8 Procedure for Reactive Ground Blasting

Reactive ground occurs when AN or Calcium Nitrate is in contact with partially weathered iron sulphides, like pyrite, which results in a series of reactions called the induction stage, the intermediate stage and the ignition stage. Each stage or reaction produces catalysts that drives the reactive ground reaction in the intermediate and ignition stages that result in rapid increase in temperature which can and does result in premature detonation.

Prior to blasting in material with reactive ground, a formal risk assessment must be conducted with participation of members of the shot crew. This risk assessment must be signed off by the Superintendent Drill and Blast, a representative from the explosives supply company and the Mining Engineering Manager. In addition to the risk assessment, relevant competency-based training in “Blasting in Elevated Temperature and/or Reactive Ground” for those undertaking the task must be completed. All personnel involved in charging operations will have undertaken the competency-based toolbox talk on “Blasting in Elevated Temperature and/or Reactive Ground” within one month of any reactive ground blast being charged.

Temperature measurements can be done without the need of a risk assessment or “Blasting in Elevated Temperature and/or Reactive Ground” training if personnel completing this task are deemed competent.

Ensure weather forecast is analysed to ensure uninterrupted loading.

8.1 Identification of Reactive Ground

Geologists collect samples that are sent to laboratories that test the AN reactivity test for reactive ground. This test is taken from the AEISG Code of Practice for Elevated Temperature and Reactive Ground. A significant amount of work goes into the reactive ground sampling to ensure that the best possible samples are collected so that the best quality AN reactivity results are obtained as per MAC-TCS-PRO-002 Reactive Ground Sampling. This procedure also details how the laboratory results from the AEISG Code AN reactivity testing is disseminated to the rest of MAC site personnel. It also details how the results are captured in a site Reactive Ground Risk Register.

Reactive ground is identified through the D&B Eng at the preliminary design, drill design, and loading design stages. At each of these stages, a mandatory checklist must be undertaken. These checklists include steps to check the site's Reactive Ground Risk Register. If reactive ground is identified, the D&B Eng notifies the Senior Drill and Blast team that the pattern has reactive ground. If the reactive ground is reactive >55°C, then the D&B Eng will include the Blast Hole Temperature Logging Form (MAC-STE-FRM-111) in the Blast Pack and ensure the blast pack states to temperature log at least 5% of holes. The aim of this is to ensure the ambient temperature is less than 50°C to allow the use of uninhibited products.

7 Procedure for Elevated Temperature Blasting

Due to product limitations this procedure DOES NOT cover work carried out in ground with temperatures greater than 150°C. Also, this procedure does not cover blasting with temperatures greater than or equal to 100°C. In effect, blasting is limited to less than or equal to 90°C to account for the inaccuracies of temperature monitoring and provide a level of risk mitigation recognised as being appropriate for industry best practice. Therefore, all holes greater than 90°C shall be backfilled prior to blasting.

All main drilling operations are to be completed prior to loading operations starting. This will limit any unnecessary interaction. If redrills are required, then an assessment can be made on whether loading starts or is postponed until redrilling is finalised.

Ensure weather forecast is analysed to ensure uninterrupted loading.

By definition:

Normal Blasting:

- As defined by temperatures less than 55°C.
    - MAC will employ a 5°C buffer, which yields normal blasting as less than or equal to 50°C.

Hot Hole Blasting:

- As defined by temperatures 55°C to <100°C.
    - MAC will employ a 10°C buffer for the higher temperature, which yields hot hole blasting as greater than 50°C but less than or equal to 90°C.

High Temperature Hole Blasting:

- Temperatures 100°C to 150°C.
    - MAC will not blast above 90°C.

Non-Ambient Temperature Hole:

- Temperature greater than 30°C.

Prior to blasting in material with elevated temperatures, a formal risk assessment must be conducted with participation of members of the shot crew. This risk assessment must be signed off by the Superintendent Drill and Blast, a representative from the explosive's supplier company and the Mining Engineering Manager. In addition to the risk assessment, relevant competency-based training in "Blasting in Elevated Temperature and/or Reactive Ground" for those undertaking the task must be completed. All personnel involved in charging operations will have undertaken the competency-based toolbox talk on "Blasting in Elevated Temperature and/or Reactive Ground" within one month of any reactive ground blast being charged.

