APPENDIX C–OTA RECOVERY TESTS

Introduction

As indicated in chapters I I and Ill, a number of tests, demonstrations, and training exercises have been conducted by BATF, the Aerospace Corp., FBI, 3M, BOM, IME, local police departments and others in which attempts were made to recover the 3M identification taggants from the postdetonation debris. These tests usually had limited objectives, such as demonstrating that taggants could be found by trained law enforcement personnel; as a result, little or no control was placed on the tests and little or no documentation was attempted. As an example, BATF conducts 2-week training courses at its academy at Glenco, Ga. Over 50 test bombings of automobiles have been conducted with tagged explosives as part of that training exercise, but no data has been collected on recovery.

Due to the different aims, purposes and procedures used, similar tests conducted by different groups resulted in widely varying recovery rates. As an example, table 11 of chapter II shows that BATF and Aerospace were able to recover taggants from automobile bombing demonstrations under both relatively benign and very adverse conditions. I n similar I ME tests, shown in table 13 of chapter 11, difficulty was encountered in recovering taggants from automobile detonations, even under benign conditions.

As none of the tests were well-controlled or documented, it was extremely difficult to analyze the reasons for the differences, or even quantify the recovery expectations under any conditions. OTA therefore accepted an offer by BATF to conduct a controlled series of tests under OTA control.

Test Objective

The objective of the test series was to obtain quantified data on the postdetonation recovery of the 3M identification taggants under carefully controlled test and recovery conditions. Such data would provide an indication of the recoverability of the taggants under those conditions (although probably not a statistically valid demonstration). It might also provide insight into recovery under similar conditions, and help to resolve the dichotomy of prior test results. It was originally hoped that tests could be run against a variety of targets, including buildings and automobiles; due to time and fiscal constraints, however, it was necessary to limit the target to automobiles. Test facility restrictions limited the placement of the automobiles to unpaved surfaces; the surfaces used were hard-packed, gravel-laden earth. Within the constraints it was hoped that the tests would resolve the following four specific questions:*

1. Is it reasonable to presume that sufficient taggants can be recovered from automobile bombings under real-life conditions to enable a determination to be made as to the origin of the tagged explosives? Even if taggants are recovered from each test condition, no more than a presumption of recoverability may be made. A more extensive testing program would be necessary to determine the conditions under which the taggants are recoverable. Parameters of a definitive test series would include weather, fire, fireman response, and between-test replication variability. Failure to recover taggants under each of the test conditions would lead to a presumption that the taggants could not be expected to provide information on the origin of explosives in car bombings. Success in some of the tests would indicate that information would presumably be available from a subset of automobile bombings; definitive testing would be required to precisely define that subset.
2. Are there conditions that are more likely than others under which automobile bombings will yield taggants sufficient to establish the explosives' source? The specific condition to be tested is the relative strength of the explosive. Test conditions may also permit a limited assessment of the effects on recovery of the skill or dedication of the investigator, the weather, and the effects of fire and subsequent fire-fighting efforts.
3. What is the magnitude of the effort necessary to recover sufficient postdetonation taggants for explosive source determination? If, in fact, heroic efforts are required (as was reportedly the case in one of the Aerospace/BATF tests) then the utility of taggants in automobile bombings would be limited to the bombings of high-value targets and would not be of value to routine investigations normally carried out by bomb squads, These limitations would apply only to those conditions under which heroic efforts were necessary. This question only has meaning if the taggants are, in fact, recovered, even after heroic efforts.

● These questions are repeated verbatim from a pretest plannining document and have been modified only to reflect the unavaliability of paved surfaces

4. Are the taggants field readable? One of the advantages of the 3M taggants is their ability to be easily and quickly read by agents in the field. If, in fact, large amounts of debris must be collected and laboratory processed, then the taggants are not field readable, at least for those automobile bombings which are similar to the test conditions. If the 3M taggants are not field readable, then perhaps some of the other tagging methods, rejected for that reason, should be reconsidered.

