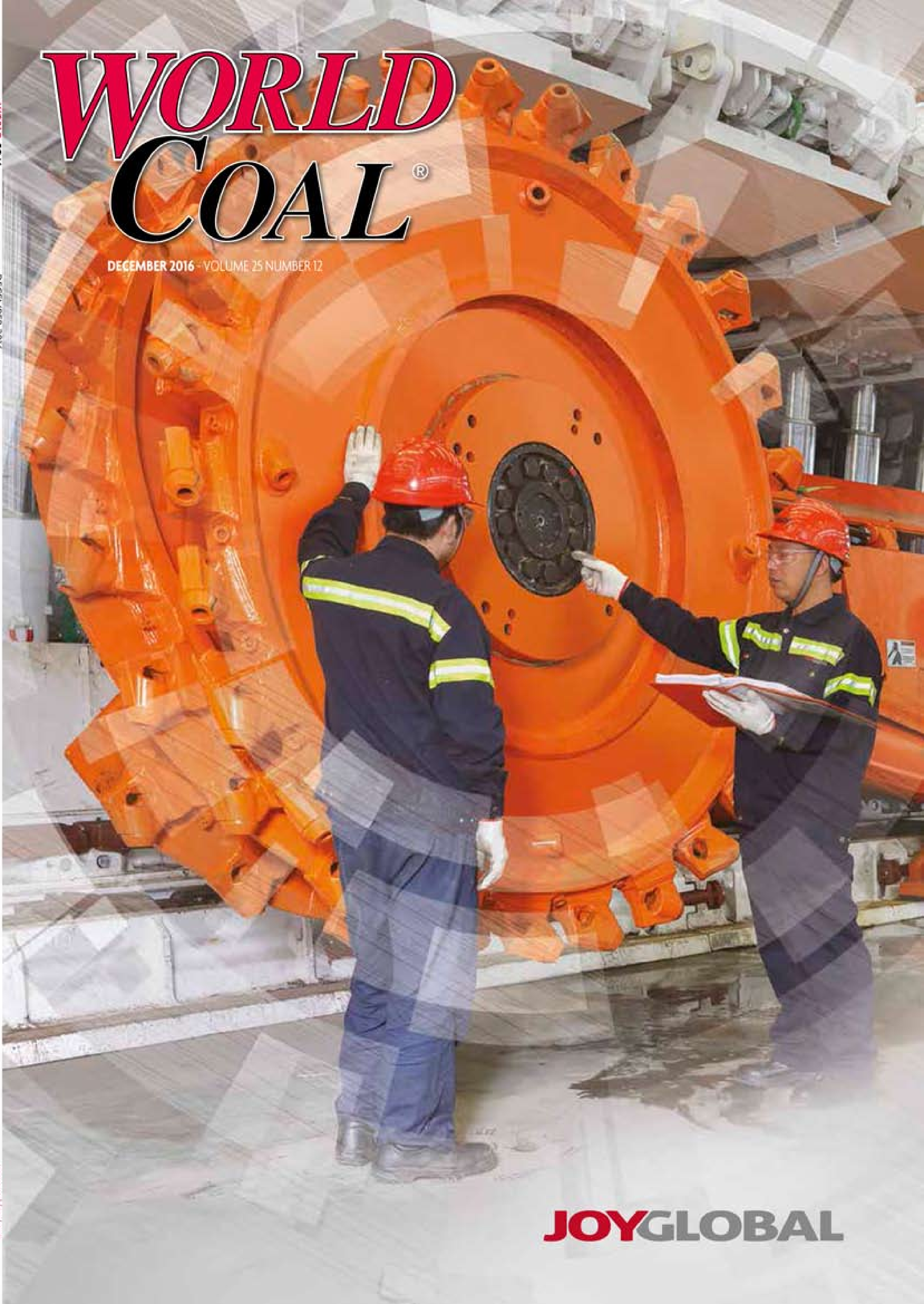
WORLD COAL®

DECEMBER 2016 - VOLUME 25 NUMBER 12



WORLD COAL
DECEMBER 2016
www.worldcoal.com

SILO FIRE FIGHTING: WINNING THE GAME OF HAZARDS

Justin Clift, Hazard Control Technologies, USA, outlines the risk of coal silo fires and methods to combat and prevent them.

