SPARK EXTINGUISHING SYSTEMS

INTRODUCTION

Facilities in which finely divided, combustible materials or fibers are air-conveyed periodically experience fires or explosions in their dust collection systems.

Sparks capable of ignition may be caused by metal fragments from processing equipment, by foreign materials in the product being conveyed, or by the product itself. If sparks are drawn into the pneumatic duct system, they can cause either a fire or an explosion in the downstream equipment.

Spark extinguishing systems are custom designed to detect fast-moving sparks in ducts and operate a downstream water spray system that discharges a small amount of water extinguishing the spark as it passes, preventing fires and explosions. Additional downstream detectors are usually used to confirm extinguishment or operate other protection features such as system shutdown and product diversion measures.

POSITION

Use process hazard evaluation techniques as covered in *OVERVIEW* to identify hazards which require spark extinguishing systems. Protect hazards such as the following with spark extinguishing systems:

- High speed sanders and abrasive planers used on dry wood surfaces. Sanding belts may migrate or break causing sparking on metal surfaces. Abrasives may strike foreign material in the wood causing sparks. See PRC.17.8.1.
- Wood saws, edgers and hogs used on dry wood creating small particle sizes. Saw blades and cutters may strike foreign material and create a red hot metal fragment. Logging saws usually produce large particles with high moisture content making spark extinguishment systems unnecessary.
- Equipment handling hardwood. Knots in woods can create hot embers by friction.
- Ducts with in-line fans. Mechanical failure of the fan may create sparks carried with combustible dusts or fibers.
- Cotton processing equipment. Hidden metal fragments or rocks may cause sparks when contacted by fast moving metal machine parts. See PRC.17.21.1.
- Metals buffing operations. Combustibles in the form of buffing agents and fibrous buffing medium can be ignited by metal parts which enter the buffing stations.
- Pharmaceutical and food product milling and grinding. Ignition may come from broken machine fragments.

Spark extinguishing systems are one way to prevent fire or explosions. They are not meant to cope with an explosion flame front, but rather are intended to eliminate sparks and burning embers. Where explosions can be expected, however, spark extinguishing systems should be used in conjunction with other protective systems, such as product diversion, explosion venting, explosion suppression and sprinkler protection. Spark extinguishing systems and explosion suppression are addressed in NFPA 69. Explosion venting is addressed in NFPA 68. See PRC.13.5.1 for information on explosion suppression systems.

These systems are not meant to replace sprinkler protection in ducts carrying combustibles. Use spark extinguishing equipment listed for the intended use by a nationally recognized testing laboratory. The entire system is listed as a package and consists of specialized detection equipment, control unit, system piping and nozzles. The spark extinguishing system must be capable of intermittent, high speed, reliable operation. It is considered as a preventative device rather than a protection device. System design criteria is set by the spark extinguishing equipment manufacturer. These systems are expected to douse burning embers without interfering with production. Usually the small amount of water discharged does not affect operations and all systems continue to operate. However, if this presents a problem, the process may have to be shut down during cleanup operations.

Although some systems are designed not to release water on the first spark detected, AXA XL Risk Consulting prefers that sparks not be allowed to pass through the spark extinguishing system protection zone.

Because of the fine water nozzles used in these systems the water used in the system most be very clean. Some systems may not be connected to the fire protection water supply for this reason. Care must be taken to ensure the reliability of any such supply.

In cold climates where piping may be subjected to freezing, heat tapes and insulation may have to be used.

Do not run the process equipment unless the spark extinguishing system is in service. This can be done by interlocking the process with the spark extinguishing system so that the process will not run unless the spark extinguishing system is in service.

If the number of sparks or frequency of sparks generated is too great for the spark extinguishing system to handle, the spark extinguishing system may need to automatically shutdown the process or divert the air stream to a safe location. Correct the problem before resuming production.

Spark extinguishing systems require specialized maintenance to ensure their performance. For this reason, the system owner should have a service contract. Monitor protection equipment against possible impairment. This can be done by using a program such as AXA XL Risk Consulting's RSVP program covered in *OVERVIEW*. Include the spark extinguishing system in the weekly Fire Protection Equipment Inspection.

DISCUSSION

Combustible wastes are produced by processes such as wood working, textile fiber processing and some metal working operations. In addition, any system air-conveying combustible product will probably have some small fines or dust carried in the air stream. Most grain processing facilities typically use metal detection and explosion venting.

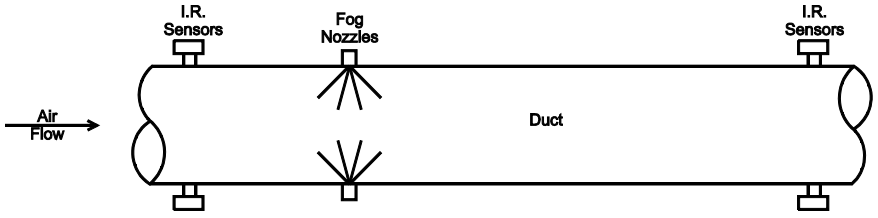

Figure 1. Typical Spark Extinguishing System.