Similarly, OTA believed that if taggants were not recovered in usable quantities in the tests, this would not necessarily indicate that taggants could not be recovered under more favorable conditions; for example, a bombing that damages but does not destroy a building. However, the presumption that taggants could not be recovered under some real-world conditions would affect OTA's analysis of the utility of taggants, and the greater the range of conditions in which taggants could not be recovered —or could be recovered only after heroic efforts –the greater the negative impact on estimates of taggant utility.

Test Conditions

Bombs, each consisting of approximately 2 lb of dynamite, were placed in five automobiles and remotely detonated. The automobiles were located on hard-packed, relatively level earth. Three were on dirt roads and two were on bare patches of hard-packed ground. No brush or debris was in the immediate vicinity of the automobiles. Specific test conditions are summarized in table C-1. By comparing the results of tests 1 through 3 it is possible to relate recovery to the power of the dynamite; by comparing the results of tests 1 and 4, it is possible to assess the effects of a fire and subsequent fire-fighting activities, by comparing tests 3 and 5, it is possible to assess the effects of the added confinement provided by the engine block.

The explosives for the tests were chosen by OTA from a larger inventory of factory-tagged explosives provided by the Aerospace Corp. A 0.05 -percent concentration of encapsulated taggants was used in each case, except that in test 4 the explosive contained 0.05 percent of each of two separate unencapsulated taggants. The explosives were assembled into a bomb and covered with a brown bag by Dr. Edward James of the OTA analysis team and placed in the target by Dr. James, with the assistance of a different FBI agent for each test; the FBI agents could not see the explosive cartridges. The choice of explosives and placement decisions were made by David Garfinkle and Dr. James, the OTA test coordinators, and were unknown to anyone else. Samples were removed from each bomb for analysis to ensure that taggants were, in fact, present in each type of dynamite and to validate the identity of the postdetonation recovered taggants.

Recovery Procedures

An attempt was made in the recovery process to see if differences in training and experience resulted in differences in the probability of recovering taggants. To test the question of field recovery skill, two sweeps were made of each target. The first sweep was made by an "amateur" team, to roughly simulate the procedure and skill that might be expected from a typical bomb squad. The second sweep was made by a trained BATF team. The amateur team, in each case, consisted of a member of the OTA study group, another non-BATF volunteer, and one BATF agent. The non-BATF volunteers, one to a team, included Randall Bowman of NRA, Robert Hodgdon of the Hodgdon Powder Co., Officer Larry Linville of the Washington Metropolitan Police Bomb Squad, and Dennis Kline, an FBI agent. The team was given approximately 5 minutes of instruction and 1 hour for the search. The searches of all but the firebombing site (test 4) were conducted between approximately 3 and 4 p.m., with the use of blankets, black lights, and magnetic brooms contained in the Aerospace Corp. developed kits, shown in figure C-1. The amateur teams searched for taggants with the black light, did a magnetic sweep, and collected debris for laboratory analysis.

Table C-1 .–Specific Test Conditions, OTA Recovery Tests

Test	Placement	Dynamite	Test condition
1	Under driver's seat	Collier C, low power	5-gal gas in tank, no fire
2	... Under driver's seat	Unigel, medium power	5-gal gas in tank, no fire
3.	Under driver's seat	Power Primer, high power	5-gal gas in tank; no fire
4., .,	Under driver's seat	Collier C, low power	1-gal gas adjacent to bomb, fire, firefighting
5 ., .,	Between engine and firewall	Power Primer, high power	Dry tank, no fire

SOURCE Office of Technology Assessment

Figure C-l.–Portable Kits, Developed by the Aerospace Corp., Were Utilized in the OTA Taggant Recovery Tests

Photo credit: U.S. Department of the Treasury

The six-man BATF professional teams then conducted a thorough second sweep of each target, including further collection of debris, magnetic sweeping, and taggant black-light search. For this search, the area was divided into grids, and the collected material was carefully identified by the grid number. Figure C-2 shows the grid used in test 3. Each BATF search took approximately 3 hours.