Temperature measurements can be done without the need of a risk assessment or "Blasting in Elevated Temperature and/or Reactive Ground" training if personnel completing this task are deemed competent.

7.1 Identification of Elevated Temperature Shots

There are 4 methods where elevated temperature shots can be identified:

1. The D&B Eng at the preliminary design, dill design and loading design stages. At each of these stages a mandatory checklist must be undertaken. These checklists include steps to check the survey hazard layer in Vulcan which has all the historical elevated temperature areas which the D&B Eng uses to determine if the current pattern is in such an area or not. If it is the D&B Eng notifies the Senior Drill and Blast team that the pattern has the potential to be an elevated temperature pattern. The D&B Eng also includes the Blast Hole Temperature Logging Form (MAC-STE-FRM-111) in the Blast Pack. Any new elevated temperature ground shall be surveyed and included in the survey hazard layer.

2. The drillers while drilling the shot can witness heat shimmer, hot air radiating from holes or hot drill rods etc. If encountered the driller shall notify the Drill Supervisor of elevated temperature ground. The Drill Supervisor shall notify the Blast Supervisor and the D&B Eng of elevated temperature ground. Any suspect areas will be temperature checked with a calibrated IR temperature device (see Section 8.3 Temperature Calibration for details). Any Non-Ambient Temperature Holes will need to be temperature checked with a calibrated thermocouple (see Section 8.3 Temperature Calibration for details). This will include surrounding holes to assess the scope of the elevated temperature ground. Once the elevated temperature ground has been defined the Drill Supervisor shall liaise with the Blast Supervisor regarding the extent of hot ground. The Blast Supervisor shall notify the Shotfirer/s to start the temperature monitoring process as defined in 8.4 Temperature Measurement with the data captured on the Blast Hole Temperature Logging Form (MAC-STE-FRM-111).

3. The blast crew, while dipping the shot, can witness heat shimmer or hot air radiating from holes etc. If this is identified, the supervising shotfirer shall be notified. The supervising Shotfirer shall notify the Blast Supervisor and D&B Eng of elevated temperature ground. Any suspect areas will be temperature checked with a calibrated IR temperature device (see Section 8.3 Temperature Calibration for details). Any Non-Ambient Temperature Holes will need to be temperature checked with a calibrated thermocouple (see Section 8.3 Temperature Calibration for details). This will include surrounding holes to assess the scope of the elevated temperature ground. Once the elevated temperature ground has been defined the D&B Eng shall organise survey to pick up the relevant elevated temperature holes for inclusion into the survey hazard layer. The Blast Supervisor shall notify the Shotfirer/s to start the temperature monitoring process as defined in 8.4 Temperature Measurement with the data captured on the Blast Hole Temperature Logging Form (MAC-STE-FRM-111).

4. The blast crew, while charging the shot, can witness heat shimmer or hot air radiating from holes etc. If this is identified, the supervising shotfirer shall be notified and loading operations shall be stopped until the extent of any elevated temperature ground is understood. The supervising Shotfirer shall notify the Blast Supervisor and D&B Eng of elevated temperature ground. Any suspect areas will be temperature checked with a calibrated IR temperature device (see Section 8.3 Temperature Calibration for details). Any Non-Ambient Temperature Holes will need to be temperature checked with a calibrated thermocouple (see Section 8.3 Temperature Calibration for details). This will include surrounding holes to assess the scope of the elevated temperature ground. The zone of elevated temperature ground, including a three row buffer of ambient

temperature holes of less than 30°C, shall be marked via a peg and red tape fence. No charging of holes shall be undertaken inside the taped zone until the temperature monitoring process, as defined in 8.4 Temperature Measurement, has been completed and captured on the Blast Hole Temperature Logging Form (MAC-STE-FRM-111). Standard loading practices Once the elevated temperature ground has been defined the D&B Eng shall organise survey to pick up the relevant elevated temperature holes for inclusion into the survey hazard layer.

7.2 Temperature Calibration

The Supervising shotfirer shall organise for both the thermocouples and IR thermometers to be calibrated every day prior to being used to measure the temperature of blast holes.

The first calibration involves measuring the temperature of a matte black piece of cardboard on a wall with a NATA certified thermometer attached to the wall alongside the matte black cardboard. This setup will be located in a dedicated zone within the Drill and Blast startup building. This is calibrating the temperature monitoring devices at the temperature of the airconditioned room (20°C - 25°C) and this shall be the only calibration that is required if accurate blast hole temperatures are required up to 55°C.