Industrial operations across the world pride themselves on professionalism, productivity and a dedication to safety. Given the amount of serious hazards commonly found in an industrial setting, safety must be a core value of management and employees and never compromised when priorities change. Yet, preventable incidents still occur, resulting in injury, death, damaged assets and lost production. These incidents are often the result of common preventable contributing factors, found again and again across different industrial operations. These contributors are frequently found in any post-incident investigation reports thus deemed the 'usual suspects': lack of preparedness, complacency, and failure to recognise, understand and properly mitigate situational hazards.

An institution where management and employees convey a complacent attitude towards safety and operate under the impression that 'as long as I continue to have no problems, everything must be okay' are following a dangerous logic, according to Guy Colonna, a Division Director with NFPA. Considering the potential magnitude of industrial hazards, a complacent safety culture operates under a false sense of security and endangers lives. It is only a matter of time before a foreseeable operational hazard arises, placing personnel safety at risk and jeopardising plant production. Operating without a proper understanding of risk or without mitigating procedures for a potential hazard is a dangerous game of maintaining hazard control.

The word hazard is believed to have originated during the Crusades, while first appearing in English literature around 1520 to describe a gambling game of chance played with dice (an ancestor of today's variation of craps). Today, facilities may unwittingly place personnel safety at risk playing this dangerous game. Rolling the dice daily, near miss event after near miss event, some facilities go incident free, while depending on an irresponsible and unsustainable degree of luck to safely navigate hazardous operations. Proper training, site specific procedures and situational awareness can help control and eliminate foreseeable operational hazards safely without incident.

Bulk storage fires are preventable, especially once understood. Spontaneous combustion is a foreseeable yet unexpected hazard, which is only likely to occur once certain conditions have been met. Problem areas (stagnant material, oxygen rich hang-ups) within bulk storage silos, hoppers or bunkers should be identified and addressed to minimise spontaneous combustion. If smouldering material is historically appearing in one area of the silo versus another, there is a reason why. Detecting the problem is reactive; understanding why it is here versus there can help a facility identify and proactively eliminate hazards. With that said, the conditions for spontaneous combustion are commonly present when faced with associated equipment failure and an unexpected outage. It is a common best practice to empty all material before a planned outage. In the event of an unexpected outage, safely removing all of the material can be easier said than done. If the outage can be resolved within 1 – 2 weeks, a facility may choose to monitor the material rather than unload it. This roll of the dice may pay off with a little luck, but if dealt with an outage extension from unforeseen issues, it is likely to lead to emergency response operations.

The following is an abridged hazard mitigation guide based on Hazard Control Technologies' (HCT) emergency response (ER) operational experience in combating bulk storage fires. These generalisations may serve as effective

Coal barn fire command post.

Cement silo fire, internal temperatures double readings on camera.

Steel silo fire, internal temperature 100˚F readings on camera.

discussion points when evaluating a facility's existing procedures. It is of the utmost importance that each facility uses the following information only as a guide to help create a site-specific standard to follow in the event of a silo (bunker) fire based on design, response capabilities, water supply, training, available resources, etc.

Study up

During ER operations, the initial actions taken are crucial to safely mitigating the situation. Straying from industry recommended practices can jeopardise the outcome and set people up for failure. Mistakes are often made during the initial response period due to the lack of situational awareness and preparation. As the saying goes: you don't know what you don't know. Thus, to properly prepare for a silo fire, a facility needs to prepare for the potential magnitude the hazard represents and understand the safest options to mitigate and then eliminate the smouldering material. An educated emergency responder with a respect for the hazards can mitigate the situation with a careful, cautious approach when dealing with fire activity in a combustible dust environment. Thankfully, a smouldering bulk storage fire is a stationary static fire event. When detected early and monitored, a bulk storage fire allows facilities the required time to review procedures, assess the hazard, eliminate secondary hazards and develop a plan of action.