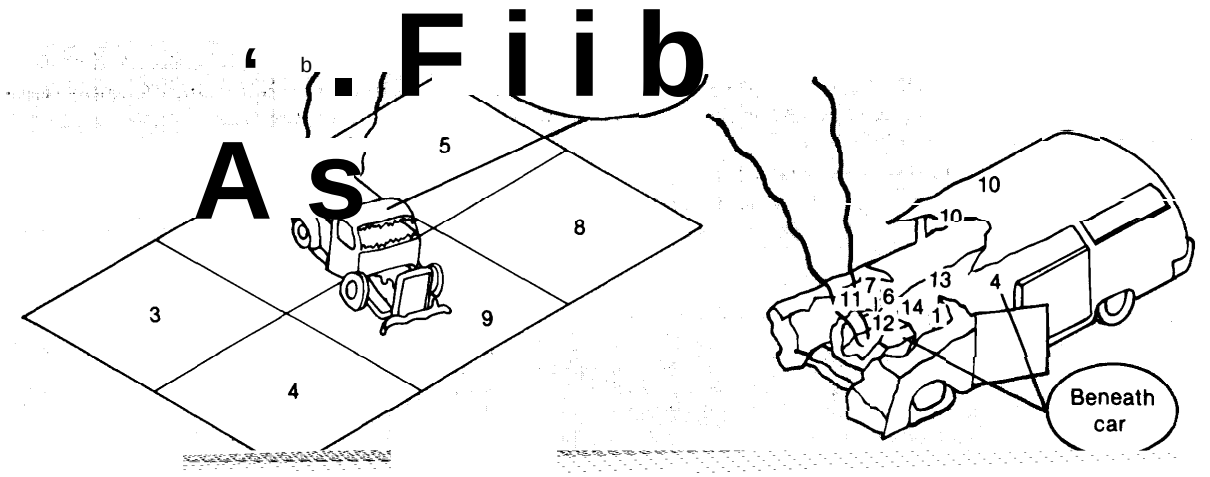
Laboratory Analysis

A preliminary analysis was conducted at the test site by a team from the BATF national laboratory. A few taggants were identified from the first three tests conducted (actually tests 5, 1, and 2) to demonstrate field laboratory identification. The material was then taken to the BATF national laboratory and quantitatively analyzed. The time necessary to recover more than 20 taggants for each test was recorded, as was the location of the debris from which the taggants were collected. The taggants were then mounted on slides and the codes read. Identification of the explosives was then made from the taggant code. Most of the laboratory analysis was conducted by Mr. Richard Strobel of the BATF national laboratory, although a volunteer team from NRA separated four of the taggants from the test 3 debris.

Test Results

The results of the tests are summarized in table C-2. Over 20 taggants were recovered in the laboratory from the debris of each automobile bombing. Laboratory time ranged from less than Vi hour to approximately 4 hours (plus 5 hours preliminary time to refine procedures). Taggants were recovered from the amateur sweep in three of the five tests. In one test, the amateur and professional sweep material became mixed up during transportation to the BATF national laboratory as a result of a deep chuckhole. In the final case, the amateur search material was inadvertently stored separately from the other recovered debris and not examined. Photo micrographs of the recovered taggants are shown in figures C-3 through C-7, one for each test. Some of the mounted taggants from test 5

Figure C-2.-BATF Search Grid



a. General recovery grid

b. Recovery within automobile

Table C-2.–OTA Recovery Test Results

Test	Condition	Number of taggants recovered	Source of taggants	Laboratory time (hours)
1, .	Collier C, low power, under driver's seat	28	Amateur search	1 1/2
2.	..., Unigel, medium power, under driver's seat	23 + 1 contaminant	Amateur search	1/2
3.	Power Primer, high power, under driver's seat	21 total 12 type A, 9 type B	Unknown	1 1/2
4, .,	Collier C, low power, under driver's seat, fire, firefighting	23	BATF team, primarily from automobile interior and under automobile	3
5.	Power Primer, high power, between engine and firewall	26 + contaminants (training tags from collection equipment)	Amateur search	4 hours + 5 hours preliminary time to define procedures, This was first material processed in laboratory.