To calibrate the IR thermometer, turn the device on and check that the temperature being measured in is degrees Celsius (°C). Point the IR thermometer at the matte black cardboard, directly beside the NATA certified thermometer, using the red laser dot and depress and release the trigger and the temperature will be recorded on the digital display. Note this temperature on the Temperature Calibration form (MAC-STE-FRM-329 – see Table 1 as an example). The temperature measuring device is in calibration if it is within ±3°C of the NATA certified thermometer. Any IR thermometer that is outside tolerance, the operator shall place an out of service tag with details for identification. The Blast Supervisor will organise getting the device/s recalibrated and put back into circulation.

To calibration a thermocouple, tape the thermocouple to the wall, at the same location the NATA certified thermometer is located, prior to switching it on. Turn the thermocouple on ensuring that it is reading in degrees Celsius (°C) and wait for the digital display to settle on a temperature. This should take a couple of minutes. Note this temperature of the Temperature Calibration form (MAC-STE-FRM-329). The temperature measuring device is in calibration if it is within ±3°C of the NATA certified thermometer. Any thermocouple that is outside tolerance, the operator shall place an out of service tag with details for identification. The Blast Supervisor will organise getting the device/s recalibrated and put back into circulation.

Date	Time	Name	Thermometer type	Equip No.	Equipment °C	Nata °C	Calibrated Y/N
17/08/23	6.23am	J Doe	Thermocouple	TC01	24.3	25	Y
17/08/23	6.25am	J Doe	IR Thermometer	IR001	26.2	25	Y
17/08/23	6.27am	J Doe	Thermocouple	TC02	29.3	25	N
17/08/23	6.31am	J Doe	Thermocouple	TC03	28.4	25	Y
17/08/23	6.38am	J Doe	Thermocouple	TC01	101.3	99	Y
17/08/23	6.45am	J Doe	IR Thermometer	IR001	98.8	99	Y
17/08/23	6.48am	J Doe	Thermocouple	TC03	97.7	99	Y

Table 1: Daily Calibration Record Sheet

If accurate temperatures are required at higher temperatures >55°C, then a second point calibration is required. This calibration will involve using a dedicated urn, or similar, to bring water to boiling point. The IR thermometer will not require a second point calibration as any temperatures measured above ambient will need to be determined by thermocouple measurement.

To undertake a second point calibration at ≈100°C of a thermocouple, turn the thermocouple on, ensuring that it is reading in degrees Celsius (°C). Place the thermocouple in the urn, or similar, and wait for the digital display to settle on a temperature, which will take a couple of minutes. Note this temperature on the Temperature Calibration form (MAC-STE-FRM-329). The thermocouple is in calibration if it is within ±3°C of the NATA certified thermometer that is placed in the same urn, or similar. Any thermocouple that is outside tolerance, shall have an out of service tag placed with details for identification. The Blast Supervisor will organise getting the device/s recalibrated and put back into circulation.

Post Temperature Calibration:

- Turn off the urn, or similar.

- Make 2 copies of the Calibration sheet for that day and leave the original on the clip board in the calibration area on the wall.
- Place an Out of Service Tag on all uncalibrated temperature measuring devices and provide these to the Blast Supervisor together with a copy of the calibration sheet.
- Provide a copy of the calibration sheet to the Supervising shotfirer to put into the Blast Pack.
- The Blasting Supervisor will organise for recalibration of any device/s that fail calibration tests.
- The Blast Supervisor will ensure stock levels of temperature device/s is suitable and any reordering is completed in a timely manner to ensure availability of devices.
- The Blast Supervisor will ensure that there are two NATA certified thermometers in calibration at any one time. This will involve having at least three NATA certified thermometers, with redundancy for calibration requirements.

7.3 Temperature Measurement

In accordance with section 7.4, any areas of concern must undergo temperature verification using a calibrated infrared (IR) temperature device, as detailed in Section 7.2. Additionally, non-ambient Temperature Holes should be checked using a calibrated thermocouple, referring to the same section for calibration guidelines. This process also involves examining adjacent holes to determine the extent of the area with elevated ground temperature. Once this area is clearly identified, the D&B Eng is responsible for arranging survey to pick up any specific holes and incorporating them into the survey hazard layer. Following this, the Blast Supervisor is tasked with informing the Shotfirer/s to initiate the temperature monitoring procedure as outlined in Section 7.3. All temperature data should be recorded on the Blast Hole Temperature Logging Form (MAC-STE-FRM-111).

