequence of colors in the layers of plastic is a particular code. Eight layers are used including the spotting and magnetic layers. The spotting layer fluoresces (orange, green, or white) when exposed to ultraviolet light. The magnetic layer may be black or grey. If it is grey, it may occupy any position other than the spotting phosphor position. If the magnetic layer is black, it may be placed in any of the six positions other than that occupied by the spotting layer and the layer adjacent to it. There are 10 colors available for use, numbered from 0 to 9, as follows:

0 BLACK	5 GREEN
1 BROWN	6 BLUE
2 RED	7 VIOLET
3 ORANGE	8 GRAY
4 YELLOW	9 WHITE

This is the same code as that used for electrical resistors. Only three of these colors (white, gray, and yellow) are used next to the spotting layer, and two adjacent layers are never the same.

Taggants are added to explosives during manufacture at a weight concentration of approximately 0.05 percent. The average half-pound stick of dynamite will contain about 2000 taggant particles. Once these taggants are added to the explosive material, they are virtually impossible to remove.



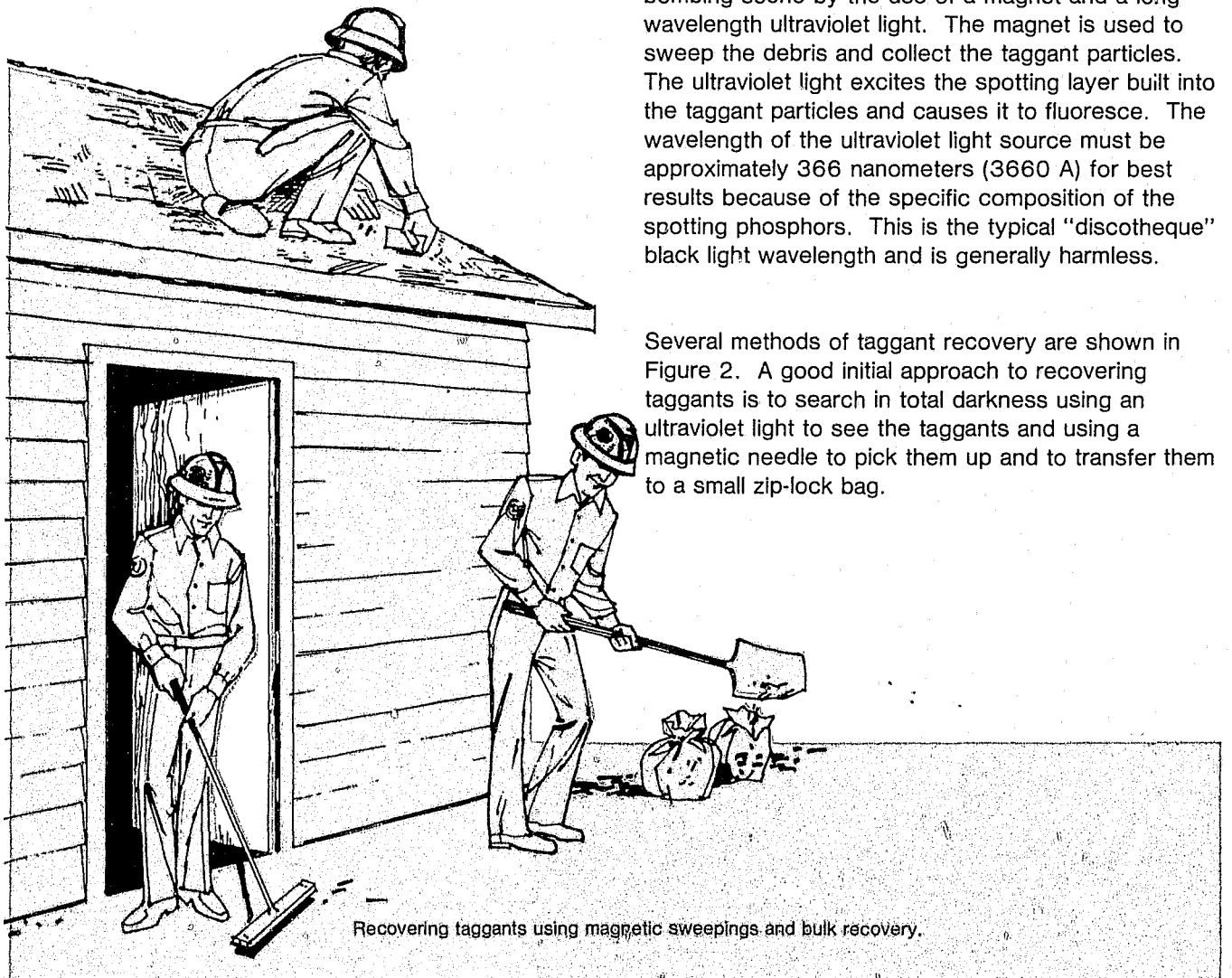
Recovering taggants using UV light and magnetic needle.

