United States
Department of
Agriculture

Forest Service

**Technology &
Development
Program
SDTDC**

5100-Fire Management
April 1991
9151 1801

Fire Investigation Procedure For Multipurpose Small Engine & General Purpose Spark Arrester Exhaust Systems

Fire Investigation Procedure For Multipurpose Small Engine & General Purpose Spark Arrester Exhaust Systems

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TEO1P11
Technical Services, Fire Management

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SCOPE

With the multiposition small engine (MSE), general purpose, and locomotive spark arrester qualification test programs and test facilities at the San Dimas Technology and Development Center (SDTDC), the Forest Service has become expert in the area of spark arrester exhaust systems and their application. SDTDC can also provide technical support in a fire investigation (FI) involving a MSE, general purpose, or locomotive spark arrester and its application. SDTDC is capable of testing evidence confiscated for purposes of determining lawful use. An evaluation of the spark arrester includes laboratory testing, a review of the original qualifying records held at SDTDC, and determinations of any structural modification and if the unit was being operated under the correct application. SDTDC has the ability to provide expert testimony as necessary.

This FI procedure for spark arrester exhaust systems outlines the process required in requesting SDTDC's services to provide technical support in a FI. This process includes the handling of confiscated evidence in the field and upon receipt at SDTDC. This FI procedure also details the physical examination of evidence, the recommended course of action, tests performed, the written report, and return of the confiscated evidence.

INITIAL CONTACT

A request for technical assistance in a FI is usually initiated by a telephone call to SDTDC at 714/599-1267; FTS 793-8000; FAX 714/592-2309. The request usually originates from a Forest Service Fire Management Officer (FMO), a Law Enforcement Officer, a Fire Prevention Officer on a Ranger District or from a cooperating agency. This call will be directed to the MSE, General Purpose/Locomotive Spark Arrester Project Leader, Fire Prevention Project Leader, or the Fire Management Program Leader. Information given at this time includes:

1. All FI requests are initiated by a formal letter addressed to the SDTDC Center Manager. Within the Forest Service, this formal letter request may be sent via the Data General (DG) to the Center Manager at MAILROOM:W07A. The requesting officer must be very specific about what it is they want SDTDC to do, as in any suggested testing or specific areas of concern.

2. Obtain the name of the requesting agency, requesting officer, title, address, phone number, and DG mailbox.

3. If the request came from outside the USDA Forest Service, call and verify that the Regional Office (RO) FMO is aware a request for technical assistance in a FI has been initiated.

4. SDTDC will request an expenditure authorization to cover the estimated cost of services, time, and materials. Submit an authorization for "Not To Exceed" $1,000 on form 6500-46, "Authorization for In-Service Expenditures." This may be charged directly to the fire. Additional funds will be requested, if the estimated cost is revised as the evaluation progresses.

5. All hardware sent must follow normal procedure for transfer of confiscated evidence and be by registered mail. All hardware must be heavily packed for transport to prevent damage and possible invalidation of the evidence.

6. Request all MSE hardware involved in the investigation be sent intact and undisturbed. The exhaust is not to be removed from the power unit nor the exhaust system dissembled. These actions will contaminate the evidence significantly. This is very important.

7. If a general purpose spark arrester is involved, it may not be practical to send the spark arrester and power unit together. Photographs should be taken of the spark

arrester installation and fitup to the power unit before and after removal. Also, request that the exhaust system and the exhaust manifold be examined for cracks or drain holes larger than 0.023 in. Document these with photographs if present.

8. Required information with a general purpose spark arrester consists of the make/model of the power unit and the engine specifications for the engine that the spark arrester/muffler was mounted on. The engine specifications are to include the engine displacement, the number of cylinders, the number of cycles, and the maximum governed engine rpm.

9. The gas from a MSE is to be drained into a clean, airtight, gas-compatible container. Request the container be labeled and held for possible testing at a later date.

10. Inform the requesting officer that the evidence will undergo an initial examination and a recommended course of action will be discussed at that time. Authorization will be obtained from the requesting officer for any testing that may be destructive to the evidence.

11. Determine if a time condition exists. A tentative date of completion can be set after a recommended course of action is determined.