Size up

When a fire alarm goes off after detecting a silo fire, a facility is faced with navigating an abnormal situation with multiple known and unknown hazards. To safely overcome the event, the slide gate should be closed to isolate the smouldering hazard. Once identified and contained, the atmospheric conditions should be monitored and an assessment of the structure should be conducted with a thermal-imaging camera. The initial assessment will provide the known facts and is the first step in the hazard elimination process used by HCT's ER services. This initial data should be logged and used to evaluate progress moving forward. Knowledge management is key to successful operation; thus continuous assessments should be conducted until the fire is eliminated. A fire hazards analysis is a comprehensive situational plan that can provide a detailed picture of the scenario and the potential consequences. Ideally, a fire hazards analysis is created before an event to address the known hazards, available countermeasures and initial control tactics. A fire hazards analysis should contain all available information and resources that focus on the fire hazard (equipment drawings, previous fire activity, silo manufacturer, subject matter experts, specialised ERTs, clean-up contractors, portable conveyor rental, post-incident investigators, etc.).

A fire hazards assessment provides the fire hazard's current status and predictive developments. An assessment should include the nature of the fire, location, stage of combustion, access points, secondary hazards, associated equipment, required lock-out, suppression flowability and reliability (water supply, gpm, psi at various elevations, F-500 agent available, required equipment, hand tools and ropes). The assessment is used to generate a formal incident action plan, which will dictate the appropriate course of action given the current conditions and available resources. An incident action plan needs to evolve to address any unknown or unforeseen hazards that typically impede or complicate safe mitigation. HCT's ER services has dealt with the following unknown/unforeseen hazards or issues in the past:

- Clogged pipes.
- No pressure.
- No water.
- Broken gates.
- Jammed gear box.
- Missing equipment.
- No power.
- No education, no induction (UK).
- Inadvertent operation.
- Hidden dust.
- Material shifts.
- Equipment engulfment.
- Large CO spikes.
- Asbestos.
- Shift compatibility.
- Erroneous information.
- Equipment failures.
- Hazard ownership.
- Unrelated fire events.
- No man power.
- Hose burst.
- A red-tailed raptor's nest with hatchlings.

Hazard mitigation equipment tied up and secured for remote activation.

Early detection allows facilities preparation time to consult with subject matter experts (SME) on bulk material hazards. A SME should be on scene to assist local emergency responders and plant personnel with the evaluation and executions of mitigating procedures. ER teams with specialised training on bulk material handling hazards should be found in a completed fire hazards analysis. It is important to understand that a deep-seated silo fire should not be a one day event. The PRB Coal Users' Group offers a collection of teachable moments available on their website.[1] The collection contains events where silo fires were believed to have been extinguished in one day before triggering a secondary explosion in the following days. Thus, resources should be in place for the potential for prolonged operations; these resources will vary depending on the time of year. Facilities relying on local fire department equipment and man power will likely encounter communication issues and justified resistance. Communication issues can be resolved with a unified incident command post (Figure 1), which ensures responders and involved personnel are accounted for and on the same page at all times. Facilities with a pre-existing relationship with the local Fire Department/Fire Service (FD) are less likely to encounter resistance. However, prolonged operations can deplete local resources and may unintentionally strain community relations. A properly executed silo fire response is a methodical step-by-step hazard elimination process conducted remotely or under controlled and monitored conditions. When a facility eliminates dust explosion hazards and maintains control of a silo fire hazard, no visible flames should be seen and no life safety hazards should exist. From a FD's perspective, they accomplished their primary objectives and are now left overseeing a property conservation event. However, the hazard is active and still capable of death and destruction. Coal is an effective thermal insulator so smouldering activity is difficult to confirm or deny with thermal imaging equipment. A silo fire should never be considered a safe scene until all the material has been removed from the structure remotely under controlled conditions.

Clean up

Secondary combustible dust hazards in the surrounding area and within associated equipment possess the potential to propagate a flame front and/or trigger a secondary explosion. A facility's dust management programme should keep this potential hazard under control during normal operations. However, due to the potential consequences these fuel deposits represent during abnormal operations, they must be completely eliminated before any attempts to mitigate the smouldering fire activity. Eliminating the secondary combustible dust hazards reduces the potential magnitude behind the hazards and is the second step in the hazard elimination procedures developed by HCT's ER services.