TAGGANT RECOVERY

Survivability of the taggants is a function of the type of explosive involved, the type of container used (e.g., pipe bomb), the degree of post-detonation fire, the resultant postdetonation washdown by the fire department, and other similar occurrences. Tests to date confirms that several hundred taggants will survive most detonations. Some will be damaged (i.e., charred or broken), but many will be intact and readable. The polyethylene coating will be absent after the blast, and the particles will be somewhat smaller due to fracture, but still easily readable in most cases.

The color-coded taggants are retrieved at the bombing scene by the use of a magnet and a long wavelength ultraviolet light. The magnet is used to sweep the debris and collect the taggant particles. The ultraviolet light excites the spotting layer built into the taggant particles and causes it to fluoresce. The wavelength of the ultraviolet light source must be approximately 366 nanometers (3660 A) for best results because of the specific composition of the spotting phosphors. This is the typical "discotheque" black light wavelength and is generally harmless.

Several methods of taggant recovery are shown in Figure 2. A good initial approach to recovering taggants is to search in total darkness using an ultraviolet light to see the taggants and using a magnetic needle to pick them up and to transfer them to a small zip-lock bag.



Recovering taggants using magnetic sweepings and bulk recovery.

Figure 2. Methods of taggant recovery.

In almost all situations, one attempt to recover taggants should utilize a magnetic sweep. This can be accomplished by using a special magnetic broom or a hand-held magnet. The hand-held magnet is enclosed in an inside out plastic bag which is used to collect all magnet-sensitive residue (Figure 3). The plastic bag used is a commercial variety designed for storing food. The most flexible bags provide the greatest ease in collecting the taggants; however, care must be taken to ensure that the bag is not torn by the debris or by the magnet. Once a sweep is completed, the bag should be carefully inverted and the magnet removed, as illustrated in Figure 4. It is useful to place an evidence card inside the bag to identify the date and specific location of the sweep. This information should also be recorded on the master map of the bomb scene. The polyethylene bag should be closed and tied, then placed inside a plastic zip-lock bag, sealed (with evidence tape), dated, and initialed.

During this recovery process, an ultraviolet light may be used to confirm that taggants are actually being collected. The ultraviolet test may not be conclusive because dirt and other debris can mask the reading. Hence, no magnetic material should be discarded on the basis of a cursory ultraviolet examination. Also, the field microscopes can be used to determine if the color-coded taggants are readable. Again, this technique may be inconclusive, but it is useful in estimating how many readable particles have been recovered.

For larger sweeps, the magnetic broom may be used (Figure 5). The magnets are removed from inside the sweeper at the end of a sweep, and the taggants are brushed off with a paint brush or washed off with water or a volatile fluid (e.g., alcohol) into a suitable container. Again, detailed records should be made of the time and place of the sweep. The recovered taggants should be separated from the washing fluid by placing a magnet under the container and then pouring off the fluid or by evaporation. The recovered magnetic material should be transferred to a polyethylene bag. This bag should be closed, tied, and inserted into a larger plastic zip-lock bag. The zip-lock bag should be sealed (with evidence tape), dated, and initialed.

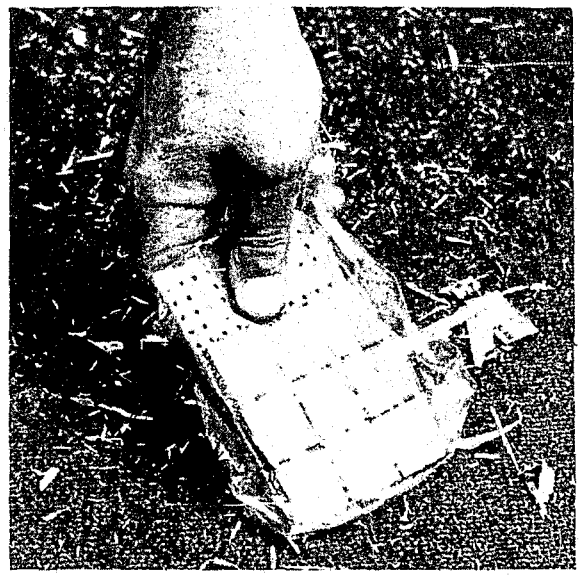


Figure 3. Collecting taggants with magnet in plastic bag.

