Ceramic Filters
Runaway Regeneration

The installation of diesel particulate filters (DPF) on equipment can increase the risk of fires. Other Best Practices have discussed the hazard of hot surfaces from the addition of filter piping and housings and filter fires on permissible equipment. This Best Practice covers the potential for uncontrolled regeneration (overheating) in a ceramic filter. Although the ceramic material itself does not burn, the accumulated soot can burn rapidly. This rapid burning can melt the ceramic filter material.

Ceramic filters (made of either Cordierite or Silicon Carbide) are typically installed in the hot exhaust stream of the diesel engine operated in non-gassy applications in metal, non-metal mines (i.e., nonpermissible equipment). This high exhaust gas temperature, in fact, is needed in many ceramic filters designs to allow the filter to continually (passively) regenerate. This process slowly burns off the accumulated soot to keep the filter from plugging up during normal vehicle operation. Other ceramic DPF's merely accumulate the soot during equipment operation and are manually regenerated at a specified time when the equipment is off-duty.

Proper operation of either type of DPFs should not pose a risk of uncontrolled burning of accumulated soot within the DPF. However, when the filter is loaded with soot beyond its design limit as indicated by exceeding the maximum allowed working back pressure specified by the engine manufacturer and the DPF supplier, the possibility of uncontrolled burning of the soot increases.

In passive (self-regenerating) DPF's, continual operation above the back pressure limits increases exhaust temperature, increases soot emissions, and loads the DPF with more soot. When this is the case and the engine is placed under heavy load followed by a period of very low load, the soot can ignite. Because there is so much soot it can create internal temperatures that can may crack or melt the ceramic material in the DPF. This is especially a concern with Cordierite which melts at a lower temperature than Silicon Carbide. The ceramic element and burning soot will be contained within the DPF shell, although the DPF surface will get abnormally hot and may pose a risk of igniting nearby combustible components on the equipment through radiant heating. Some DPF's are designed with double walls to retain exhaust heat for regeneration and thus will also minimize the temperature rise of the DPF shell during a uncontrolled regeneration. Ask the DPF supplier about this safety feature. *MSHA requests mine operators notify MSHA of any runaway regeneration of ceramic filters.*

MSHA recommends that all machines equipped with ceramic filters be provided with backpressure monitors that warn the operator prior to the filter developing an excessive backpressure. These monitors should be developed in consultation with the engine manufacturer and the filter manufacturer who know the proper back pressure settings for your engine and DPF.

A second concern with ceramic filters are possible hazards during active regeneration which, based upon the DPF system design, can occur on-board or off-board the equipment. As with passive (self-regenerating) DPF's, when the regeneration is performed on a properly loaded filter there is no risk of uncontrolled regeneration. The surface of the DPF may become hot, and thus combustible material, hoses, etc. should be kept away from or shielded from the radiant heat of the DPF. Excessive soot loading of the DPF, however, may increase the risk of an uncontrolled regeneration during the regeneration cycle, which may result in melting or cracking of the ceramic material causing permanent damage of the filter.

For DPF systems in which the DPF is removed from the equipment for regeneration, the DPF is placed in a manufacturer's regeneration system. Because the surface of the DPF may become quite hot, the regeneration station should be located where it cannot ignite combustible materials from the radiant heat from the DPF. The same precautions regarding soot loading and uncontrolled regeneration for the on-board DPF apply here.

Whether regeneration takes place on-board or off-board, there should be sufficient ventilation at the exit of the DPF to disperse the concentrations of CO and hydrocarbon gases that are emitted during regeneration.

In summary, to avoid runaway regeneration of DPF systems they must be operated within their designed backpressure limits at all times. Passive, self-regenerating DPF's exhibit surface temperatures similar to that of existing exhaust systems during normal operation. On-board regeneration of active, manually regenerated DPF's will probably have higher surface temperatures during regeneration than a normal exhaust system. The surrounding area should be kept free of combustibles or hoses should be adequately shielded. The DPF manufacturer should be asked about the surface temperature of their systems during regeneration. Uncontrolled regeneration, when it occurs, is likely to result in destruction of the ceramic filter element,.