To The Point
Mining Shovels

Highly flammable fuels, oils, and hydraulic fluids flow through pressurized lines within inches of super-heated engine blocks, manifolds, and turbochargers. A single ruptured line can result in a fast-spreading fire. Under these circumstances, fire propagation is rapid and relentless; a major fire loss can occur in just a few minutes. Extensive fire damage is often caused to the equipment before a fire crew can even assemble, let alone respond at the scene.

Fire Safety Enhancements

To enhance fire safety and minimize risks in mining operations, consider implementing the following measures:

- Fire resistant hydraulic fluids for all mining equipment
- Isolation and venting of hydraulic fluid compartments
- Emergency fluid evacuation lines
- Fire barriers and commercially available “wraps” to shield engine hot surfaces from the spraying of Pressurized fluids
- Emergency engine/hydraulic shutoffs
- Engineer designed, and certified equipment/cab fire detection equipped with visible/audible cab alarms
- Engineer designed and certified suppression systems
- Trained and qualified installation and service technicians
- Frequent and thorough inspections of equipment hydraulics, fuel, electrical systems, and detection/suppression systems
- Frequent fire emergency preparedness training for equipment operators and emergency response teams

Emergency Shutoffs and Hydraulic Safeguards

Fires typically occur when a fuel or hydraulic line or connection breaks and sprays atomized fuel onto a superheated turbocharger or exhaust manifold. If the engine continues to operate, atomized fuel will continue to discharge. The standards and regulations developed by MSHA for fire protection of large mining equipment in underground coal mines are found in 30 CFR, Part 75, and for metal and nonmetal mines in 30 CFR, Parts 56 and 57.

In general, underground coal mine requirements are more stringent, requiring the use of fire-resistant hydraulic fluid and automatic fire suppression systems. For metal/nonmetal mines and all surface mines, MSHA permits the use of non-fire-resistant hydraulic fluid and requires only fire extinguishers or manually activated suppression systems. Chubb recommends automatic fire suppression systems combined with automatic engine/hydraulic shutdown. A delay of 15 to 30 seconds may be incorporated into the systems to allow for safe parking and evacuation prior to actuation.

Additional safeguards include:

- Installing heat shields/barriers around hot exhaust and turbocharger surfaces to minimize exposure to hydraulic spray reaching hot ignition surfaces. If overheating is a concern, a newer product is available that incorporates an auto-closing fire damper/shield designed to actuate/close under fire conditions via detection and create a fire/splash barrier to the hot surfaces.
- Strategically relocating pressurized hydraulic fluid and fuel lines. Line orientation should be designed away from hot surfaces, batteries, and their connections.
- Using stainless steel hydraulic lines with reinforced steel sleeves. At a minimum, hydraulic hose lines should be adequately secured, and fittings torqued to their recommended foot-pound. Raceway openings should also be provided with suitable protection to minimize chafing exposures.

Detection/Actuation Systems

When a fire breaks out on a large piece of mining equipment, the potential for major damage or total loss of property is substantial. Every second or fraction of a second counts in the role of the fire detection component of a complete system. Except for some underground coal mining operations, there is no requirement for automatic operation of the fire suppression system or vehicle shutdown. Chubb strongly recommends automatic operation and vehicle shutdown. Electronic detection and actuation systems should be designed to provide detection, alarm, machine shutdown, and suppression system actuation—all automatically.

Thermal detectors: These can be either spot or linear detectors. To be effective, they need to be physically in or very close to a fire or fire plume. They cannot detect fire remotely. Thus, a fire may need to grow substantially before it can be detected, possibly resulting in extensive damage before the fire suppression system activates.

Dual-agent suppression systems provide both immediate knockdown and essential cooling to prevent re-ignition.

Heat generation is a major concern in the seconds it takes for this method of detection to detect the fire and then activate the fire suppression system. Regular cleaning of heavy deposits of mud and debris is recommended for linear detectors. Spot detectors are more sensitive, and often a unit should be replaced rather than cleaned.

Infrared detectors: The infrared (IR) band can be divided into near, mid, and far bands. Single-band IR detectors are typically prone to false alarms unless used in highly controlled environments. Radiation detectors often sense multiple bands of energy, such as near IR/far IR, to achieve superior false-alarm immunity. When added to existing linear wire or spot detection, the fire can be detected within milliseconds of ignition, providing a faster response. By using infrared technology, the fire has no opportunity to propagate, and therefore heat build-up is not likely to be an issue. Another benefit of these detectors is that they can be positioned in areas where linear detection cannot.

Radiation detectors can be blinded by contamination, requiring daily cleaning and inspection. Manual suppression system actuators and engine/hydraulic shutdown buttons should be installed within the cab and at ground level in an accessible area.