Figure 4. Removing taggants from magnet.

Figure 5. Using magnetic broom.

Figure 6.

TAGGANT SEPARATION FROM DEBRIS

While individual taggants can be recovered at the bomb scene, the process is tedious, takes considerable time, and, in general, does not result in finding all of the available taggants.

It is always advisable to collect samples of bulk debris (e.g., soil, plastics, cloth) for later examination. (It is important to note that one soil sample taken from the seat of the explosion should be sealed in a vapor-proof container and should be sent directly to the laboratory without being subjected to the following process.)

One method for slurrying is by placing a strong magnet under a beaker of debris and water. The contents of the beaker is poured back and forth into another beaker. The magnetic debris will accumulate in the beaker having the magnet under it (Figure 6).

To separate taggants from bulk debris, one can place a small amount of debris in a large (i.e., 2 liter maximum) beaker. Then put a magnet inside a close-fitting test tube (Figure 7) and gently swirl the test tube and magnet in the debris/water slurry in order for the magnet to attract the magnet-sensitive taggants. This action (magnetically) separates the taggants from the debris (Figure 8). Next remove test tube/magnet from the slurry, hold it over a petri dish, and remove the magnet from the test tube (Figure 9).

The taggants can then be washed into the petri dish from the outside of the test tube (Figure 10). After a strong magnet is placed under the bottom of the petri dish, alcohol or water is added, the contents are stirred, and the fluid is carefully poured off, leaving only the magnet-sensitive material (Figure 11).

This separation process is quite time consuming, especially, when a large amount of debris is processed. However, experience has shown that by trying to speed up the process by using larger quantities of debris in larger beakers, the probability of missing taggants is increased considerably.

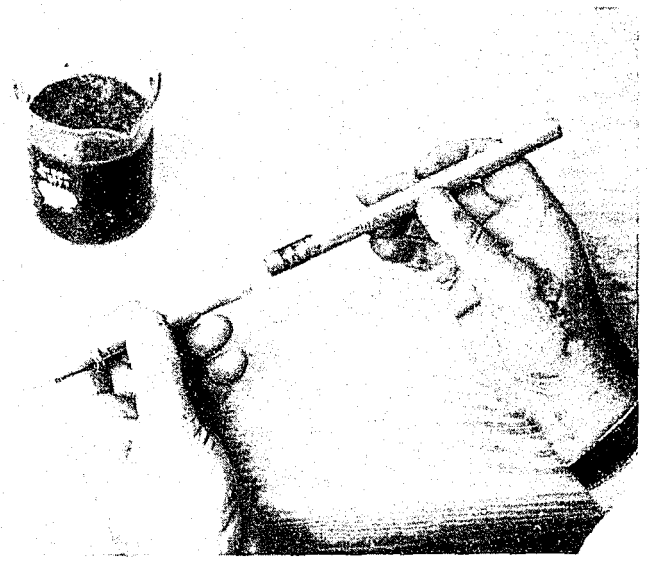


Figure 7.

Figure 8.

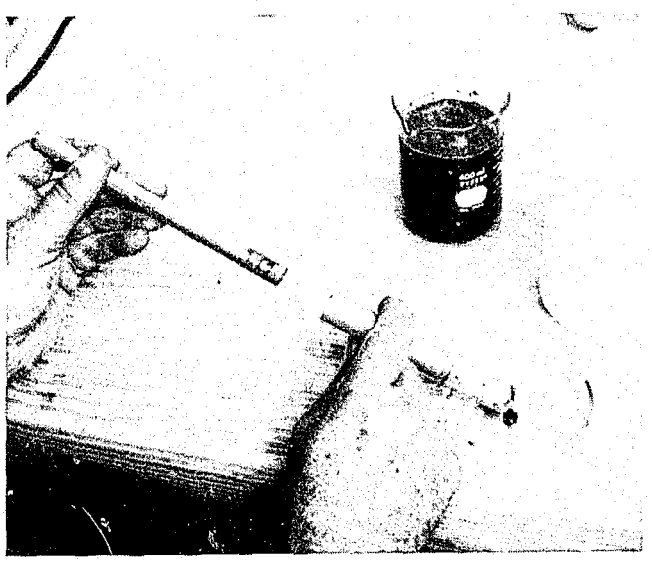


Figure 9.