12. The final output of a FI is in the form of a formal report. Any queries generated by a FI or the written report are referred to the Fire Management Program Leader at SDTDC. A total of nine copies will be prepared with eight copies placed in binder form. The unbound copy will be held at SDTDC as a master copy. One bound copy will also go into the permanent SDTDC FI file. A minimum of two copies will be given to the requesting agency. One copy will be held for the Washington Office (WO). Distribution of copies of the FI report to persons other than with the agency that originally requested the FI will be done only upon instruction of the SDTDC Fire Management Program Leader.

13. All the above information is complied into a DG document, filed in the FI drawer, and mailed to members of the FI team. A file is not opened or a FI number assigned until the formal request for an investigation is received.

RECEIPT OF FORMAL REQUEST AND CONFISCATED EVIDENCE

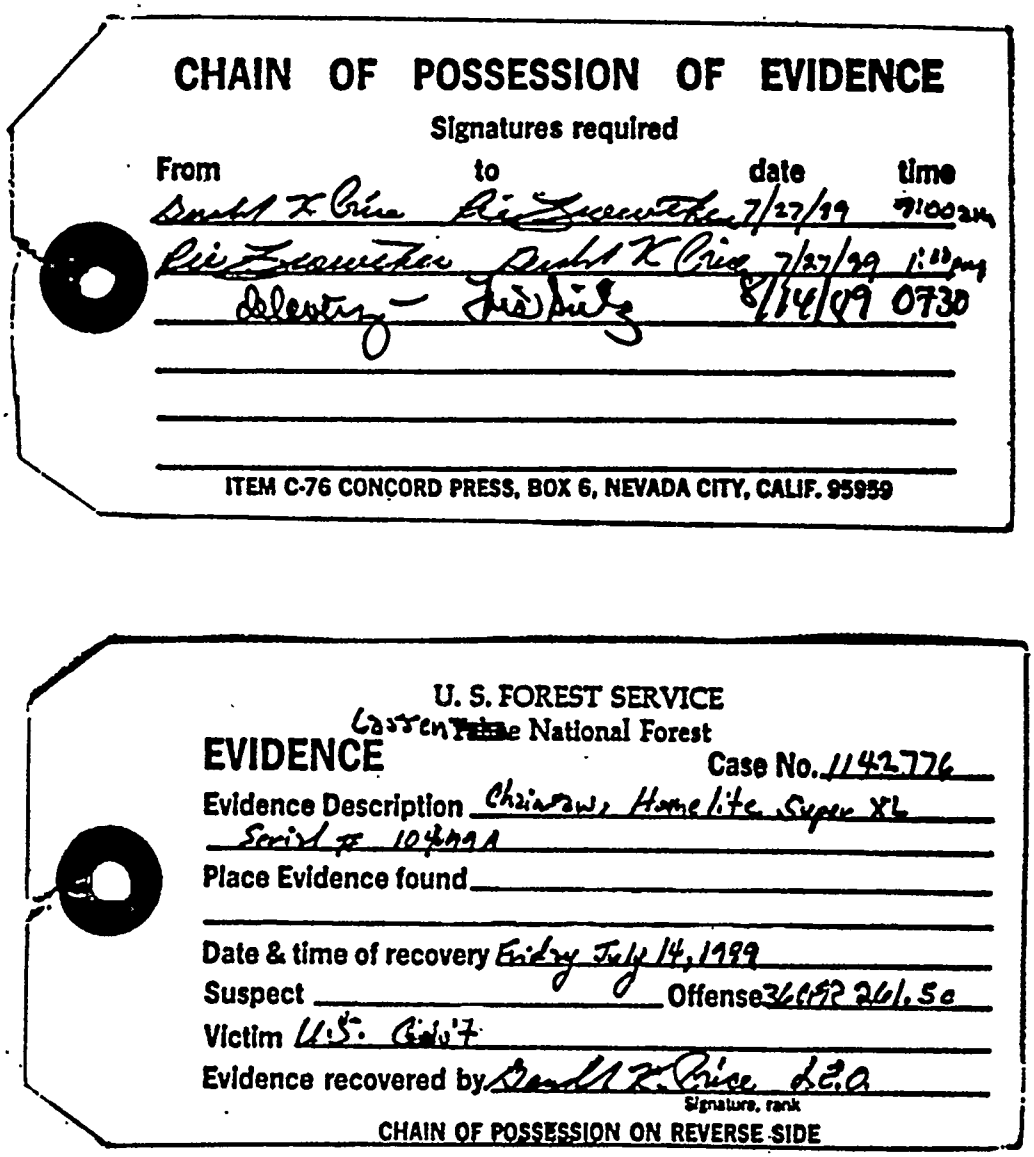
1. Upon receipt of the hardware at SDTDC, a chain of evidence tag (fig. 1) is to be signed by the receiving person. This chain of evidence tag must stay with the property at all times. Custody of the hardware must be documented on the tag form as the hardware is evaluated by the FI team. The Project Leader will place the hardware in the FI locked cabinet in Room 30 of SDTDC when not being actively evaluated.