Dust collectors are used to remove air borne materials present in air-conveyed products and waste produced during processing. The dust, chips or lint are generally collected continually during the production operation. The waste is pneumatically conveyed through ducts to either cyclone separators and/or bag houses. Hot metallic objects or glowing embers must be eliminated before they reach essential downstream equipment. Sparks, fanned by continuous air movement, can either ignite combustible bag material or initiate an explosion in combustible dust particles. Loss of essential equipment either by fire or explosion could create production bottlenecks or restrict operations due to environmental concerns.

Such disasters may be prevented by installing a spark extinguishing system. Figure 1 shows a simplified sketch of a typical spark extinguishing system. As the spark is transported through the duct, it passes high speed infrared spark detectors. These detectors are designed to respond to a rapid increase of infrared radiant energy. It is important that the infrared detectors are of a sensitivity and speed appropriate to the hazard. Some detectors are capable of responding to a 1 μw source of radiant energy within 75 μs. Many systems have adjustable sensitivity so that it can be tailored to the hazard.

As the sparks pass in front of the detectors, the detectors “sense” the radiant energy in the spark and send a signal to the control panel. The control panel actuates a solenoid valve which allows water to flow through the fog nozzles. Although the system is usually designed to discharge for about 10 s, the system may be able to extinguish burning embers within 250 ms from time of detection.

Spark extinguishing systems can:

- Reduce unnecessary equipment shut-downs.
- Prevent expensive repairs.
- Prevent the need to clean up debris.
- Prevent the operation of ceiling sprinklers and other extinguishing systems.
- Prevent the need to dry out product that has been wet by other liquid extinguishing systems.

A typical control unit may incorporate the following features:

- Dust tight enclosure;
- Self-test of the system’s functions and components;
- Back-up battery supply;
- Spark counting ability;
- Adjustable extinguishment time;
- Interlocks with external equipment shutdown capability;
- Print-out event recorder;
- Ability to interface with process computers and programmable logic controllers.

Most spark extinguishing systems use water as their primary extinguishing medium. Water is an effective spark quenching agent, it is readily available, low cost and compatible with most process materials. Where water is not suitable, other extinguishing agents can be considered.

When designing a spark extinguishing system determine how much protection is economically and technically feasible. Minimum protection for a pneumatic material conveying duct system usually consists of a detection station and an extinguishing station. The actual separation distance between detection and extinguishment is a function of the velocity of the material conveyed within the duct, and both response and operation delays inherent in the spark extinguishing system. As an example, if the velocity is 100 fps (30.5 m/s) and there is response time of 0.3 s, the separation of detection and extinguishment is 30 ft (9.1 m).

For greater protection, a secondary detection signal can be used to perform additional measures such as ensuring extinguishment, shutdown of process equipment, operation of a deluge system, or

product diversion. The location of the secondary detection may vary with respect to fans, cyclones or filters, but will always be downstream of the primary detection and extinguishing zone.

Spark extinguishing systems are not intended to cope with an explosion flame front. The detectors react to the explosion but, due to the intensity and rapid propagation of the flame front, the extinguishing system is usually not effective. Therefore, the use of secondary detection is desirable to activate a deluge system or to prevent the flame front from reaching dust collection apparatus.

Any number of secondary detection units can be added. Their function is simply to provide a signal to perform additional operations. The degree of complexity eventually becomes a matter of economics versus potential loss.

Degrees Of Protection

Consider a simple filter system in which an in-line fan draws air and material from the process equipment and blows it directly into a filter unit. See Figure 2. After the sparks from the process equipment have been extinguished, there is a possibility that sparks can be generated by foreign material striking the fan blade. To extinguish these sparks, another spark extinguishing system can be installed downstream of the fan. If the fan blades are of non-sparking materials this second zone can be eliminated. The minimal level of protection for this equipment would be a spark extinguishing system placed between the process equipment and the fan to sense and extinguish the sparks emitted from the equipment before they develop into a fire or explosion.

Should a higher level of protection be required, an additional detection zone can be installed prior to the primary filter. The secondary detector station can be utilized to operate a deluge system in the primary filter and shut down the process equipment. For more complex installations see Figures 3 and 4.