SOURCE Office of Technology Assessment

Figure C-3.—Recovered Taggants From Test 1 (low power)

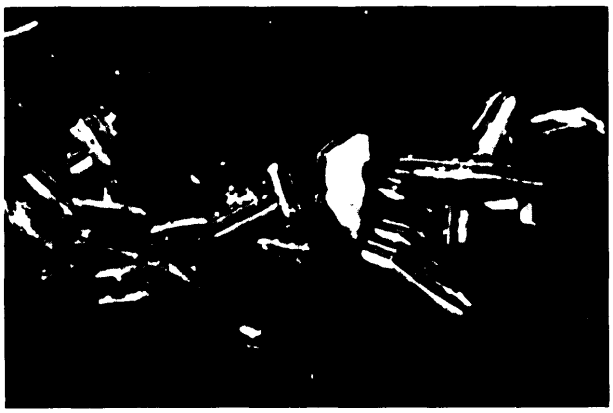


Figure C.4.—Recovered Taggants From Test 2 (medium power)

were accidently brushed off the mounting Slide; other recovered taggants are shown.

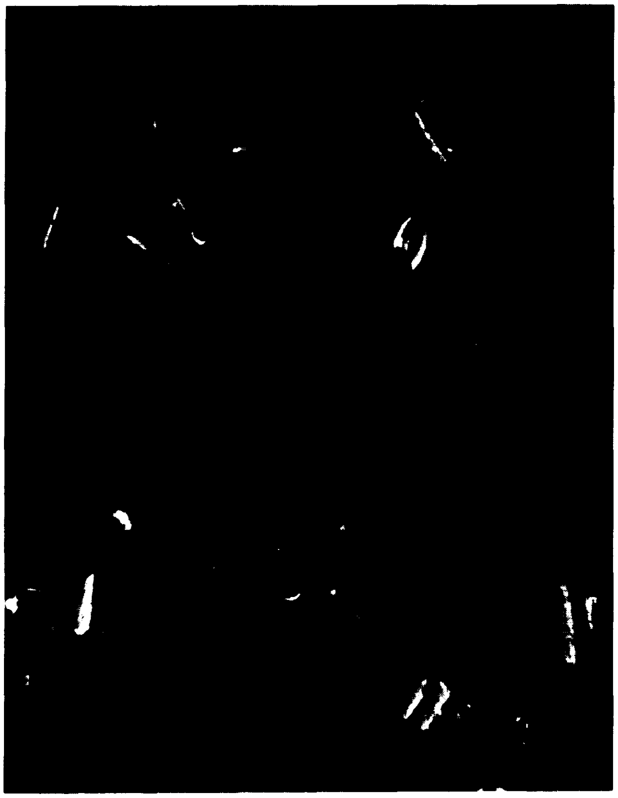
No taggants were individually recovered in the field, recognized as such, and field read.

All the explosives were correctly identified by BATF as a result of the color code on the taggants. The letter from BATF to OTA, which gives the identification information, is shown as an attachment. The test nomenclature in the letter differs from that used in test. The letter refers to the scenes in chronological order; in the text the tests have been grouped for ease of comparison. The following conversion of the letter "scene" designation to the text "test number" designation is necessary:

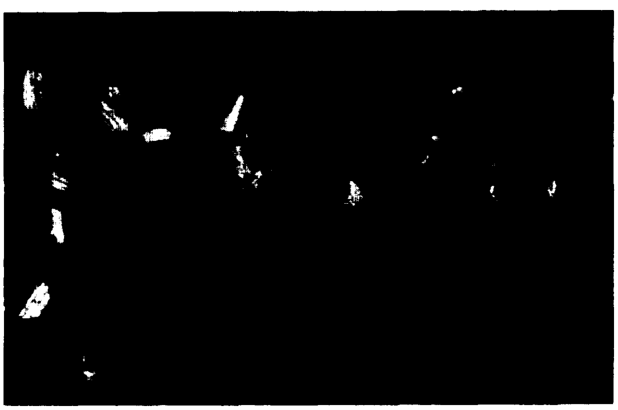
Scene 1. . . . . Test 5
Scene 2. . . . . Test 1
Scene *3*. . . . . **Test** 2
Scene *4*. . . . . **Test** 3
Scene 5. . . . . Test 4

Figure C.5.—Recovereci Taggants From Test 3 (high power)

F gure C 6 Reco e ed Taggan s F om Tes 4 ow powe re



F gu e C 7 Reco e ed Taggan s F om Tes 5 h gh powe con nemen



Tes Responsb y

w p d d ph
d b O A O A h h p b
d h b mb g mb d d d h

bombs, and placed the bombs in the target. (FBI agents inserted the detonators and initiated the explosives.) No one else knew which explosives were used on each automobile, or even which explosives from a larger selection were chosen. OTA, with assistance from NRA, observed the laboratory procedures and participated in the separation process.