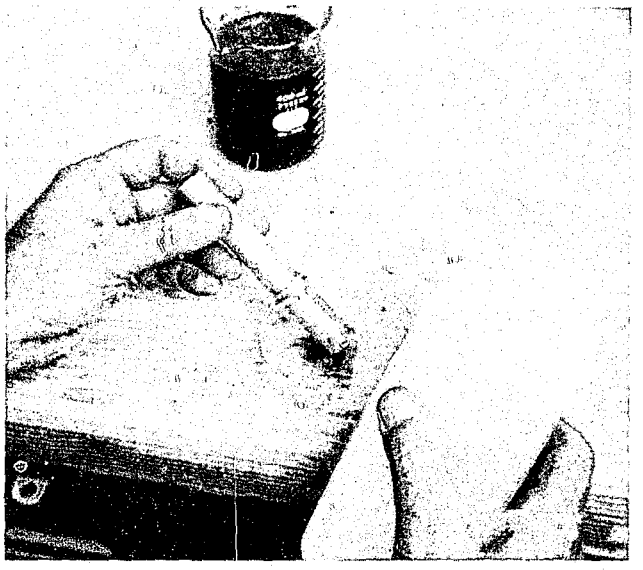


Figure 10.

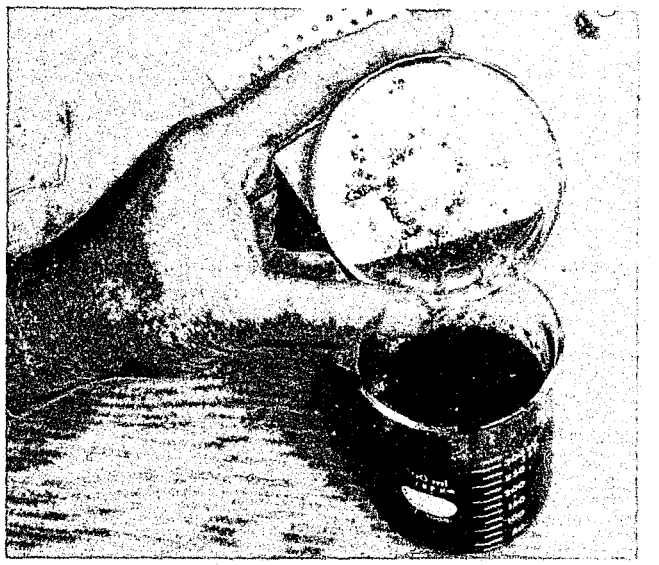


Figure 11.

Figure 12.

Figure 13.

Figure 14.

Figure 6: Slurrying by pouring. Figure 7: Inserting magnet into test tube. Figure 8: Magnet in test tube is gently swirled in debris/water slurry. Figure 9: Test tube is placed over petri dish and magnet is removed. Figure 10: Taggants are flushed from outer surface of test tube. Figure 11: Taggants in petri dish are further washed with alcohol. A powerful samarium cobalt magnet is placed under the petri dish to ensure that no taggants are lost. Figure 12: Saturated zinc chloride solution is added to magnetic debris to float out taggants. Figure 13: The slurry is stirred to accelerate the separation. Figure 14: Using magnetic retrieval technique.

The scene of a bombing is generally not free of magnet-sensitive material. There are many naturally occurring materials and materials from the exploded device (e.g., pipe-bomb debris), that can be picked up by the magnets. The technique used to separate the taggants from this magnetic material is based on the difference between the specific gravity of the taggants and that of other commonly occurring magnet-sensitive debris. The debris is placed in a solution of high density, and gravity separation occurs. Ideally, the taggants float and the non-taggant materials sink.

A useful material for performing the separation is a saturated zinc chloride ($ZnCl_2$)/water solution. This is prepared by dissolving one pound of $ZnCl_2$ crystals or powder in 100 ml of water.

