PILBARA PORTS AUTHORITY

LIGHTNING AND PREPAREDNESS RESPONSE PLAN

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1. USING THIS PLAN

This document is to be read in conjunction with Pilbara Ports Authority's (PPA) "Lightning Preparedness and Response Operational Procedure" (Procedure). The plan:

- Provides additional background information and context to the lightning risks at PPA's ports which may be a useful reference to all personnel;
- Provides task and event specific responses for specific scenarios which are not covered by the Procedure; and
- Provides additional details to health and safety personnel, supervisors and managers who have responsibility in managing the health and safety of personnel working in or accessing areas where they could potentially be exposed to lightning.

Terms used in this plan that have been defined in the Procedure, have that same meaning in this plan, unless otherwise defined in this plan.

2. LIGHTNING BACKGROUND

2.1 Background

Lightning is one of the most dangerous and frequently encountered weather hazards in Australia. It is estimated there are six to ten deaths and over one hundred severe injuries caused by lightning every year (DMIRS 2018).

Lightning Facts:

- Lightning can warm the air by 27,700 degrees Celsius, five times hotter than the surface of the sun;
- A strike can contain a hundred million electrical volts;
- If your hair stands up on the end of your head, it could indicate positive charges are rising through you. If so, seek immediate shelter;
- Thunder is caused by the expansion of rapidly heated air; and
- A strike can vaporise the water in a tree causing steam which can blow the tree apart.

2.2 Types of Lightning Strikes

Cloud to ground lightning bolts typically begin when a step-like series of negative charges, called a stepped leader, races downward from the bottom of a storm cloud towards the earth along a channel at about 300,000 km/hr with each of the segments being approximately 46 meters long.

When the lowermost step comes within 46 meters of a positively charged object, it is met by a climbing surge of positive electricity, called a streamer, which can rise through a building, a tree, or even a person.

When the two connect an electrical current, which flows as negative charges, flies down the channel towards earth and a visible flash of lightning streaks upward at 300,000,000 km/hr, transferring electricity as lightning in the process.

Another form of lightning which can strike objects on the ground is called Positive Lightning. These occur at a ratio of around 1 to 20 with cloud to ground strikes. Positive Lightning originates from the positively charged tops of storm clouds. These strikes reverse the charge flow of a typical lightning bolt and are far stronger and more destructive. They can strike out of the blue as far as 16 km from a storm either as a leading strike to the storm or a trailing strike after a storm.

Other types of lightning include:

- Lightning that travels between differently charged areas within or between clouds (this is more common than cloud to ground strikes);
- Ball lightning, which is a small charge sphere that floats, glows and bounces along; and
- Rarer forms which can be triggered by fires, volcanic eruptions, and snowstorms.

2.3 Impacts of Lightning

2.3.1 Human Health

Lightning can cause injury to humans through a range of mechanisms including:

- Direct strike – where lightning directly hits the victim;
- Indirect strikes – may also have consequences as serious as a direct strike. Indirect strikes include:
  - Side flash – when standing near an object that is struck; and
  - Contact potential – from physical contact with a struck object.
- Step voltage / ground current – occurs when lightning strikes the ground or infrastructure and voltage gradient occurs across a person between two or more contact points such as in a two footed stance (therefore, it is recommended to keep your feet together when trapped in the open);
- Upward streamer – occurs when a non-intercepting upward streamer is launched through or around a person;
- Surge propagation – when a person is close to or in contact with an electrical appliance, power line or communication line which is struck by lightning; and
- Shock wave – impacts from the force of a lightning strike and/or associated damage to nearby objects can cause injury (i.e., throwing the victim off their feet or cuts from shrapnel strikes).

Direct strikes account for only 3 to 5 per cent of all injuries and deaths associated with lightning. Ground currents, which spread out over the ground after lightning strikes, account for up to 50 per cent.

The effects of being struck by lightning range from minor to life-threatening. According to guidelines published in Annals of Emergency Medicine, 90%

of people struck by lightning survive, but they commonly suffer permanent after-effects and disabilities (Zimmermann *et. al.* 2002).

Short term effects can include:

- Impaired eyesight;
- Ear ringing;
- Ruptured ear drums;
- Loss of hearing;
- Loss of consciousness;
- Severe electrical shock;
- Seizures;
- Paralysis;
- External burns to the skin;
- Internal burns to organs and tissues;
- Blunt trauma (from falling); and
- In severe cases, cardiac arrest can occur.

Long term effects include:

- Sleep disturbances;
- Memory dysfunction;
- Headaches;
- Irritability;
- Fatigue;
- Abnormal gait (cannot walk or balance properly);
- Joint stiffness;
- Muscle spasms; and
- Dry eyes.

2.3.2 Light Vehicles

Lightning strikes have the potential to cause damage to vehicles through several mechanisms including:

- Direct strike – where lightning directly hits the vehicle;
- Indirect damage – when another item is damaged by lightning and then falls or is thrown into or onto the vehicle; and
- Causing a vehicular accident when a lightning's strike to or near the vehicle impacts on the driver's ability to safely operate the vehicle.