2. Assign a FI number with the receipt of the formal letter request to the SDTDC Center Manager. Use the previous FI number plus one, and the last two digits of the present year; example: FI-17-91.

3. Start a permanent hardcopy file and a DG folder, following the format of previous folders. Obtain a hardcopy of the initial telephone FI request, formal request letter to the SDTDC Center Manager, and the FI Chart, SDTDC 7100-36 (3/91), see figure 2.

4. Obtain the assigned name of the fire, date of the incident, and assigned incident number.

5. Determine that an expenditure authorization to cover estimated costs has been included with the formal letter request or is forthcoming.



CHAIN OF POSSESSION OF EVIDENCE

Signatures required

From	to	date	time
Sandra K Price	Ric Encinias	7/27/99	9:00 AM
Ric Encinias	Sandra K Price	7/27/99	1:00 PM
Delivery - Fed Ex		8/14/99	0730

ITEM C-76 CONCORD PRESS, BOX 6, NEVADA CITY, CALIF. 95959

U. S. FOREST SERVICE

Lassen Plumas National Forest

EVIDENCE Case No. 1142776

Evidence Description Chainsaw, Homelite Super XL
Serial # 1045998

Place Evidence found

Date & time of recovery Friday July 14, 1999

Suspect Offense 36 CFR 261.5a

Victim U.S. Gov't

Evidence recovered by Sandra K. Price L.E.O.
Signature, rank

CHAIN OF POSSESSION ON REVERSE SIDE

Figure 1. Example of a "chain of evidence" tag form.

FIRE INVESTIGATION CHART

Side

1. Initial request and funding. (Side 1 is this side.)
2. FI status and correspondence.
3. Engineering notes.
4. Test data sheets and engineering references.
5. Photos..
6. Any duplicate copies/requesting agency fire report (if available).

MANAGEMENT CODE NUMBER:			
Date	**Elapsed Time**	**Action**	**Name**

SDTDC 7100-36 (3/91)

Figure 2. Fire investigation chart form.

6. The Project Leader will complete a property list of all evidence sent. Record the hardware serial number, model number, decal, and any manufacturer markings.

7. Do a photo layout of the hardware as received. The confiscated evidence tag or another type identification note must to be clearly readable in each photo. Obtain nine copies of all photos taken.

8. Determine the exhaust identification with the use of the Spark Arrester Guide (SAG), the on-site fire report and manufacturer markings or decal. Document the exhaust identification with drawings from the original test file.

9. Determine the date of manufacture, if possible, with the assistance of the manufacturer, utilizing the model and serial number.

PHYSICAL EXAMINATION OF EVIDENCE TO DETERMINE FURTHER ACTION

The following physical examination will be completed and the outcome discussed with the requesting officer, resulting in further tests to be conducted and a recommended course of action. Examination results will be documented with photographs. The physical examination of evidence includes:

1. Conduct a photo layout as the exhaust is being dismantled from the power unit and as the exhaust system is disassembled.

2. Determine if the power unit is equipped as qualified. An MSE may be listed as qualified with a required chain brake, hand guard, spikes, air filter, exhaust plate, exhaust guard, or hand bar wrap. A general purpose spark arrester may be listed as qualified only for one position with a definite number of cycles, horsepower, or airflow, and with or without a diffuser.

3. Examine visually for any obvious signs of different ages in weld lines, fractured surfaces, removed appurtenances, or any other signs of structural modifications.