The ambient in-ground temperature is typically between 25°C and 30°C but may increase if the ambient air temperature is higher or spontaneous combustion is occurring. It is important to find elevated temperature holes and then determine the boundary of the elevated temperature zone together with the temperature of these holes and the temperature trend of these hole temperatures using thermocouple measurements at 0.5m intervals. Only the maximum temperature in each hole is recorded.

The blast hole logging thermocouple shall be a calibrated K-Type Thermocouple (rated from -200°C to 1370°C). The thermocouple shall be calibrated each day blast hole temperature measuring is conducted (see section 7.2). A Teflon insulated cable shall be used in conjunction with a digital thermometer. Temperature measurement with the thermocouple is not instantaneous and therefore it is recommended that discrete measurements be taken approximately every 0.5 meters up the hole from the bottom. Each measurement shall be allowed to stabilise, so the digital display shows the same temperature over a minimum of 30 seconds. The head of the thermocouple must be near the blast hole walls to minimise hole temperature inaccuracy caused by monitoring air rather than the wall.

To provide a history of the hole temperatures over time, all holes > 30°C shall be measured, at a minimum, at the following stages:

- As soon as practical after the hole has been drilled.
    - This flags any hole that requires further investigation.
- At least two days before the commencement of loading.
- The day before the shot is to be loaded.
- Immediately prior to charging the blast hole.

This provides a minimum of 3 separate thermocouple temperature monitoring events prior to loading to establish a recent history. Should the temperature of a hole be increasing over time, it shall not to be loaded if it appears that the hole will go beyond the temperature of the method of blasting being used. If any uncertainty exists as to the peak temperature within a given blast hole, the hole must be measured again.

Care shall be taken to correctly number and label all holes to avoid confusion during the measuring process. If required survey can provide reference pegs to ensure compliance.

If any malfunction of equipment is noted, all measuring shall cease until replacement or repair can be implemented. For this reason, it is recommended that spare equipment or parts are made available.

The results of temperature monitoring shall be recorded on the blast measure sheet MAC-PRD-FRM-006 and shall include.

- Hole Identifier (hole number).
- Depth (noting any restrictions or cavities).
- Water presence.
- Maximum Temperature (°C).
- Date.
- Comments / Unusual Events (e.g. smoke or fume emanating from hole).
- Person taking the measurement.

The Supervising Shotfirer shall include a copy of the temperature measurements for that day in the Blast Pack plus their shotfirer notes with copies of the temperature measurements to the Blast Supervisor.

7.4 Blast Hole Identification

Should blasting of an area of hot holes be considered, then each hole shall be clearly identified by placing a survey peg at the collar and writing on that peg a number which is exclusive to that hole.

Once all temperature monitoring has been completed each hole shall be marked according to the following system:

Normal Hole	≤ 50°C	White Peg
Hot Hole	>50°C to ≤90°C	White Peg with Green Paint
High Temperature Hole	>90°C to 140°C	Green Cross painted on ground
Excessive Temperature	> 140°C	Green Cross painted on ground

Table 2: Daily Calibration Record Sheet

All blast holes with a temperature of greater than 90°C shall be backfilled prior to blasting.

7.6 Safety Area

Prior to charging commencing, a suitable safety area around the blast site shall be established and access restricted to authorised personnel only. Sentries shall be organised before loading commences in case there is a need to initiate or evacuate the elevated temperature shot at short notice.

Hot Hole Blasting

The following details the steps required for hot hole blasting:

- Prior to any charging commencing the Supervising Shotfirer shall undertake a risk assessment that shall incorporate a physical check of all holes to be charged to ensure the charge sheets correspond to the blast hole temperature marking with respect to temperature. If there are any variations, then no charging shall take place until the differences are resolved.
- Before any holes are charged, all holes that have been measured with a temperature above 90°C shall be treated as a high temperature holes.

  - This means these hole/s are to be backfilled prior to blasting.