BATF supplied the automobile targets, the test site, and the agents for field recovery and laboratory analysis of the taggants. The explosives were supplied by the Aerospace Corp.

IME was invited by OTA to participate in the test series. Due to the short time available for the test planning, IME was not able to fully participate. They did provide some valuable guidance, however, in a working session attended by OTA, BATF, SAAMI, NRA, and I ME representatives.

Discussion of Results

Too few recovery tests of the 3M identification taggants were conducted under real-world conditions to allow a definitive judgment to be made of recovery. In addition, only one type of target, automobiles, was used in the tests. However, the ease with which taggants were recovered, under the rather severe test conditions, indicates that taggants could be expected to be recovered under a wide range of bombing conditions, given the proper training and effort by field and laboratory investigators. A number of points should be made as a result of the test series.

In the first place, the taggants do not appear to be field recoverable and readable, at least under the test conditions. Approximately 25 people looked for taggants, for a total of approximately 35 man-hours, in both daylight and nighttime conditions, without visually recovering a single taggant. This was the case even though taggants were easily recoverable from the debris in the laboratory. BATF operating procedure, which calls for visual search, is not only ineffective, it is counterproductive. Investigators are likely to become disenchanted when they can't visually find a taggant, and not collect samples for laboratory analysis. BATF procedures should stress the importance of the collection of debris for analysis. It has been claimed that the earth at the test site is unusually rich in magnetic materials and materials which fluoresce naturally, and that the tests were particularly severe from the visual recovery standpoint. Visual recovery may, in fact, be possible in situations such as an automobile bombing on a large paved area, or a small bomb in a large building. It appears likely, however, that taggants will be

missed quite often if visual recovery means are emphasized.

The second point is that taggants appear to be recoverable from bombings, with a modest, but coordinated, effort on the part of field and laboratory personnel. Even under conditions of partial confinement, taggants from a high-energy dynamite were easily recovered. Similarly, taggants from a low-power dynamite were recovered even after a severe fire and firefighting activity. Additional tests would be required before the effects of full confinement, such as in a pipe bomb, or before the effect of fire after a high-energy detonation, could be known. Similarly, no tests have been conducted with large charges, or with tagged boosters and detonators used to detonate an untagged blasting agent.

It appears that the power of the explosive does not significantly affect recovery probability or the laboratory time necessary to separate taggants from the debris. Confinement and the occurrence of fire, however, do significantly affect laboratory recovery time, as the size of the taggants decreases.

Some difficulty was encountered in reading the colors of the taggant layers, even by experts from 3M. The pigments currently available, however, have been substantially improved, hopefully leading to fewer errors in interpreting the code.

The tests were conducted and field recovery completed on three of the five tests under near ideal weather conditions. A light rain fell before debris was collected from two tests, however, including the unconfined Power Primer and the case in which a fire followed the detonation. The light rain did not appear to hamper recovery, even for those severe test conditions; a heavy rain might, however, have more effect.

It should be noted that the automobile tests conducted represent rather severe tests of recovery (at least neglecting confinement). It is reasonable to infer, therefore, that taggants could probably be recovered from building bombings, bombings in the open, and most other nonconfined bombings.

It is interesting *to* note that no fires occurred as a result of the bombings, when fuel was in the fuel tanks, even for the most powerful commercial explosive (excluding boosters). While a sample of three is hardly significant, the tests do indicate that fires do not occur as a matter of course in automobile bombings.