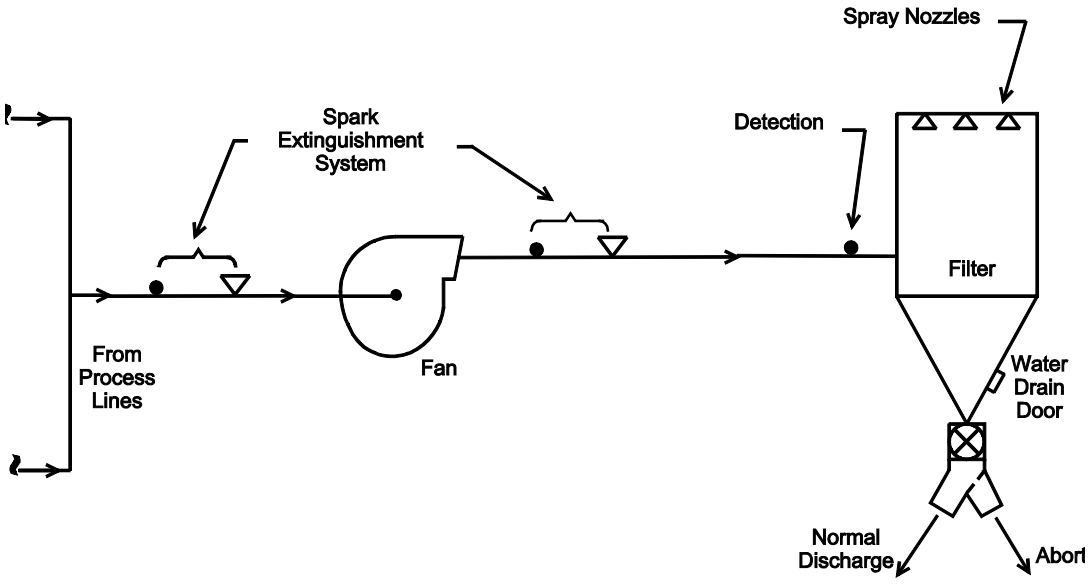

Figure 2. Typical Primary Filter System With Spark Extinguishing And Sprinkler Protection.

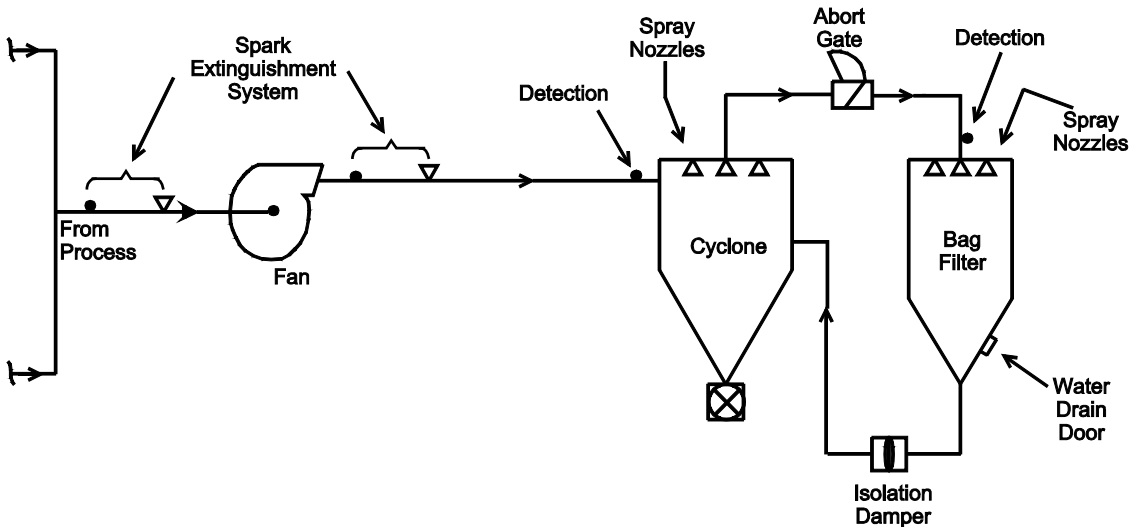

Figure 3. Typical Secondary Filter System With Spark Extinguishing And Sprinkler Protection.