- All hot hole charging shall be completed within 4 hours from the commencement of loading the hot holes.
- The shot shall be fired as soon as possible but within 4 hours from the completion of loading.
  - This will comply with the 8 hour sleep time assigned to hot hole blasting (see Section 7.9).
- Under no circumstances shall charged hot holes be slept in excess of 8 hours as there is the potential for rapid heating of the product once it is confined within the blast hole.
  - The explosive supplier shall be contacted at the earliest time if the 8 hour window is likely to be exceeded.
- All holes shall be top primed.
- Holes shall be loaded to within 2m from the design charge length and the primer placed on top of the explosive column.
  - The hole shall then be topped up to the design charge length to trap the primer in the bulk explosive.
- The loading sequence shall be conducted in such a way that if there exists a need to fire the shot at any time loading may be suspended and that portion of the shot already loaded may be fired without adverse effects on the unloaded portion.
  - An example of this would be to start loading from the design initiation point or free face and work back preferably charging from coolest to hottest blast holes.
- The column rise shall be monitored to ensure bulk explosive products are not escaping into cracks and fissures around the blast hole.
  - In the event that column rise is not being achieved and it is suspected that product is being lost into the ground, detergent laden water shall be applied in copious quantities to wash out the bulk explosives.
- It is important to remember that explosives may detonate prematurely if exposed to high temperatures.
  - Any abnormal indicators, such as smoke, steam or fume before charging must be investigated with the view of not charging these holes.
- In the event of any charged blast hole smoking or fuming or molten Ammonium Nitrate (AN) flowing out of the hole then all personnel must be removed from the area, as per the sentry map designated exclusion zone, a blast exclusion zone instigated, and supervision notified.
  - No entry shall be allowed until every sign of chemical activity has completely ceased and authorised remedial actions determined.
  - If there are unstemmed loaded blast holes, then the exclusion zone should be increased and will be a case-by-case basis.
- Re-entry time is to be limited to that specified by the designated mine official to fire the blast after the chemical activity has ceased.
- All holes shall be stemmed immediately after loading is completed.
- Only those products that are to be used specifically for hot hole blasting in non-reactive ground shall be taken into the blast area (see Section 7.9)
- Explosive products used will follow all technical and recommended application advice to safely manage blasting over 50°C to less than or equal to 90°C (see technical data sheet/s and material safety data sheet/s).
- Once the area is cleared the shot may be initiated in the normal manner.
- After a period of 10 minutes has expired and all signs of dust and fume has dissipated, the Shotfirer shall proceed to inspect the blast for misfires and other hazards which may present a danger to personnel working in the area.
- It should be noted that the resulting muck pile may contain extremely hot material.
  - Unless it is necessary to do so, walking on the muck pile should be avoided.

- Once the Supervising Shotfirer is satisfied with the result of the post blast inspection the all clear shall be called.

The following critical steps shall be followed at all times:

1. **Verification of Explosive Delivery Vehicle Flush:** The explosive supplier's explosive delivery vehicles and associated process equipment needs to be completely emptied and cleaned out prior to the use of hot hole bulk explosives or intermediates.

This can be achieved by either:

- Cleaning the Ammonium Nitrate Emulsion (ANE) tanks to a standard such that there will be less than 1% uninhibited ANE contamination when reloaded with hot hole ANE (including purging any ANE from the pump and associated pipe work).
- After non hot hole ANE has been used in the explosive delivery vehicle, run the first load of hot hole product into a non hot hole blast area.

Note: Cross contamination must be considered when explosive delivery vehicles are transferred from other sites.

2. **Explosive Delivery Vehicle Operator Awareness:** Operators of the explosive supplier's explosive delivery vehicles should be fully aware of the correct hot hole explosives to be used.
3. **Adherence to Sleep Times and Products:** All sleep times and products specified in section 7.9 must be strictly followed.
4. **Blast Guard Readiness:** Blast guards must be fully briefed on their positions and remain contactable to execute blast clearance at any time. Prior to the commencement of loading activities, a blast guard meeting is required to confirm operational readiness. This meeting is vital for addressing any potential hazards in accordance with the guidelines detailed in section 8.5.
5. **Crew Awareness for Chemical Reactions:** It's crucial for the blast crew to recognise the importance of quickly reporting any indications of chemical reactions. This includes signs like premature detonations, smoking or fuming blast holes, or molten/bubbling explosives. In these scenarios, an immediate evacuation to the designated blast boundary is essential. The execution of a full blast clearance shall be implemented as soon as practicable along with implementing protocols outlined in section 8.5. Additionally, if there are unstemmed holes, special attention must be given, as this may necessitate an expansion of the exclusion zone.
6. **External Auditing:** Audits conducted by parties external to the blast crew and team should be undertaken to ensure full compliance with the procedure.