Reported impacts on vehicles include pitting, damage to electrical systems, stopping the motor when a running vehicle is directly hit and setting off air bags.

Depending on the design of the vehicle it may be safe to shelter in a stationary vehicle during lightning activity. For information on safety of sheltering in vehicles see Section 5.1.3.

2.3.3 Mobile Plant – Safety Hazards Associated with Lightning Impact

Lightning strikes on mobile plant can have many of the same impacts as on light vehicles. Additionally, overheating of rubber because of lightning strikes on heavy vehicles may cause tyre explosions which could potentially result in accidents if the vehicle is in operation (i.e., if a front-end loader was in operation with the bucket raised).

When a rubber tyre becomes overheated, a chemical reaction in the rubber called pyrolysis can occur. Pyrolysis causes the rubber to deteriorate. At a certain point, this deterioration can create a very rapid pressure increase inside the tyre that can lead to a sudden and unexpected explosion.

Once this chemical reaction starts, it can continue on its own even after the heat source is removed. Pyrolysis can last seconds or hours. There are no visible signs when it's taking place until the explosion occurs (this has been known to take up to 21.5 hours). Pyrolysis can occur in temperatures as low as 185°C and does not require oxygen, meaning nitrogen filled tyres are also at risk. Anyone standing near the explosion is at risk of serious injury or even death.

2.3.4 Buildings

Lightning passing through a building may branch and utilise more than one path to ground at a time. It can also jump from one conductive path to another as a side flash. The three main hazards to the building are:

- Fire danger: flammable materials can be ignited if electrical energy from lightning passes through or near to them (i.e., down pipes or wires);
- Power surge damage: electrical energy can damage wiring and attached electronic devices;
- Shock wave damage: lightning can cause an explosive shock wave which can fracture solid materials, blow out plaster walls, shatter glass, create trenches in soil and crack foundations. This can result in shrapnel which can create secondary damage to the building or injury to inhabitants.

2.3.5 Fixed Plant

Lightning risks for fixed plant are similar to other buildings. Risks during lightning include:

- Direct strikes to personnel in open areas of the plant;
- Indirect strikes to personnel in contact or close proximity to metal structure;
- Damage to electrical components and electronic devices;
- Fire danger;
- Injury to personnel due to step voltage effects from standing on metallic or wet surfaces; and
- Shock wave damage.

2.3.6 Marine Vessels

According to Seaworthy Magazine (BoatUS 2015) insurance data indicates that:

- The probability of lightning strikes to boats increases for larger vessels, dual hull vessels and taller vessels;
- The most common damage is to electronics;
- Damage may also occur to fibreglass when lightning goes through jack stands or chains; and
- Extreme damage to a vessel is the exception, not the rule.

This damage may occur both with direct hits and hits near the vessel. The worst-case scenarios can include:

- Damage to electronics resulting in loss of control; and
- Hull damage resulting in sinking of the vessel.

The extent of lightning damage is often not immediately apparent as subtle damage, such as a gradual leak in the hull, can go unnoticed and result in the vessel sinking in the hours or days after the storm.

2.3.7 Helicopter Operations

Helicopters develop strong negative charges when flying and may trigger lightning if interacting with positively charged clouds. This can mean that they have a higher chance of being struck by lightning then a person on the ground.

Lightning strikes can cause major physical damage to rotor blades and other parts of helicopters. In addition, when lightning strikes the electromagnetic field can damage electrical equipment.

Helicopter operations are outside of PPA's core business expertise and subsequently PPA engages specialist contractors to undertake helicopter operations. It is the responsibility of these contractors to manage any risks relating to helicopters and lightning.

2.4 Weather Patterns in the Pilbara

Weatherzone provided PPA with an extract of lightning strike records for the three years prior to November 2019. The data extracted showed all lightning strikes that had been recorded within 40 km of each port's centre point. This section presents an analysis of all lightning strikes to ground for the period.

Lightning activity was highest at the Port of Port Hedland, with an average of 380 lightning strikes to ground within 10 km per annum and lowest at Dampier with 76 strikes respectively. A summary of the data is presented in Table 1.

Table 1: Average Annual Lightning Strikes to Ground Near PPA Port Sites

DISTANCE FROM WEATHERZONE REFERENCE POINT	AVERAGE ANNUAL NUMBER OF LIGHTNING STRIKES TO GROUND		
	Port Hedland	Ashburton	Dampier
0 - 10 Km	380	205	76
10 - 20 Km	1,525	602	441
20 - 40 Km	8,161	3,405	2,533
Total	**10,066**	**4,211**	**3,050**

Lightning followed a similar seasonal pattern at all sites with:

- Either no lightning or very minimal lightning recorded between April and October at all sites;
- Lightning events starting to occur in November and December;
- The bulk of recorded lightning activity at all sites occurring between January and March;
- Peak lightning activity for Port Hedland was recorded in March, with 213 lightning strikes to ground within 10 km, and a peak in February for Ashburton and Dampier with 117 and 49 strikes within 10 km respectively;
- Out of the blue strikes to ground near the port sites are relatively rare. Over three years of data from Port Hedland, only one ground strike occurred within 10 km of the port without previously recorded lightning activity in the last 30 minutes. The other 1140 ground strikes that occurred within 10 km of the port all occurred within 8 minutes of the last recorded lightning activity and 98.9% occurred within 1 minute of the last recorded activity.

