DEPARTMENT OF MINERALS AND ENERGY WESTERN AUSTRALIA

S A F E T Y B U L L E T I N No. 46

LIGHTNING – HAZARDS & SAFEGUARDS

Introduction

Two recent non-mining fatalities caused by atmospheric lightning serve to remind of the likely consequences that this 'all too familiar' hazard can present. Both incidents occurred in open spaces, one victim being struck while beach strolling and the other (a jockey) during early morning horse training.

In 1994 a lightning strike at the Milford Haven (UK) Texaco refinery caused a fire and serious plant disturbances that resulted in an explosion, 26 people injured and massive site damage.

While few persons expect to survive a lightning strike, most believe that the likelihood of this occurring to be extremely remote. '*It will not happen to me*'. This is a perception only, and persons need to be aware of certain influences that significantly increase risk, and exercise rudimentary precautions.

Another popular notion is '*lightning never strikes in the same place twice*'. Particular regions of Australia, and specific natural features within those regions, experience inordinately higher activity levels than other places; and a certain well-known professional golfer after suffering the effects of lightning several times now promptly vacates the course at the first sign of a thunderstorm's approach.

Worldwide, it is estimated that lightning strikes the earth around 6000 times per minute, and within Australia it poses a greater threat to individuals than almost any other natural hazard, accounting for five to ten lives and well over 100 injuries annually.

Lightning phenomena

Lightning is an electrical discharge that neutralises oppositely charged regions that develop within thunderclouds, or between thunderclouds and the ground.

The atmospheric processes that cause the build up of charge occur on a vast scale, require the coincidence of particular meteorological conditions, and remain the subject of scientific debate. However, there is some consensus that charge separation distribution and accumulation is associated with the collision of ice particles swept upwards by intense circulating air currents within the cloud.

Discharge to ground occurs when the cloud's potential difference with respect to the earth attains a voltage level sufficient to overcome and ionise the air in between. Energy levels are extreme and can support voltages in the order of 100 million volts and discharge currents up to 200 000 amperes. Arc temperatures around 30 000 degC give rise to rapid heating and cooling of the surrounding air, which in turn causes the familiar sound shock-wave known as thunder.

The first stage of a lightning discharge involves a downward travelling 'leader' which originates within the thundercloud and rapidly progresses towards the earth in roughly 50 metre steps. As the 'leader' approaches within 200 metres from ground one or more 'streamer' discharges initiate from points on the ground and propagate upwards until one connects with the 'leader' and completes the discharge path.

'Streamers' will always initiate from the most favourable ground protrusions that exist in the vicinity of the downward travelling 'leader', and it is this characteristic which forms the basis of lightning protection.

Protection of buildings and structures

When necessary, the damaging effects of lightning strikes to buildings and structures can be controlled by purposely installing one or more **air terminations** (lightning rods) in elevated positions, and electrically connecting them to grounding electrodes. In this way, the air terminations serve to attract and divert the lightning discharge which otherwise would strike vulnerable parts of the building or structure being protected. Below each air termination is a defined zone, within which direct protection may be assumed.

The decision whether or not to provide lightning protection should be based on a risk assessment of the likelihood of the building or structure being 'struck' and the consequences if this occurs. Factors relating to the building or structure that need to be considered include usage occupancy and contents, construction material, height, situation, and the prevalence of thunderstorms in the locality.

In some instances such as public buildings, explosives magazines, headframes, lookouts and essential services there will be little doubt regarding the need to provide protection, whereas in other places where an inconsequential loss is anticipated, the cost of protection may not be justified and the risk is accepted.

Protection of persons

Personal protection can be achieved by minimising the chances of becoming a 'human' air termination, and by avoiding contact with and the near vicinity of objects that substitute as an air termination.

In built-up outdoor areas, the usual presence of buildings, trees, overhead power lines and street lighting poles etc; normally afford a degree of protection that is not available in the more exposed locations.