The $ZnCl_2$ solution should be poured into a 50- to 400-ml beaker. The magnet-sensitive blast debris, containing taggants, can then be added (Figure 12), and the mixture carefully stirred (Figure 13). After 15 to 30 minutes, most of the separation will have occurred, and the lighter material (including those taggants that are free to float) can be skimmed off the top using the magnet-in-a-test-tube as before (Figure 14). Some nontaggant material will still be present. This flotation process can be repeated to achieve a high degree of purity. It should be noted that the heavy material that sinks in the $ZnCl_2$ may also contain some taggants, and an ultraviolet examination should be made before it is discarded or placed in storage. It should be also noted that this magnetic residue is a good place to look for other evidence such as clock parts, etc.

Figure 15. Searching for taggants at car bombing.

WHERE TO LOOK FOR TAGGANTS

Taggant particles can be expected to be carried by the dust cloud of a bombing many feet from the seat of the explosion. Bombings that take place inside a house can send taggants to rooms of the house remote from and otherwise unaffected by the explosion. The roof of the house is frequently a fruitful place to find taggants because they are carried by the explosion's dust cloud. Downwind areas are reasonable places to magnetically sweep for taggants. Because they can be consumed by an ensuing fire, it is profitable to look for taggants which are blown clear of the explosion in addition to the area surrounding the seat of the explosion. Taggants may also often be found in areas where water accumulates after the fires caused by a bombing have been extinguished.

In all cases, it is important to make an early assessment of the situation to avoid obscuring or losing taggants by burying them or sweeping them away or grinding them into the dirt. As in all bomb-scene investigations, the search should begin at the seat of the explosion and work outwards. The following general factors should be considered:

1. Taggants are light, small, and easily lost in postblast debris.

2. Taggants (like sand) will sink in water and will be washed to a low spot where they can accumulate.

3. Taggants will adhere to or be embedded into almost any surface.

4. A surface examination with an ultraviolet light is more easily performed with no background light. Use natural darkness or black cloth with available light barriers (e.g., doors, blankets) to eliminate any background light, and give eyes a chance to get dark-adjusted.

5. A certain amount of fluorescent clutter will always be present, usually of the wrong color. (A color card is available from ATF with samples of the spotting layer pigments so an on-the-spot comparison can be made.)

6. A particle that has the right color under ultraviolet light and that is picked up on a magnet is probably a taggant. Treat it carefully.

7. All visible tag-like particles should be recovered and screened carefully (within the limits of time and good judgment). A minimum of 20 taggants should be recovered of which at least 11 must be the same code. The collection of additional taggants is highly desirable in order to build an air-tight court case.