A summary of the data is presented in Figure 1 and Figure 2.

Figure 1: Average Monthly Lightning Strikes within 10km of PPA Ports

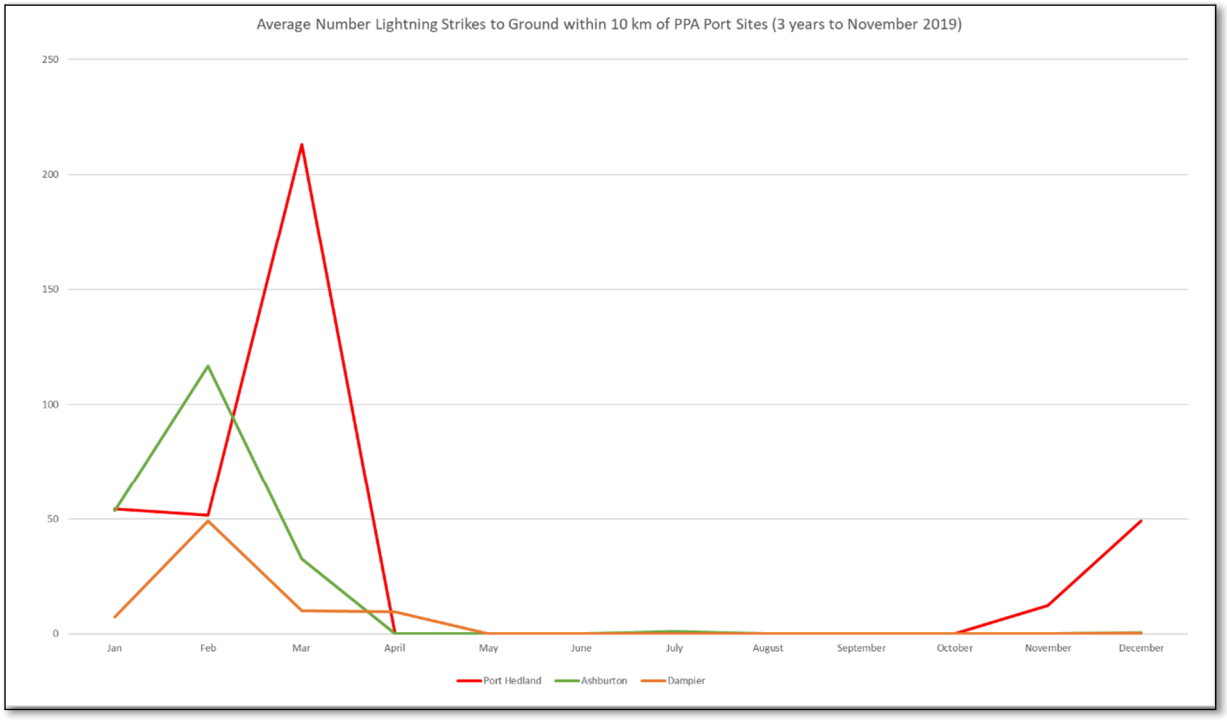
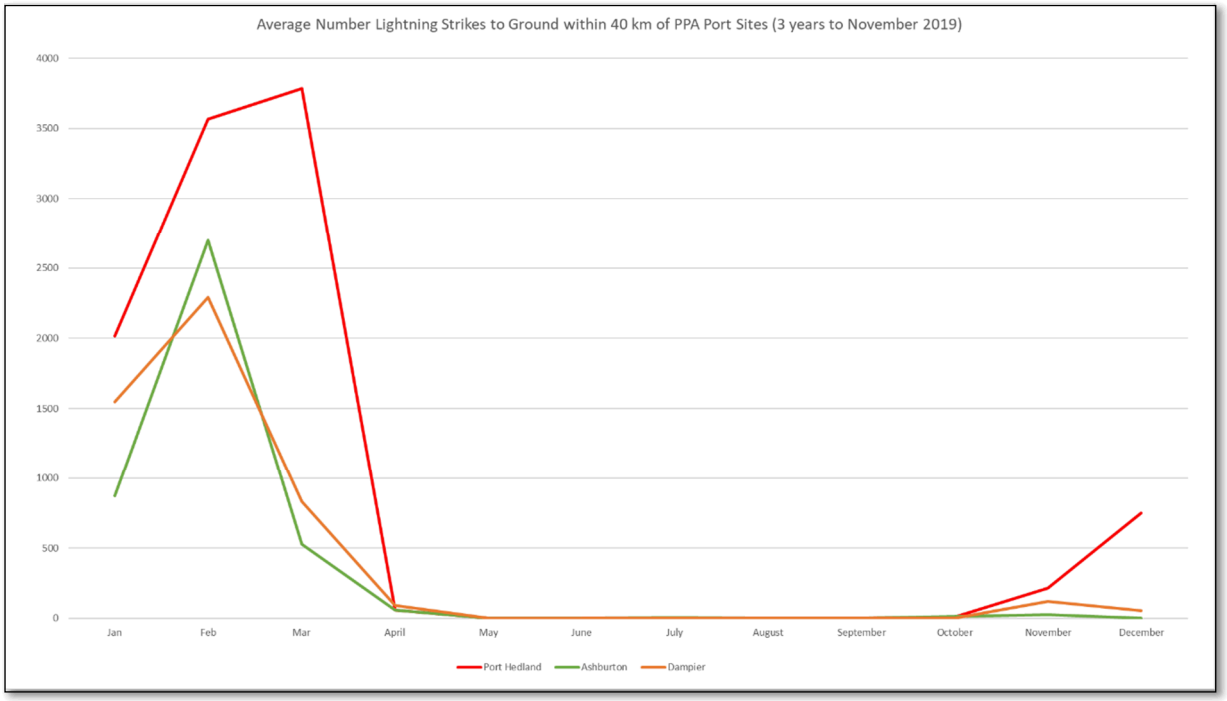