Persons in exposed outdoor locations should immediately seek to protect themselves at the first indication of a thunderstorm's approach. With or without rain, if you can hear thunder you are within immediate striking range of lightning and the following precautions should be observed:

- Preferably, seek shelter in a substantial enclosed building and avoid structures of lesser construction.
- It is safer inside an enclosed metal bodied vehicle than outside. Vacate open-top vehicles and plant.
- Seek low ground and avoid elevated positions such as hilltops ridges and rooftops.
- Avoid open ground, boating and expanses of water in general.
- Vacate sports fields, golf courses, racetracks, tennis courts, cycles, swimming pools and the like.
- Do not shelter under isolated trees (side flashes occur). If you are under the foliage you are too close.
- Avoid touching, handling and proximity to any metallic objects that may become part of the discharge path such as towers, mobile plant, powerlines, pipes, rails, fences, clothes hoists etc.
- A last resort is to crouch close to the ground with feet together (preferably in footwear).

Whilst persons inside buildings are generally protected against the direct effects of lightning, other circumstances exist where the indirect effects of lightning can be transmitted within buildings via entry points such as the electricity mains, telephones, aerials, flues, air-conditioners, metallic roofs gutters and downpipes, and exit points such as water and gas services. Despite certain installation practices that minimise these indirect effects, and whether or not the building has an air termination, persons inside buildings should take basic precautions by avoid unnecessary contact with such entry and exit points.

- Avoid the use of telephones systems (other than radio mobile and cordless telephones).
- Avoid contact with electricity/gas/water services and appliances.
- Avoid washing, bathing, showering, and contact with metallic sinks basins and plumbing.
- Avoid contacting larger metallic objects generally, window frames, ducts, vents, skirtings etc.
- Any disconnection of television aerials and 'valued' electronic equipment should be at the wall-socket and well in advance of the storm's arrival.

Additional protection on minesites

Further to the issues outlined, a major hazard can prevail at mining operations (if not properly managed) regarding the possible premature ignition of explosives by either the direct or indirect effects of lightning. The hazard can occur above and below ground, and the extreme consequences that are likely to result demand strict operational procedures be adhered to whenever lightning poses an unacceptable risk.

Before delivering explosive materials to the workplace an assessment should be made of the forecast weather conditions, and plant such as drilling rigs shovels and lighting towers removed from the area. Purpose designed lightning detectors should be used to provide an early warning system.

Mines Safety and Inspection Regulation 8.38(2) states:

> *If, in the opinion of the manager of a mine, the proximity of an electrical storm is such as to constitute a danger to the process of charging and firing, the manager must ensure that the work in connection with the charging and firing ceases, and that **all** employees are withdrawn from the area of that work.*

The manager's duty is clear, and so is the need to withdraw all employees (not just blast crewmembers).

More generally, all mining work practices including drilling, loading, hauling, dumping, processing, maintenance and construction need to be considered, and take into account any additional hazards associated with fire, tyre explosions, high winds and accompanying heavy rainfall.

Summary

Lightning is a phenomenon that cannot be prevented. Only the effects of lightning can be safeguarded against by employing protective systems and by exercising due diligence and long-standing established precautions. Absolute protection in all instances cannot be guaranteed.

Circumstances vary considerably and risks presented to individuals are not equal. While a 'spotter' high up on waste dump is far more exposed to the direct effects of lightning than an attendant truck-driver, the truck-driver may have to further contend with slippery road conditions high winds and poor visibility.

Thunderstorms can approach rapidly and their distance can be estimated using the 'flash-bang' time scale which equates to 1 mile for each 5 second interval between the lightning flash and the sound of thunder.

Early avoiding action is paramount, and employees need to be conscious of their exposure and the appropriate course of action to be taken. For this to occur in a timely manner, employers should adopt a risk management approach, develop site specific policy and systems of work that effectively deal with the hazard, and adequately communicate the outcomes to their employees.

Further information may be reference from Australian Standard AS1768 – 1991: Lightning Protection.

J M Torlach
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SAFETY AWARENESS SAVES LIVES