4. Examine the condition of the surface coat throughout the exhaust system to include the presence of surface oxidation, blistering, any unusual or heavy carbon deposits, debris, or unidentified surface residues.

5. Note any deformation that appears to have been generated from high temperature stresses.

6. Note the presence of a screen and if it appears to be the original screen.

7. Note the position of the screen as centered or off center. Also note any carbon deposit imprint patterns on the screen and if the exhaust flange is present.

8. Note if the exhaust system compares with the drawing of the originally qualified exhaust.

9. Note any unusual or excessive carbon deposit at the exhaust inlet to the exhaust system and the general exhaust condition.

10. Assess the general condition of the screen, exhaust, flange/deflector, power unit, air filter, chain, chain gear teeth, chain bar, and any other appurtenances that may be present.

11. Note any unusual characteristics of old "caked" sawdust inside the chain saw cover and in the general area.

12. Do not remove any debris adhered to the power unit or the exhaust system. Record in detail the physical characteristics of any debris noted.

13. Determine carburetor and idle settings by measuring the number of turns to

the closed position; record and return to the original settings.

14. Note the general condition of the spark plug head, to include the physical characteristics of any debris deposits in the center and side electrodes and condition of the electrodes.

15. Note the condition and placement of the spark arrester exhaust inlet gasket, if required. Check for any carbon deposits over the surface of the gasket, which is indicative of escaped gas exhaust flow.

16. Examine the spark arrester fitup for any openings larger than 0.023 in between the engine block exhaust outlet and the spark arrester exhaust inlet.

17. Check for the presence of a drain hole for the spark arrester manifold, if the power unit is received with a general purpose spark arrester. Determine if the drain hole placement is above or below the location of the spark arrester. Compare to the original manufacturer engineering drawings.

RECOMMENDED COURSE OF ACTION

The physical exam will be discussed with the requesting officer. This will conclude with a mutually agreed upon recommended course of action. These actions may include:

1. Photograph the exhaust system as received with close-ups of the exhaust system, component parts of the exhaust system, and other areas that warrant documentation.

2. Examine the exhaust system to determine if it is qualified.

3. Determine if any modifications have been made to the qualified exhaust system.

4. Determine the general exhaust system condition.

5. Perform a periphery screen test to determine proper screen fit-up and installation.

6. Perform a screen test for the size of screen openings.

7. Examine for general screen condition.

8. Operate the power unit under no load or a loaded condition. Method of loading by bucking cut, dynamometer, or as determined by reason for loading. Observe operational performance.

9. It may be determined that general purpose spark arrester testing or MSE temperature testing is required and/or a physical comparison test be performed. The requesting officer will be notified that MSE temperature testing may be a destructive test.

PERFORMANCE OF TESTS AS FURTHER ACTION

MSE's manufactured after July 1, 1978, are required to comply with the minimum performance standards established by SAE Recommended Practice J335, "Multiposition Small Engine Exhaust System Fire Ignition Suppression," when used on national forests. The exhaust system must be equipped with a screen having a maximum opening size of no greater than 0.0232 in and is to be constructed of a 0.013-in (or larger) diameter heat and corrosion resistant wire, or is to have a usable life of at least 50 hr. The exhaust system should be so designed that the exposed surface temperature does not exceed 550 ^{o}F (288 ^{o}C) and the gas exhaust temperatures will not exceed 475 ^{o}F (246 ^{o}C) as determined when tested in accordance with SAE Recommended Practice J335.

General purpose spark arrester requirements are set forth in the USDA Forest Service standard 5100-1, "Standard for Spark Arresters for Internal Combustion Engines" and are

tested in accordance with SAE J350, "Spark Arrester Test Procedure For Medium Size Engines." Locomotive spark arresters are tested in accordance with SAE J342, "Spark Arrester Test Procedure for Large Size Engines," Forest Service standard 5100-1, and the Association of American Railroads Recommended Practice.

After a recommended course of action is agreed upon and the necessary funding is available, assemble a test team to include the Fire Management Program Leader, MSE and General Purpose/Locomotive Spark Arrester Project Leader, Fire Prevention Project Leader, Engineering Technician, and Photographer.