Figure 2: Average Monthly Lightning Strikes within 40km of PPA Ports



3. MONITORING

By monitoring lightning activity, the likelihood that personnel will be trapped in the open during a lightning event is reduced. The Lightning Safety Guidelines (Zimmerman *et al.* 2002) recommend that a combination of data sources is used when monitoring for lightning activity as neither personal observation of lightning or use of lightning detection systems of themselves can guarantee safety. While PPA has the Weatherzone system to provide alerts, never let the lack of warning from this system override your instincts and physical observations of lightning activity.

3.1 Weatherzone

PPA subscribes to a service provided by Weatherzone who operate a network of lightning sensors which are used to accurately record both lightning strikes within clouds as well as lightning strikes to ground[1]. This information is processed in real time so that:

- It can be monitored online via a subscription service using computers or smart devices;
- It can generate alerts via email and SMS which are sent out to a distribution list; and
- A phone app is available which can provide location specific monitoring and alerts based on the GPS location of the phone.

When engaging work groups or contractors to undertake works where lightning presents a risk to safety, managers must ensure that arrangements are in place to monitor lightning activity and manage the associated safety risks. This may include providing them with access to Weatherzone for the duration of the works.

3.1.1 Access to Weatherzone

The Weatherzone contract is managed by PPA's Dredging team.

PPA personnel who require login access to the online Weatherzone subscription service should contact the Dredging team. Non-PPA personnel who require access should contact their PPA representative/contact to facilitate organising access.

3.2 Hand-Held Lightning Detectors

Personal hand-held lightning detectors can be used to monitor lightning activity and should be used if available when access to Weatherzone is not possible. They detect the electromagnetic pulse (EMP) emitted by a lightning strike. By measuring the strength of the detected EMP the device is then able to provide an estimate of how far way the detected strike was.

[1] Note: Weatherzone have stated that the detection rate is ~90% for ground strikes and ~70% for inter and intra cloud strikes (personal communication C. Janson 13/11/2019). Numbers of cloud strikes are much greater than ground strikes (of all strikes recorded by Weatherzone within 40 km of PPA sites between November 2016 and November 2019 18.3% were ground strike and 81.7% cloud strikes).

3.3 30/30 Rule

Electronic systems for monitoring lightning are not infallible and as such workers in unsafe locations should also visually monitor around their work environment for approaching storm systems and lightning activity.

The “30-30” rule can be used in conjunction with electronic monitoring systems and as a last resort when Weatherzone or a hand-held lightning detector is not available. This rule works on rule of thumb that for every 3 seconds of delay between seeing a flash of lightning and hearing the corresponding thunder equates to 1 km.

So, if the timing is less than 30 seconds, indicating that lightning is within 10 km, then you are in immediate danger and should apply a lightning “Red Alert” level and follow the response actions as described in Sections 4.1.2 and 4.2.

If you cannot see the lightning, just hearing the thunder means you are most likely to already be within striking range, and it is time to seek whatever appropriate shelter is available. Apply a lightning “Red Alert” level and follow the response actions as described in Sections 4.1.2 and 4.2.

4. LIGHTNING RESPONSE

4.1 Raising Alerts

PPA subscribes to the Weatherzone service which will automatically send out alerts when lightning activity occurs within proximity of one of its port sites. Users working at the port sites can be set up to receive alerts by email or SMS (see Section 3.1.1 for details).

