

Fire Management

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An Introduction to Spark Arrestors

SPARK ARRESTERS AND THE PREVENTION OF WILDLAND FIRES

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HISTORY

Spark arresters have been used in the United States since the early 1800s when screens were placed on the stacks of Jupiter locomotives, which were notorious for starting fires. The first legislation requiring spark arresters was passed in 1905 and applied to engines and boilers operated in, through, or near forest-, brush-, or grass-covered lands.

The United States Department of Agriculture (USDA) Forest Service effort in combating equipment-related fires started in the 1920s with external combustion engines (steam donkeys) used in logging.

In the early 1950s, the USDA Forest Service became interested in reducing the number of fires caused by internal combustion powered logging equipment. This effort was based on the 1934 report by J.P. Fairbanks and Roy Bainer entitled "Spark Arresters for Motorized Equipment," published by the University of California at Berkeley. The research demonstrated that exhaust particles with a diameter of 0.023 in or larger were responsible for the majority of fire ignitions.

A spark arrester is a mechanical device that traps or destroys hot exhaust particles expelled from an internal combustion engine. Since spark arresters prevented many fires, laws were subsequently passed to require spark arresters on certain types

of engines. The result of the USDA Forest Service's 1950 effort led to the establishment of a spark arrester testing and qualification program at the San Dimas Technology and Development Center (SDTDC), located in San Dimas, CA.

In April 1968 the Society of Automotive Engineers (SAE) in conjunction with the USDA Forest Service and small-engine manufacturers published the SAE Standard J335. It set the standard for small engines (chain saws, string trimmers, etc.) that not only prohibits the escape of carbon particles greater than 0.023 in but also regulates the allowable temperatures of the exhaust gases and the surface temperature of the exhaust system. The USDA Forest Service Specification 5100-1 defines performance specifications for spark arrester exhaust systems used on general-purpose engines (generators, motorcycles, agricultural equipment, etc.).

Currently, a significant number of States, municipalities, federally managed lands, and all USDA Forest Service regions require that all internal or external combustion engines must be equipped with a spark arrester that meets the requirements established by the SAE Standard J335 or USDA Forest Service Specification 5100-1. The Code of Federal Regulations, 36 CFR 261.52, and orders written by USDA Forest Service line officers explain the requirements.

CARBON AND THE INTERNAL COMBUSTION ENGINE

All internal combustion engines produce exhaust particles that are predominantly carbon with contaminants. These particles originate from deposits formed on the internal surfaces of an engine or exhaust system. Exhaust gases and carbon particles may be expelled from the engine block at temperatures exceeding 3,000 °F. Exhaust system surfaces can reach temperatures of 1,000 °F. Wildland fuels, however, can ignite at temperatures of only 400 to 500 °F. With these figures in mind, it is evident that fires can be started by wildland fuels coming in contact with hot exhaust gases or from contact with the hot surfaces of the exhaust system.

The condition of an engine, or how well it is tuned, can affect its ability to start a fire due to the temperature of its exhaust and the size and amount of carbon particles it produces. The type and quality of gas and oil, and the mix ratio can affect the size and composition of exhaust particles. The design and location of the exhaust system itself can greatly affect whether a piece of equipment will start a wildland fire. The temperature, humidity, and density all contribute to how well the wildland fuels will burn.

SPARK ARRESTERS CATEGORIES

Spark arresters can be divided into two broad categories: multiposition small engine (MSE) and general purpose (GP). Multiposition small-engine spark arresters are designed for engines used on hand-held equipment, such as chain saws, string trimmers, blowers, and brush cutters. Most MSE spark arresters use a screen to trap the exhaust particles.

The GP spark arresters are designed for use on engines in a single position, such as tractors, motorcycles, or railroad locomotives. There are a variety of spark arrester designs for general-purpose engines. The most common types are the trap, screen, and disc.

HOW SPARK ARRESTERS WORK

Spark arresters work on the principle of trapping or pulverizing carbon particles that have a diameter greater than 0.023 in. Although they are not always 100 percent effective, a properly installed and maintained spark arrester will significantly reduce the risk of fire. The most common type of spark arrester will trap carbon particles in the exhaust system. It works by screening the larger carbon particles out of the exhaust. Through centrifugal force, the heavier carbon particles are thrown against the inside walls of the arrester and directed into a trap. The most common screening types use a screen or a disc. In a disc-type design, additional discs can be added to reduce backpressure and increase exhaust flow.

TURBOCHARGERS, SUPERCHARGERS, AND MUFFLERS

Turbochargers use exhaust gases to turn a turbine that works to turn a compressor. Turbochargers perform the spark arrester function when 100 percent of the exhaust gases pass through the turbine. Turbochargers with waste gates allow a portion of the exhaust stream to bypass the turbine wheel and, therefore, do not qualify as spark arresters. A properly maintained turbocharged engine does not need a spark arrester.

Superchargers do not use the exhaust gas but are directly coupled to the engine. Engines equipped with superchargers require a spark arrester.

Mufflers are designed to reduce the noise emitted by the engine and are not considered effective spark arresters. Catalytic converters are not considered effective spark arresters either. They can reach temperatures high enough to start fires through contact with dry vegetation. There are several MSE spark arresters that have a catalytic element to reduce harmful emissions. These spark arresters have been tested according to the SAE J335 and are qualified.

INSTALLATION AND MAINTENANCE, WHO IS RESPONSIBLE?

Good spark arrester maintenance is essential, because poor upkeep usually results in substandard equipment performance and increased fire risk. Laws and regulations do not require that spark arresters be sold already installed. As long as the arrester is provided as part of the sale, the requirement has been met. The owner or operator is responsible for the legal operation of equipment that requires spark arresters. Failure to do so may result in criminal and/or civil liability.

SPARK ARRESTER OR MUFFLER, HOW TO TELL THE DIFFERENCE?

Spark arresters must include a way to remove the trapped carbon. Most GP arresters have a cleanout plug, and MSE spark arresters have a means to clean out the screen. Spark arresters must also have a brand name and model name. Once a device is identified as a spark arrester, it is then determined whether it is qualified. Labels such as "USDA Forest Service Approved!" do not make the arrester qualified. The USDA Forest Service only requires the manufacturer to label the spark arresters by make and model. MSE spark arresters are qualified with the power unit. Due to the small size of the spark arrester, it is difficult to label the units with the complete exhaust system number and the brand name. The manufacturers are only required to have the labels on the power unit itself.

SPARK ARRESTER GUIDE

The *Spark Arrester Guide* is the only authoritative industry source for information on qualified spark arresters for use on internal combustion engines. Use the guide when identifying qualified spark arresters. If the spark arrester number appears in the guide, then SDTDC has evaluated the arrester.

There are two volumes to the guide: *General Purpose and Locomotive*, Volume 1, and *Multiposition Small Engine*, Volume 2. A revision of the guide is published every year. Therefore, each volume is published every 2 years. An online guide, updated every quarter, is available on the USDA Forest Service Intranet at <http://www.fsweb.sdt dc.wo.fs.fed.us>. It is a searchable database that allows the user to make powerful searches.

ADDITIONAL INFORMATION

This Tech Tip offers a broad introduction to spark arresters. There are four other Tech Tips in this series. For more information on spark arresters, or to receive copies of other related Tech Tips, contact:

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San Dimas Technology and Development
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San Dimas, CA 91773

Attn: Spark Arrester Program Leader
or
<http://www.fsweb.sdt dc.wo.fs.fed.us>

Approximate English to Metric System Conversion Factors

To Change	To	Multiply by
inches	millimeters	25.4

Temperature Conversion of Units

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32$$

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