Dual Agent Suppression Systems

While the ignition sources of the fires varied, the actual root cause of the extent of the loss was consistently due to one major factor: the on-board fire suppression systems were grossly inadequate. When called upon, these systems did not do their job. Up until the 21st century, the fire suppression systems used to protect equipment lost to fire were comprised of single-agent, dry-chemical only. Herein lies one of the greatest problems with past systems: once a fire is detected, a blast of dry chemical is simultaneously discharged from the system nozzles. While the fire is momentarily knocked down, it is not necessarily extinguished, and if it is, the effect is short-lived due to the likelihood of re-ignition from the heat generated at the fire's outset.

In many instances, eyewitnesses of equipment fires have attested to observing this exact sequence of events. When a fire breaks out involving hydraulic oil, heat build-up is rapid; dry chemical alone provides absolutely no cooling effect, allowing the rapid buildup of heat to serve as an ignition source after initial knockdown. The use of dry chemical alone is not an adequate approach to extinguishing a fire under such extreme circumstances; hence, the necessity and introduction of the dual-agent concept.

With dry chemical as the first agent discharged, serving as the knockdown element, a wetting/cooling agent is then released just prior to the final discharge of dry chemical to provide the cooling effect required to fully extinguish a fire on this equipment. The wet chemical agent flows readily into areas where flammable liquids settle, providing both fire suppression and superior cooling of superheated surfaces while blanketing the fuel and cutting off oxygen to help prevent reflash.

An added feature of newer systems today includes an extended discharge for the dry chemical agent. This combination has proven to be very effective for excavator/shovel equipment due to the compartmentalized nature of the equipment.

While having wet chemical back up the initial dry chemical agent, there are new products emerging in the fire suppression market that combine both the knockdown and cooling benefits of these respective agents into a single solution, helping reduce overall cost and maintenance.

A recent industry trend has been to install fixed piping with deluge spray nozzles located strategically along the fixed deluge piping line. A hose can then be hooked up to a portable water truck designed to provide additional cooling in the event of the suppression system not extinguishing the fire, as has been the case in a number of fire incidents.

Another recent trend is the installation of a clean agent extinguishing system located in the operator cab, complete with manual and automatic actuation, designed to enhance operator safety.

Certified System Installers

In the not-too-distant past, almost anyone who was inclined could become a Fire Protection/Suppression System Installer and Technician.

The fire protection/suppression system manufacturers and their distributors were not following an established protocol that predetermined the eligibility for someone to become an installer or technician.

Even today, installers and technicians in the occupation may or may not have a technically relevant background that makes them suitable candidates for this field of work. For that reason, it is important to request that the system design and installation be completed by an authorized company and installer. In addition, obtain a Certificate of System Compliance that confirms the system and its installation meet design and installation requirements.

Frequent Inspections & Service

Certified mechanics and service technicians should be fully trained in the "nuts and bolts" of the unit by the manufacturer's representative.

Service and inspection activities and frequencies should adhere to the manufacturer's recommendations. The inspections and services should be documented and maintained in a file, with any outstanding work orders monitored via a tracking system.

Emergency Preparedness

A recent incident occurred when hot hydraulic fluids escaped from a hydraulic shovel and collected on the ground underneath after a fire broke out within the unit and the suppression system activated. The hydraulic liquid that had pooled on the ground was hot enough to re-ignite, and nearby personnel could only watch as the unit erupted in flames with no further suppression available to extinguish the fire. For this reason, companies should consider having a portable foam caddy or a fire truck equipped with a foam generator readily available near the equipment while in operation, which could be used to attack a hydraulic oil pool fire underneath the unit if one were to occur.

The most important factor during an emergency is to ensure safe operator egress following the outbreak of a fire. Many equipment manufacturers have not adequately addressed this issue to date. Considering the location of most equipment cabs, it is highly probable that the main access/egress staircase on these units will not be accessible when a fire is out of control. In such instances, an alternate emergency escape system would be beneficial. Emergency escape chutes are now available on the market, providing alternate emergency egress for fixed and mobile mining equipment.

Equipment operators and emergency response team members should be fully trained in fighting industrial and hydraulic fires, the use and limitations of portable fire extinguishers, the detection/suppression systems incorporated into each piece of supplied equipment, and any other firefighting equipment available on site (e.g., portable foam/water truck with hoses, water truck with hoses, monitors, etc.).

Frequent tabletop exercises and mock drills should be conducted to ensure training and awareness are maintained.

Resources

NFPA 120: Standard for Fire Prevention and Control in Coal Mines

NFPA 122: Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

Analyses of Mobile Equipment Fires for All U.S. Surface an www.cdc.gov/niosh/docs/mining/works/coversheet1342.html

Reduction of Fire Hazards on Large Mining Equipment, stacks.cdc.gov/pdfjs/web/viewer.html?file=https://stacks.cdc.gov/view/cdc/10015/cdc_10015_DS1.pdf

Ansul Fire Protection, www.ansul.com/

KiddeFenwal, kiddefenwal.com/Public/Fenwal_Landing

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