The alert level for each port is based upon the proximity of lightning activity (including cloud strikes and ground strikes) to a centre point which has been defined for each port location. The points used for calculating alert levels are:

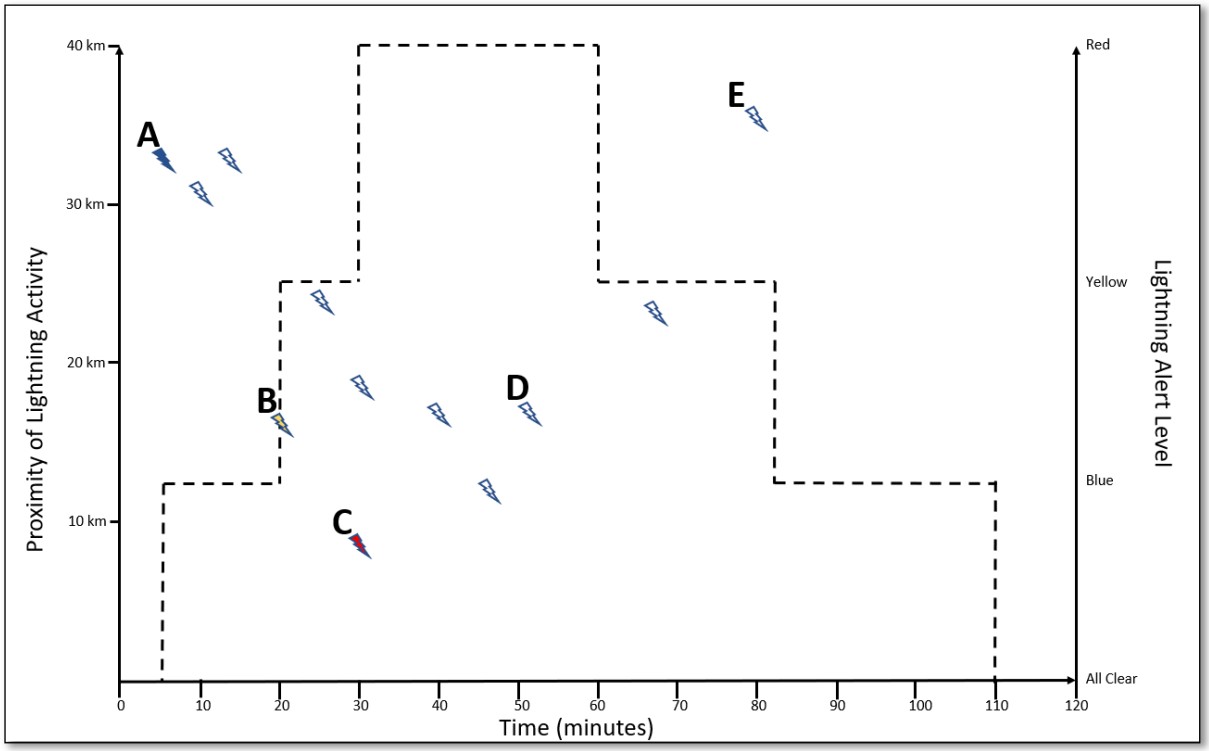
- Port of Port Hedland -20.3232° S ,118.5733° E
- Port of Dampier -20.6179° S,116.7562° E
- Port of Ashburton -21.6916° S,115.002° E

Lightning alert levels are determined by proximity of lightning activity (both inter and intra cloud strikes and ground strikes) with the highest alert level applying. The alert levels from lowest to highest are:

- “Blue Alert” – lightning within 40 km;
- “Yellow Alert” – lightning within 20 km; and
- “Red Alert” – lightning within 10 km.

Alert levels downgrade after 30 minutes with no lightning activity being detected within the designated range and an “All-Clear” is issued when no lightning has been detected within 40 km for a period of 30 minutes.

Figure 3: Example of Upgrading and Downgrading Lightning Alert Levels While a Storm Passes



Strike A - occurs within 40 km and triggers a "Blue Alert"
Strike B - occurs within 20 km and triggers an upgrade to "Yellow Alert"
Strike C - occurs within 10 km and triggers an upgrade to "Red Alert"
Strike D – 30 minutes after the "Red Alert" is triggered no more lightning has occurred within 10 km. The highest level for a strike within the previous 30 minutes applies being Strike D which was within 20 km therefore the alert is downgraded to "Yellow Alert".
Strike E – 30 minutes after the last trigger for "Yellow Alert" no more lightning has occurred within 20 km. The highest level for a strike within the previous 30 minutes was Strike E which was within 40 km and therefore "Blue Alert" applies. 30 minutes after this strike no more lightning activity has occurred within 40 km and as such the "All Clear" is given.

When undertaking work outside of the port areas a Weatherzone App is available which can be set up to display lightning alerts based on the user's current location. This app online functions when the user has access to data.

Where Weatherzone is not available the alert level must be manually calculated using a hand-held lightning detector or, if neither Weatherzone or a hand-held detector is available, using the 30/30 rule.

4.1.1 Recording Alert Levels using a Hand-Held Lightning Detector

When monitoring lightning events using a hand-held lightning detector the person responsible for monitoring must:

- Record the time and proximity of lightning strikes; and
- Manually determine the alert level.

The alert level can move up and down as described in Section 4.1.

4.1.2 Recording Alert Levels using the 30/30 Rule

The 30/30 rule is only to be used in conjunction with other systems or when workers have no access to Weatherzone or a hand-held lightning detector.