1. Two people are to be present during the entire examination/testing of the spark arrester exhaust systems and power units.

2. Authorization must be obtained from the requesting officer to conduct any testing that may be destructive to the evidence.

3. The following exhaust installation fit-up and screen tests are to be included for all MSE screen-type spark arresters:

A. Installation Fit-up Probe: With the exhaust system still attached to the power unit, probe the power unit/exhaust system mounting structure for any gaps of greater than 0.023 in to aid in determining proper installation and fit-up.

B. Periphery Probe: With the screen installed, perform a periphery probe for any gaps greater than 0.023 in in the screen/exhaust plate mounting structure.

C. Screen Probe: Remove the screen from the exhaust system and randomly probe 20X for any screen openings greater than 0.023 in. Probe with special attention noted to any curvatures, edges, or moldings on the screen. Using decreasing increments of gage sizes, find the largest diameter gage to penetrate the screen and record the value as the maximum gage size.

Any penetration using a 0.024-in wire plug gage fails the test. Do not probe with a force exceeding the 2-oz weight of the wire gage holder. Record results on the FI Screen Test Data Sheet.

4. Exposed surface and gas exhaust temperature testing is to be conducted under SAE Recommended Practice J335, "Multiposition Small Engine Exhaust System Fire Ignition Suppression." The results are recorded on the Summary of Test Results.

5. General purpose spark arresters are tested in accordance with Forest Service standard 5100-1 and SAE J350. Locomotive spark arresters are tested in accordance with SAE J342, standard 5100-1, and the Association of American Railroads Recommended Practice.

6. A physical comparison test may be done when a review of the drawings and the file research are inconclusive as to whether modifications have taken place. A comparison test may also be done to document known modifications.

7. Chemical analysis of fuel, oil, or residues; metallurgical studies, crack failure and fracture analysis; or any suggested testing not available at SDTDC will be accomplished through use of an outside laboratory at the discretion of SDTDC.

FI WRITTEN REPORT

The final output of a FI is a written report. Guidance as to this report's contents and format can be found in the appendix. A total of nine copies will be prepared with eight copies placed in binder form. The unbound copy will be held at SDTDC as the master copy. One bound copy will go into the permanent SDTDC FI file. A minimum of two

copies will be given to the requesting agency. One copy will be held for the Washington Office (WO). Distribution of other copies will only be per instruction of the SDTDC Fire Management Program Leader. Further, any queries generated by a FI or the written report are to also be referred only to the SDTDC Fire Management Program Leader.

RETURN OF EVIDENCE

When testing and the written report are completed, the confiscated evidence will be returned to the original requesting officer by registered mail. The hardware will be heavily packed to prevent damage and possible invalidation of the evidence.

Month Year

FIRE INVESTIGATION REPORT

(NAME OF FIRE HERE)

NAME OF AGENCY
AGENCY SUBUNIT NAME

Incident Number _____

Forest Service
Fire Investigation Number:
FI XX-XX

Prepared By: _____

Title: _____

444 E. Bonita Ave., San Dimas, CA 91773 714-599-1267
FAX 592-2309 FTS 793-8000/DG:w07A

[FI Written Report Title Page]

USDA FOREST SERVICE
SAN DIMAS TECHNOLOGY AND DEVELOPMENT CENTER

FIRE INVESTIGATION REPORT

REPORT DATE: _____

INCIDENT NAME: _____

INCIDENT NUMBER: (Requesting Officer's Designation)

FOREST SERVICE FI NUMBER: _____

DATE OF INCIDENT: _____

PERSON WRITING FI REPORT: _____, (Title)

REQUESTING AGENCY: _____

REQUESTING OFFICER: _____, (Title)

[FI Written Report Front Matter and Preliminary Main Body]

The following is to appear here:

1. **Contents page.**

2. **Illustrations page—list of all figures (line drawings and photographs).**

3. **Main body of text, including an introduction and discussion of the examination of the hardware submitted to SDTDC as evidence.**

[FI Screen Test Data Sheet]

FIRE INVESTIGATION SCREEN TEST

PERIPHERY SCREEN TEST

With the screen installed, the periphery was probed for any gaps in the mounting structure. (Insert No. here) periphery penetrations were obtained with the wire plug gage for screens No. X and No. Y; there will be two only if the exhaust system has two outlets.