Finally, it should be noted that these tests provide a possible explanation of the wide divergence of prior test data. Most of the tests in which BATF/Aerospace recovered taggants involved a laboratory recovery procedure; this was particularly true for the severe automobile bombings. Most of the unsuccessful tests by IME and others have either not included laboratory analysis, or have had the laboratory separation process conducted by people with no training in separating the taggants.

DEPARTMENT OF THE TREASURY
BUREAU OF ALCOHOL, T0BACC0 AND FIREARMS
WASHINGTON, **D.C. 20226**

September 28, 1979

Refer TO
DS : RD : WDW
7555

Mr. David Garfinkle
Office of Technology Assessment
600 Pennsylvania Avenue
Washington, DC 20510

Dear Mr. Garfinkle:

The following test results were obtained from the taggant survival studies conducted for you at Fort Belvoir, Virginia, on September 13, 1979.

Scene 1 was a 1949 Ford pickup truck. A 3- to 4-hour laboratory analysis of the bomb debris collected by Dr. Ed James (OTA), Mr. Randall Bowman (NRA), and Special Agent Marcus Davis (ATF) resulted in the isolation of 26 taggants bearing code F5959592M8. This identifies the explosives used in this case as Atlas Power Primer, size l-1/4~t x 8'?, Date/Shift Code 01-12-77-R2. Many contaminate training taggants were also in portions of the bombing debris. These probably came from a single contaminated recovery kit. The red layer in this early pre-pilot test version of the 3M taggant contains an organic pigment, and noticeable variation in hue was observed. This problem has subsequently been corrected in later versions of the 3M taggants.

Scene 2 was a late model Ford Galaxy. A l-hour, 20-minute laboratory analysis of the bomb debris collected by you, Mr. Robert Hodgdon (Hodgon Powder Company), and Special Agent Eugene Reagan (ATF) resulted in the isolation of 28 taggants bearing code F3913142M0. This identifies the explosives used in this case as a Hercules permissible dynamite, either Red HA, size l-1/4 x 8", Date/Shift Code Jul 12 78 Jl, or Collier C, size 1-1/4" x 8", Date/Shift Code Nov 21 78 J1. Both explosives were tagged with the same taggant code.

Scene 3 was an Oldsmobile station wagon. A 25-minute laboratory analysis of the bomb debris collected by Mr. Steve Kornish (OTA), Officer Larry Linville (Washington, DC Metropolitan Police Department), and

Special Agent Ivan Kalister (ATF) resulted in the isolation of 23 taggants bearing code F5989142M0. This identifies the explosives used in this case as Hercules Unigel Tube Shell, size 2" x 16", Date/Shift Code Jun 27 78 J1. One contaminate training taggant was also found in this debris.

Scene 4 was a Chevrolet Malibu sedan. Twenty-one taggants were recovered--l7 by our laboratory's chemist in 45 minutes, and 4 by the NRA's observers, Ms. Susan Rogers and Mr. James Flechenstein, in an unspecified time. Twelve of these taggants bear code F9986726M0, and 9 bear code F5984642M0. These taggants identify the explosives used in this case as Atlas Power Primer, size 1-1/4" x 8", Date/Shift Code 1O-24-78-R2. This material was specially produced for The Aerospace Corporation by Atlas Powder Company with an unencapsulated taggant species of one code and a taggant of a different code from which the encapsulating material had been stripped by solvent action.

Scene 5 was the Chrysler-product station wagon which was "fire-bombed" and permitted to burn until you directed the Fort Belvoir Fire Department to respond. A 3-hour laboratory analysis of bomb scene debris collected during an 8-man, 2-hour ATF search under the direction of Special Agent Eugene Reagan, resulted in the isolation of 23 taggants bearing code F3913142M0. This identifies the explosives used in this case as either Hercules Red HA, size 1-1/4" x 8", Date/Shift Code Jul 12 78 Jl, or Collier C, size 1-1/4" x 8", Date/Shift Code Nov 21 78 Jl, both with the same taggant.

These taggants and those mounted by Mr. Bowman of the NRA from field and first-day laboratory recoveries were given to you on September 24, 1979, for your use and examination. If we can be of any further service to you in documenting the results of these tests, please contact me.

Sincerely yours,

W. David Williams
Explosives Scientist