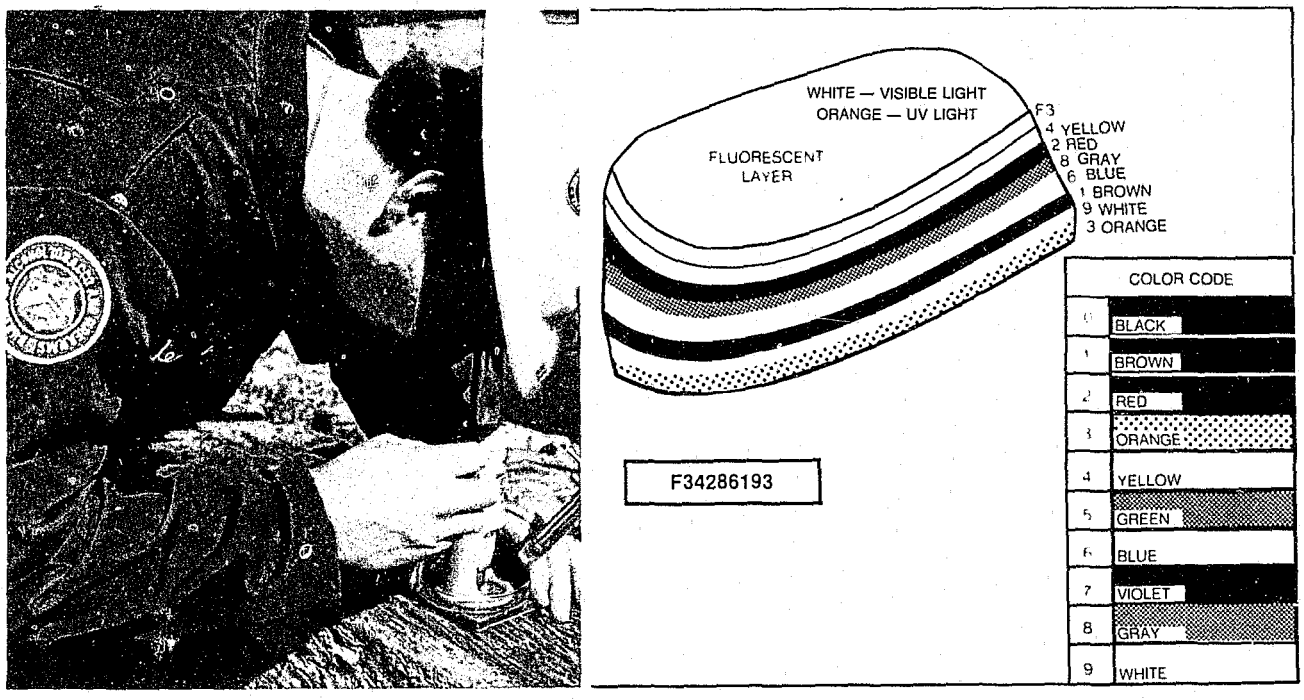


Figure 16. Microscopic readout of taggant.

READING THE TAGGANTS

Figure 15. Microscopic readout of taggant.

To determine the code, one must proceed as follows in reading the recovered taggants.

1. Get adequate illumination.

2. Use a 100X (or greater) microscope.

3. Use a color standard, if available.

4. Place a flat magnet under the dish containing the taggants and move the dish over it, thus causing the tags to stand on edge for easy reading (Figure 16).

5. Start the reading of the code with F (for fluorescent), followed by the code number of the spotting layer as viewed under ultraviolet light. With a spotting layer of orange, the number following the F would be 3. The spotting layer of any given taggant will be limited to orange (3), green (5), or white (9) under ultraviolet light. An orange spotting phosphor will indicate a permissible explosive. A white or green spotting phosphor will indicate a nonpermissible explosive.

6. Place the taggants under the microscope, use an incandescent light, and read the balance of the code following the spotting layer.

7. Assume there are always eight layers, including the magnet-sensitive and spotting layers.

8. The edge of the magnet-sensitive layer may be fuzzy or grainy in appearance due to the collection of magnetic debris during handling. This fuzz may somewhat obscure the adjacent layers. Remember, the magnetic layer is always black or gray; there may be other black or gray layers present.

9. If a taggant is dirty, it can be carefully washed with alcohol and rinsed by placing a magnet under the petri dish to hold it in place.

10. If a taggant is charred, it may be possible to expose the color layers by carefully cutting it in two using a sharp knife and the microscope.

11. The color sequence of all recovered taggants must be carefully recorded. Look for slight differences; don't assume all taggants are the same.

12. To avoid any ambiguity it is important to transmit the color sequence to ATF, whether or not the numerical code has been determined.

EQUIPMENT REQUIRED FOR TAGGANT RECOVERY

COMPLETE FIELD KIT

1. Portable microscope with light (100X or so)
2. Magnetic broom with samarium cobalt magnets
3. Ultraviolet light, batteries
4. Magnetic pallet, samarium cobalt
5. Flashlight, batteries
6. Small metal garden trowel
7. Collapsible bucket
8. Dark room cloth
9. Microscope slides
10. Metal test tube
11. Petri dish with cover
12. Plastic beakers (3), 400 ml
13. Plastic flush bottles (2)
14. Alcohol, with plastic bottle
15. Wood stirring rods (10)
16. Medium needles
17. Medicine droppers (2)
18. Tweezers, nonmagnetic
19. Plastic bags (approximately 6" x 8") (10)
20. Case, aluminum, 18" x 26" x 9"
21. Cylindrical magnet with handle (samarium cobalt)
22. Work surface
23. Magnetic broom
24. Paint brush
25. Tissues, small box
26. Zinc chloride crystals or powder

MINIMUM FIELD KIT

1. Cylindrical magnets (preferably samarium cobalt)
2. Teflon beakers (2)
3. Small shovel
4. Ultraviolet light with batteries
5. Test tubes (3) (or aluminum tube (1))
6. Small flush bottle
7. Focus cloth, 6' x 5'
8. Plastic bags (12)
9. 1" x 1 1/8" x 1/4" samarium cobalt magnets (3)
10. Petri dish

EQUIPMENT DECONTAMINATION PROCEDURES

Because the equipment used in a bomb-scene investigation will be used in future bomb-scene investigations, it is essential that all taggants be removed so that they will not contaminate a future bomb-scene search. Several procedures are useful. Ultraviolet light can be used to inspect the equipment for taggants. Taggants can be removed from magnets by using the sticky surface of masking tape to lift them. Washing the nonmagnetic equipment with water is also effective.