SCREEN TEST WITH SYSTEM REMOVED

The screen was removed from the exhaust system and randomly probed 20 times with special attention noted to any curvatures, edges, and moldings. There were (insert No. here) penetrations using the 0.024-in wire gage plug for both screens. The maximum gage size was 0.XXX-in.

SCREEN SPARK ARRESTER TYPE

Screen No. X (Note location)

Wire gage (in)	Go	No Go
0.023		X
0.024		X

Screen Opening Maximum Gage Size: 0.0XX in

Screen No. Y (Note location)

Wire gage (in)	Go	No Go
0.023		X
0.024		X

Screen Opening Maximum Gage Size: 0.0XX in

[FI Written Report Summary of Test Results Format]

SUMMARY OF TEST RESULTS

CHAIN SAW EXHAUST SYSTEM TEST WAS PERFORMED IN ACCORDANCE WITH SAE RECOMMENDED PRACTICE J335 "Multiposition Small Engine Exhaust System Fire Ignition Suppression"

1. **Make and model exhaust system tested:** _____

2. **Make and model test chain saw power head:**

   a. **Displacement:** *XXX cc or in^3.*

   b. **Serial number:** *XXX-XXX*

3. **Spark arrester type:**

   Screen with maximum opening of 0.023 in (0.59 mm)

   a. **Screen material used:** *Stainless steel XXXX. (Information supplied by manufacturer.)*

   b. **Wire diameter:** *0.XXX in (0.XXX-mm). (Information supplied by manufacturer.)*

   c. **No-go wire gage size for screen openings:** *0.XXX in (0.XXX mm).*

4. **Tested at maximum power and rated speed of** *XXXX* **rpm.**

5. **Ambient air temperature during the test:** *XX °F.*

6. **Gasoline used was 88 octane, regular.**

7. **Gasoline/oil mix:** *XX:1. (Manufacturer supplied.)*

8. **Submitted for test equipped as follows:**

   a. **Chain break/handguard: Yes ___ No ___**

   b. **Handlebar: 1/2 ___ 3/4 ___ Full ___**

   c. **Spike requirement:** _____

   d. **Other special equipment required:** _____

9. Test Results:

Required	Actual	Pass	Fail
a. Exposed surface temperature 550 °F (228 °C) max.*	____	____	____
b. Exhaust gas temperature 475 °F (246 °C) max.*	____	____	____
c. Carbon particle retention or destruct —Screen 100 percent; Other 90 percent (min.)	____	____	____
d. Debris accumulation None	____	____	____
d. Debris accumulation None	____	____	____
e. Serviceability			
f. Durability			

** = 2 percent deviation accepted*
NR = Not required to qualify

This unit is qualified when equipped as described above. Addition or removal of accessories will nullify qualification.

Test Technician _____

Project Engineer _____

Date _____

(Written Report Conclusion Format)

CONCLUSION

The following conclusions were drawn from observations made during the inspection and testing of the exhaust system:

1. **The exhaust system present is a _____ exhaust system.**
2. **The _____ exhaust system is qualified for use on a _____**
3. **The exhaust system (was/was not) modified and (does/does not) appear factory original.**
4. **The exhaust screens (do/do not) appear original.**
5. **The exhaust screens (do/do not) appear in good condition.**
6. **The exhaust flanges (do/do not) appear in good condition.**
7. **The exhaust system (does/does not) appear in good condition.**
8. **The screen periphery (does/does not) have a fit of an opening larger than 0.023 in.**
9. **The screens (do/do not) have openings larger than 0.023 in.**

ETC.....

The following, when applicable to the FI, are to be appended here:

1. **Copy of the formal request to SDTDC for the FI.**
2. **SDTDC's recommended course of further action following physical exam of evidence sent to SDTDC.**
3. **Reproduction of chain of evidence tag(s).**
4. **Illustrations depicting the applicable spark arrester that SDTDC qualified.**
5. **Reproduction of original qualification notice and test results for applicable system.**
6. **Illustrations depicting all aspects of hardware evidence received by SDTDC, both line drawings and copies of all photographs taken.**