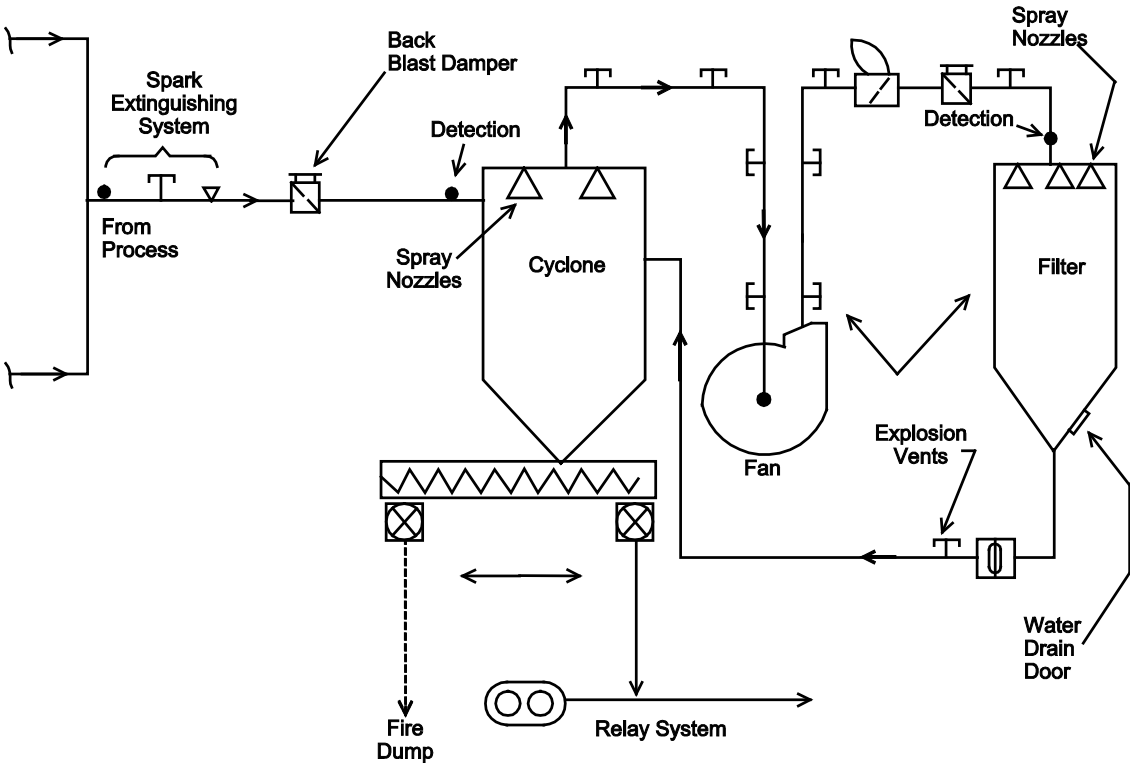

Figure 4. Typical Draw-Thru System With Spark Extinguishment, Sprinkler Protection, Explosion Protection And Dumping Capability.

The following steps will help to define the data and the system components required:

1. Determine maximum velocity and temperature in the conveying duct, pipe, etc.
2. Determine the cross sectional area of the duct. Note the diameter and wall thickness if duct is round. If duct is square record height, width and wall thickness.
3. The amount of air movement in cfm is the product of the area of duct times the air or gas velocity.

Detector to extinguisher distance is measured from the centerline of the detector to the extinguishing nozzle's centerline. The system equipment manufacturer determines the number of extinguishing nozzles needed.

Detectors should never be positioned on the bottom of a duct but at 90° from the vertical axis, 180° apart. Placement of detectors in vertical ducts or pipes is not as critical as it is on horizontal ducts; however, do not place detectors at points of high abrasion, such as near elbows or fan scrolls. See PRC.13.0.1 for guidance on detection and control equipment.

Detectors should be arranged to prevent obstruction from accumulations of dust. If dust accumulations cannot be avoided, air purge adapters may be fitted on the detectors to automatically blow down the detector face.

High duct temperatures can damage the detectors. If temperatures are greater than the detector ratings, fiber optic cables can be use to transmit the visual signal to the detectors a safe distance from the ductwork.

The water supply must be clean. Optimum water droplet dispersion may require relatively high pressure. Consult manufacturer's design manual. If the water pressure is inadequate, a mini booster pump unit can be used. If the volume of water is a problem, a small suction tank can be used to hold the necessary quantity of water.

TABLE 1
Periodic Maintenance

Item	Operation	Day	Week	Month	6 Month	Comments
Console	Clean			X		See Central Control Console Maintenance
Emergency Power	Test				X	See Battery Test Procedure
Detector and Valve	Test	X				See Detector Test Procedure
Detectors	Maintenance		X			Clean & Inspect
Water Lines	Flush strainer		X			Flush for 2 min
Booster pump	Test			X		See Booster Pump Test Procedure

Inspection And Maintenance

Develop and follow a regular maintenance schedule for testing and manually inspecting all spark extinguishing systems. See Table 1. Flush system strainers to ensure clean water flow through the solenoid valve.

Inspect and clean the outside of the control panel monthly.

Inspect detectors weekly depending on application and material being conveyed.

- Clean lens with alcohol or solvent.
- Check for broken or cracked lens.

Each 6 months:

- Check detector box for cracks.
- Check inside of detector for moisture. Desiccant capsules should dried, then reinstalled, or replaced as required.

Extinguishing device:

- Check water flow daily.
- Flush the strainer weekly.

Remove the strainer's screen monthly and inspect and clean as required. Visually inspect valve and heat tape if used.