Back up

The third step in the hazard elimination procedure is to eliminate all of the combustible dust hazards inside the structure. This primary dust hazard has the potential to again propagate a flame front and/or trigger a primary explosion inside the structure. Eliminating the primary dust hazards should be done remotely from a safe standoff distance. This can be achieved by lowering a cellar nozzle attached to HCT's piercing rod assembly into an access door: charge the line to minimise air introduced into the silo then securing the tool to the structure, tying up the hose line so it jumps when charged. A cellar nozzle will spray up and out, removing the dust deposits on the I-beams and walls while indirectly saturating the surface of the material. The cellar nozzle should be activated from a safe standoff distance for a relatively short time (10 – 15 min.) with 1% F-500 EA, before repositioning or reassessing for progress. All personnel should be cleared out of the established hazard zone. This step in the process is the most vital in establishing control of the situation. If something were to go wrong, it is most likely to occur during this operation simply because the dust is dispersed momentarily before being knocked down by the F-500 fog pattern from the cellar nozzle. Depending on the size of the structure and internal structure support, the cellar nozzle may need to be repositioned to eliminate all dust deposits within. Control of the situation is established once the explosion hazards have been eliminated and material has been well saturated with F-500 in a 1% solution. As long as the hazard is kept under control, the situation can be safely mitigated with HCT's piercing rod tool and F-500 EA. F-500 is a micelle encapsulating agent with a long-proven history of successfully extinguishing deep-seated fires in bulk storage due to its ability to encapsulate the fuel, penetrate the material and rapidly cool the hot spot. A surround and cool approach is used to eliminate the flash fuel hazards surrounding a hot spot, advancing towards the smouldering material 5 ft at a time.

Spontaneous combustion in bulk material has a tendency to spread unchecked when conditions allow. In a silo, spontaneous combustion is most likely to occur near the walls just above the taper, where the largest coal particles accumulate, allowing for an increased amount of available oxygen, coupled with stagnant older material. The smouldering hot spot's radiating heat will create liquid coal tars, which penetrates the surrounding material where it cools and creates a thin crust of congealed coal. The crust surrounding the cavity created by a hot spot will either be consumed as the hot spot expands, break apart during a material shift or collapse due to an increase in size. When the smouldering hazard is not properly controlled while it is being mitigated, this shift in material or cavity collapse can disperse dried coal dust into a cloud and trigger a flash fire with the potential for a primary explosion. When the material surrounding the smouldering hot spots is saturated with F-500 solution, there should not be any dust or flash fire fuel available to propagate a flame front. As progress is made, there should be a noticeable reduction of temperatures and CO level. A controlled collapse will lead to a change in thermal conditions and a spike in CO levels. As material shifts, CO spikes and temperature changes should be expected as trapped gasses and insulated heat are released. Continuously monitoring the area with a thermal camera will show a hot spot shifting in size and shape as mitigation efforts extinguish the remaining activity. Once all signs of combustion have been eliminated, conditions should be monitored closely until all of the material has been unloaded under control from a safe remote location. To unload the material, the hazard must not be given the opportunity to harm personnel or equipment. To accomplish this, the material should be well saturated before unloading with a cellar nozzle or equivalent fog pattern in place at the top to mitigate the potential formation of dust clouds inside the structure, as material shifts may expose dry pockets of material. If material is being offloaded from a side chute or access door, the flow must be controlled to prevent an influx of material, as well as having additional remotely activated measures in place to suppress dust from dispersing into the air once removed from the structure.

Coal barn fire response.

Outlook

A deep-seated coal silo fire is not comparable to a charcoal fire in someone's back yard, which is an inaccurate equivalent commonly overheard at coal fire's incident command post. Bulk storage fires are not easily extinguished, they will test a facility's stress points, jeopardise operation and personnel safety; they are a dangerous hazard with unknown potential and occur more frequently today due to the coal industry's transition to renewable fuels. Bulk storage coal fires must be prepared proactively; site-specific procedures need to be updated, reviewed, shared and practiced with all involved parties. A fire hazards analysis should be conducted by qualified professionals with experience in the specifics related to bulk storage fires. A valued fire hazards analysis should introduce a facility to a variety of potential solutions to assist in hazard prevention, detection, preparation and mitigation of coal silo or bunker fires. WC

References

1. See: www.prbcoals.com