If the delay between observing a lightning flash and hearing the thunder is 30 seconds or fewer then a “Red Alert” applies. If it is more than 30 seconds and you can still hear the thunder, then a “Yellow Alert” applies.

If thunder is heard in what appears to be close proximity to the work site and visual obstructions prevent observation of lightning this may mean that lightning is an immediate threat. A precautionary approach should be taken and a “Red Alert” applied.

Where possible, workers should seek access to Weatherzone or hand-held lightning detector results for determining when it is safe to return to work. If these systems are not available, then the “All Clear” is not to be issued until the storm has visually moved on and there has been no observation of lightning or sound of thunder for 30 minutes and a risk assessment has been undertaken. See Section 7 of this plan for more detail.

4.2 Responding to Alert Levels

The general response actions required in response to lightning alert levels are described in the Procedure. This Section provides additional details and requirements specific to particular sites or activities.

4.2.1 Starting and Finishing Work During a Lightning Event

It is recommended that personnel in an enclosed vehicle arriving to site where “Red Alert” is declared, park safely and shelter in place as per Section 5.1.3.

If you are sheltering in a safe location during “Red Alert” when your normal shift end occurs, it is recommended to remain in that safe location until the lightning alert is downgraded and it is safe to go home. If there is potential that extended time onsite could result in workers experiencing fatigue, see the Fitness for Work – Fatigue Management Procedure. Workers that chose to leave site during a “Red Alert” are placing themselves at risk of injury.

4.3 Operational Response Plans

4.3.1 Out loading at Utah Point – Port Hedland Wharf 4

In addition to the response actions listed in the Procedure, the following protocols are to apply to out loading operations at Utah Point.

The ship loader control room, front-end loader cabins and sample station control room are all considered safe locations during a lightning event.

During a Yellow Alert:

- Identify safe locations where front-end loaders can be parked during "Red Alert". These should take into consideration potential for lightning strikes causing a tyre explosion; and
- Personnel on exposed areas of the plant without access to a nearby safe location are to pack up and move to a safe location (i.e., personnel undertaking washdown or inspections on conveyor systems or working in towers that don't have an enclosed level with a non-conductive floor where the worker could shelter during a "Red Alert").

During a Red Alert:

- Front-end loaders to cease operation and park in a safe location until the lightning alert is downgraded at which point operations can recommence;
- Front-end loader operators are to shelter in the cabin until the alert is downgraded;
- Sampler is to shelter in the control room; and
- Ship loader operator may continue to run off any product on the circuit into the vessel and then must shelter in place in the ship loader control room until the alert level is downgraded.

4.3.2 Road Train Operations

The cabin of a Prime Mover is considered a safe location to shelter from lightning activity. Operation of road trains may be considered during a "Red Alert" lightning event where a risk assessment indicates a low risk to safety. The risk assessment needs to take into consideration:

- Risks associated with potential loss of control if a lightning strike occurred to or near the road train (i.e., taking into consideration speed, complexity of manoeuvring required and obstacles that could be impacted if loss of control occurred);
- Design of the road train and if any control systems used to operate the vehicle could conduct electricity from the outside of the vehicle; and
- Activities which could allow lightning energy to impact on the driver (i.e., exiting the vehicle, opening windows, or using wired electronics such as radios) are not to be permitted during "Red Alert".

At Utah Point, road trains on the ring road are generally allowed to enter site to tip off and then continue to exit the ring road. They must not exit the vehicle, open windows, or use wired electronics. If, however operations are not assessed as safe to continue, then drivers should park in a safe location and wait for the alert level to be downgraded.

4.4 Responding to Lightning Strikes

4.4.1 To Another Person

Response actions for responding to a lightning strike to a person are described in the Procedure.

4.4.2 To Heavy Vehicles and Mobile Plant

When a heavy vehicle or mobile plant with wheels, such as a front-end loader, is stuck by lightning there is a risk of tyre explosion. Response actions should include:

- Parking the vehicle in a safe location (if it is not already in one) where the impacts of a tyre explosion are unlikely to pose a significant threat;
- Exit the vehicle when safe to do so and proceed as quickly as possible out of the line of fire;
- Consider temporary barriers such as windrows to control a potential tyre explosion;
- Maintain an exclusion zone for 24 hours; and
- Assess vehicle for safety prior to return to service.

4.4.3 To Light Vehicles

Response actions should include a safety assessment being undertaken prior to the vehicle being driven as damage to electrical systems or components may mean that the vehicle isn't safe to operate.

4.4.4 To Boats

Response actions should include a safety assessment being undertaken on the boat prior to it being operated as damage to electrical systems or components or damage to the hull may mean that the boat isn't safe to operate.

4.4.5 To Buildings and Infrastructure

If a building you are sheltering in is struck by lightning, you will hear a very loud, powerful boom that may shake the entire structure. Lightning strikes may cause physical damage to buildings, damage electrical cables and equipment or cause fires. Fires can occur due to the heat associated with electricity from a lightning bolt running through plumbing or wiring. This may be noticeable immediately or may slowly burn for some time before signs become obvious. Fires caused by lightning have been known to start in building cavities such as inside walls and ceilings.