DISTRIBUTION TRACING

The National Explosives Tracing Center (NETC) of the Bureau of Alcohol, Tobacco and Firearms in Washington, D.C., is authorized to conduct explosives tracing. Centralizing this activity significantly reduces the burden on the explosives industry and maintains the listing of which taggants were sent to which manufacturers. Also, while the explosives manufacturers will voluntarily support all law enforcement requests for trace information, they will require independent verification of the telephone requestor's authenticity. This is a time-consuming process that can be eliminated by using the established channels and contacts of NETC.

Once the color sequence for each recovered taggant particle has been determined, that sequence should be transmitted to NETC. It is desirable that the actual color determination be made under laboratory conditions preferably using a standard microscope light source and a standard color bar. However, tracing can be initiated on the field readout when an urgent need can be shown. Using this information, the NETC will contact the appropriate explosives manufacturers to determine the primary distribution points of the explosives tagged with the recovered taggants. The name of the manufacturer, the name of the explosive product involved, the date/shift code, the package size, and the primary distribution points will then be provided to the investigative authority for subsequent investigation.

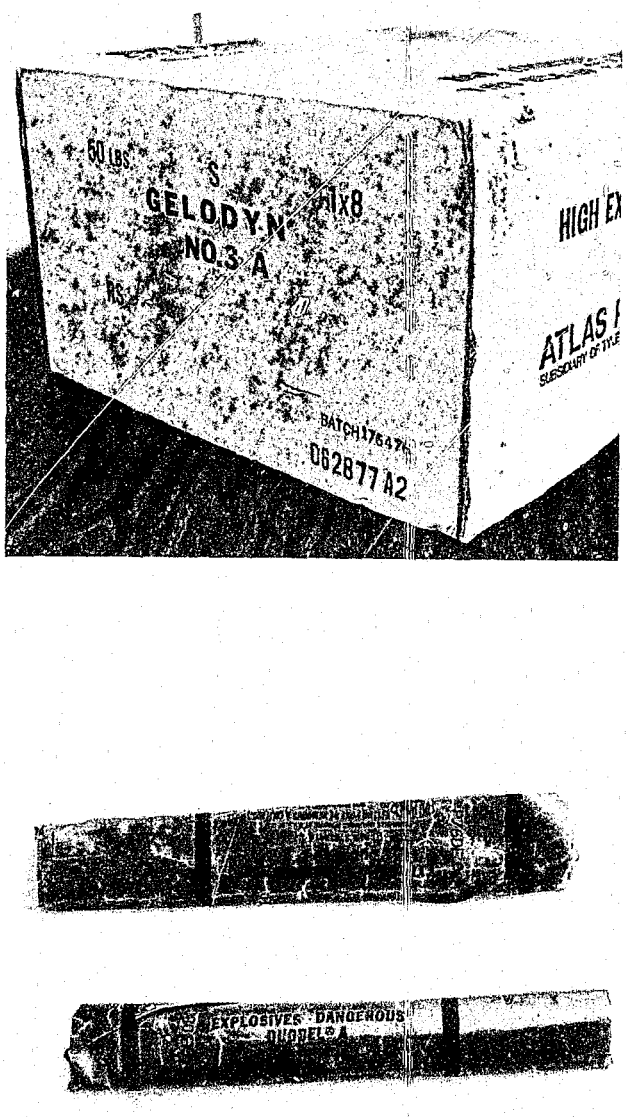


Figure 17. Existing date/shift code.

IMPACT ON TRACING UNDETONATED EXPLOSIVES

The existing trace capability based on the date/shift code and other coded or uncoded data on an undetonated cartridge is not diminished by tagging. By providing the National Explosives Tracing Center with the name of the explosives product, the size of the package, and the manufacturer's marks of identification found on the individual packages and the shipping case (Figure 17), a trace can be conducted, and a list of primary distribution points will be provided. In addition, the code of any taggants found in the undetonated explosives can be used to increase significantly the specificity of the trace.

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Bureau of Alcohol, Tobacco and Firearms

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Technical assistance in taggant recovery and decoding will be provided by any of the following Bureau of Alcohol, Tobacco and Firearms offices.

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