If lightning strikes a building that you are in, you should:

- Monitor the building for signs that a fire may have commenced;
- Remain in shelter until the lightning "All Clear" is given, if safe to do so;
- If it appears that the lightning has created a fire raise the alarm and respond using a risk-based approach (see Section 5.1.3 for more detail);
- Once the "All Clear" has been given, report the lightning strike to PPA's Maintenance and/or Operations teams so further assessment can be undertaken of fire risk and any damage, and continue to monitor for fire risk until a proper assessment is undertaken.

When assessing a building that has been struck by lightning, the following must be undertaken:

- Checking for potential fires in cavities (i.e., using heat detecting devices if available);
- Checking for physical damage;
- Checking plumbing for leaks; and
- Checking electrical systems for damage.

4.5 Recording Lightning Strikes

Any near misses or lightning strikes to personnel, vehicles, equipment, buildings, plant and infrastructure must be recorded in PPA's incident management system as per the Incident Management Procedure.

5. SHELTER LOCATIONS

5.1 Safe Locations

A list of safe locations is provided in the Procedure. Further details and guidance are provided in this Section.

5.1.1 Sheltering in Buildings

When sheltering inside a building:

- Avoid contact with conductors such as wiring, pipes, metallic materials (particularly those connected to the outside of the building) and water;
- Keep clear of windows if not fitted with shatter proof glass;
- Avoid contact with external surfaces and walls; and
- Avoid direct skin contact with earth ground as lightning can travel through soil and across wet/damp concrete.

5.1.2 Sheltering in Fixed Plant

When sheltering inside plant, personnel should follow the guidelines for sheltering in buildings with these additional considerations:

- Avoid open sections of the plant;
- Move to a safe location such as a control room which has been insulated against lightning and has shatter proof glass or an enclosed level with non-conductive flooring (e.g., concrete ground level floor that isn't wet).

5.1.3 Sheltering in Enclosed Light Vehicles and Mobile Plant

Light vehicles and mobile plant which have enclosed cabins offer protection to operators by acting like a mobile Faraday cage where most of the current flows around the outside of the car's metal cage into the ground below.

Convertibles do not have metal roofs, which compromises this effect and as such cannot be considered a safe location. In addition, some vehicles are manufactured out of non-metal parts, which impedes the ability to flow around the car and as such are also not safe sheltering locations.

There are some portions of the vehicle which current can flow through such as the vehicle's electrical systems and metal appendages such as radios, phone chargers, GPS units, door handles, foot pedals, the steering column and the steering wheel.

When sheltering inside a vehicle, operators must park the vehicle in a safe location, turn the engine off, put their hazard lights on and wait until the lightning alert level is downgraded to a level where it is safe for them to resume operational activities, or 30 minutes from the last lightning strike if you have no means of monitoring for changing alert levels. Fold your hands in your lap and avoid touching metal components inside the vehicle. Do not operate a radio or any electrical device which is connected to the vehicle.

If parking under a shelter, it is still safer to remain inside the vehicle than to exit the vehicle to try and find shelter inside a building.

Operators of heavy mobile plant with tyres need to park in such a way as to minimise the potential risks associated with a tyre explosion.

6. ACTIVITIES WHICH ARE HAZARDOUS DURING LIGHTNING

A list of hazardous activities is included in the Procedure. Further details and guidance are provided in this Section.

6.1 Crane Operations

Crane operations are not permitted during "Yellow Alert" or "Red Alert". Where design allows the boom, arms are to be lowered. During "Red Alert" moving across or remaining on exposed areas of cranes is only to be undertaken where a person has been caught out during a lightning event and is moving by the shortest path to the nearest safe location. If in a safe location, such as the cranes cabin, remain in place until the lightning alert has been downgraded.

6.2 Exposed Areas on Mobile or Fixed Plant and Machinery

During "Red Alert" moving across or remaining on exposed areas of mobile or fixed plant and machinery is only to be undertaken where a person has been caught out during a lightning event and is moving by the shortest path to the nearest safe location. If in a safe location, such as a ship loader control room, remain in place until the lightning alert has been downgraded.

7. RETURN TO WORK AFTER A LIGHTNING EVENT

After a lightning-event, workers must remain in shelter until either:

- An "All Clear" has been issued for the site; or
- The storm is travelling away from the site and the lightning alert level has been downgraded to a level in which their work activity is permitted.

Issuing of an "All Clear" or downgrading an alert level must either by via Weatherzone or the person in charge of a work group who has undertaken an operational risk assessment as described in Section 7.1 when Weatherzone is not available.

A site is given the "All Clear" status when:

- If access to Weatherzone is available, an "All Clear" alert has been issued for the workers current work location. When practical, the contracted security guards will broadcast over the public announcement system to advise people at Ashburton, Dampier or Port Hedland (as relevant) that the site is "All Clear". The message will say something along the lines of "Attention, attention, attention. All clear has been given, please return to outdoor activities with caution"; or
- If access to Weatherzone is not available – an authorised supervisor has issued an "All Clear" for workers to return to work at the workers current work location. The all clear will be based on no detections of lightning within 40 km using a hand-held lightning detector within the last 30 minutes or, where no detector is available, there has been no visible flashes of lightning or thunder for the past 30 minutes; or
- Where access to Weatherzone is not available and no manager is available – there have been no detections of lightning within 40 km using a hand-held lightning detector within the last 30 minutes or, where no detector is available, there has been no visible flashes of lightning or thunder for the past 30 minutes.

Waiting 30 minutes after a storm has passed before downgrading alert levels is required as more than half of lightning deaths occur once a storm has passed. This may result from positive lightning strikes which are more powerful than regular lightning strikes and which can occur up to 16km from a storm.

7.1 Operational Risk Assessment

When Weatherzone is not available to provide a downgrade of lightning alert level or an "All Clear," an operational risk assessment must be undertaken by the person in charge of a work group.

Return to work via an operational risk assessment may only occur where the intent of the Alert Level is met (i.e., a return to work can never be issued when lightning activity has been detected within 10 km in the last 30 minutes).

This assessment must consider:

- Records of lightning observations from monitoring with a hand-held lightning detector or from visual and audio observations of the storm event, where available;
- Alternative systems which allow real time monitoring of weather observations such as Bureau of Meteorology data or monitoring systems of neighbouring industry, where available;
- The direction the storm is travelling, ensuring that any ongoing lightning activity is moving away from site and that no thunderstorms can be seen to be approaching site (using ether visual observations or visual observations backed up by an alternative data source);
- The level of risk associated with the task taking into consideration the type of work, location of work and proximity of safe shelter.

8. LIGHTNING AND EMERGENCY RESPONSE

8.1 Fires or Fire Alarms Triggered by Lightning or During Lightning Events

Lightning strikes can potentially result in fires which could trigger fire alarms and evacuation protocols during a lightning storm. As emergency muster points are typically situated in the open away from buildings, they are an unsafe location where personnel would be exposed to the risk of lightning strike.

Where a fire alarm is triggered, the Fire Warden (or most senior person present if no Fire Warden is present) is responsible for making a risk-based decision on the appropriate course of action. Where the risk of lightning strike is a threat to personnel, they have authority to deviate from normal emergency evacuation protocols. The fire should always be closely monitored with potential response actions including:

- Use of a safe location (see Section 5.1) as an alternative muster point (this may necessitate moving across an exposed location as a last resort if the threat of fire is imminent); or

- Consideration of using vehicles as a safe location (if required to move the vehicle to get away from the fire this should be at low speed and for the minimum distance required to reach safety after which the vehicle should be parked and normal protocols for safety during a lightning storm followed as per Section 5.1.3).

When making decisions on the appropriate course of action, the following needs to be taken into consideration:

- Ensuring that normal processes to ensure all staff are accounted for are followed if safe to do so; and
- Potential spread of fire and how this could impact on alternative muster points including the potential need to evacuate these locations if the fire spreads.

8.2 Other types of evacuations

Any other circumstance that triggers an evacuation requirement should be managed using the same principles as described in Section 8.1 for fires. The person in charge of a group of workers is to follow a risk-based approach to determine the appropriate response considering risks associated with personnel moving into the open during a lightning event.

8.3 Oil Spills & Other Emergencies

If a lightning event occurs during an oil spill response or other emergency the safety and wellbeing of personnel takes priority over all other activities. This will usually mean the suspension of emergency response activities as per the emergency alert levels (see Section 4.2) unless doing so would create a greater threat to human life.

9. TRAINING AND EDUCATION

9.1 Lightning Awareness and Response Training

All personnel working outdoors at PPA's port sites are to be provided with a basic overview of lightning response in the induction.

10. CONSULTATION

A Lightning Risk Assessment Workshop was conducted on 27 September 2019. The workshop was facilitated by an external risk management consultant, Alan Meagher Executive Advisor in Risk Management at GHD, with the support of a Meteorologist, Barry Cook from GHD, and was attended by various work groups at PPA. A copy of the report and a record of attendees can be found on Objective.

The Lightning Preparedness and Response Plan and Operational Procedure were reviewed in response to the workshop outcomes. Drafts of the Plan and Operational Procedure were distributed to workshop attendees and other personnel for feedback and review. A record of consultation on the draft documents has been saved on Objective.

11. REFERENCES

BoatUS (2015) Striking Lightning Facts, Seaworthy Magazine

DMIRS (2015) Tyre Safety for Earth Moving Machinery on Western Australian Mining Operations

DMIRS (2018) Fact Sheet – Lightning and Outdoor Work

Zimmermann, C. Cooper, M.A. Holle R.L. (2002) Lightning Safety Guidelines, Annals of Emergency Medicine 39(6).

12. PROCESS OWNER

The Health and Safety Manager is responsible for this Plan.

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