8.4 Reactive Ground Blasting

This procedure applies to all blast types containing reactive ground, including elevated temperature ground.

At the preliminary design, dill design, and loading design stages the D&B Eng completes a mandatory checklist. These checklists include steps to check the site's Reactive Ground Risk Register. If reactive ground is identified, the D&B Eng notifies the Senior Drill and Blast team that the pattern has reactive ground. If the reactive ground is reactive >55°C, then the D&B Eng will include the Blast Hole Temperature Logging Form (MAC-STE-FRM-111) in the Blast Pack and ensure the blast pack states to temperature log at least 5% of holes. The aim of this is to ensure the ambient temperature is less than 50°C to allow the use of uninhibited products.

The supervising shotfirer shall organise for the daily calibrations to be undertaken on the IR thermometer and thermocouples as per section 7.2 and temperature measurements as per section 7.3.

The D&B Eng shall prepare load sheets based on measurements of blast hole temperatures and temperature trends, ensuring at least three blast hole temperatures are considered as outlined in section 7.3. This is particularly important for holes with temperatures close to 50°C and 90°C. For these holes, the engineer must decide whether to use hot hole inhibited products or backfill the hole. The D&B

Eng will collaborate with the Supervising Shotfirer to create the charge sheet design, employing the inhibited bulk explosive, initiation explosive, and sleep time matrix detailed in section 8.5. This will help determine the appropriate initiation and bulk explosives, as well as the sleep time for each blast hole in the design. Finally, the completed load sheets will be circulated among the Senior Drill and Blast team and provided on the tablets for the Shotfirer/s and blast crew.

On the first day of any shot in reactive ground, the Supervising Shotfirer will conduct a briefing immediately after the shift meeting to ensure the entire blast crew is aware of and understands the specific requirements for blasting in reactive ground. This briefing will focus on two scenarios: blasting in reactive ground where the ambient temperature is 50°C or lower, and blasting in reactive ground combined with hot ground, where blast hole temperatures exceed 50°C but are below 90°C. These conditions significantly influence the selection of initiation explosives and bulk explosives based on the temperature of each blast hole.

All blast holes in areas where the ambient temperature is above 30°C, the temperature of each hole must be measured at least three times to ensure accurate data. For holes with temperatures exceeding 50°C but not more than 90°C, the use of Senatel Pyromex packaged emulsion, is mandated.

The Supervising Shotfirer, along with the blast crew, will participate in a competency-based Toolbox Talk focused on this procedure. The primary goal of the Toolbox Talk is to cover essential actions necessary to minimise risks when dealing with reactive ground at temperatures below 50°C, as well as for blasting in both reactive and hot ground conditions. This training session will ensure that all personnel involved are adequately trained and competent in handling the specific challenges and safety measures required for these types of blasting environments.

The Supervising Shotfirer, or their designate, is responsible for completing all preparatory tasks outlined in sections 7.0 and 8.0. This includes crucial steps such as arranging for the calibration of temperature measuring devices. After completing any temperature logging, the Supervising Shotfirer must analyse this data and arrange for the distribution of the blast hole temperature measurements to the D&B Eng. The timely completion of this task is crucial as it allows the D&B Eng to utilise the temperature information to create accurate load sheets. These load sheets are distributed to the Senior Drill and Blast team and provided on the tablets for the Shotfirer/s and blast crew.

The Supervising Shotfirer is responsible for verifying that the information on the shot aligns precisely with the data on the load sheets. In the event of any discrepancy, the Supervising Shotfirer must ensure that no loading activities begin until the mismatch has been fully resolved.

The Supervising Shotfirer, or their designate, is tasked with conducting a thorough risk assessment. Based on this assessment, they are to create a loading plan that prioritises loading from the coolest to the hottest blast holes. This plan must also address any blast holes that should not be charged due to high temperatures. Specifically, holes with temperatures exceeding 50°C, or in some cases 90°C, should be backfilled prior to blasting. This step is particularly crucial in scenarios where hot hole blasting is being employed.

For the hot hole portion of the blasting pattern, the specific guidelines outlined in section 7.7 must be strictly followed. Simultaneously, for the portion of the pattern with temperatures at or below 50°C, standard charging and firing procedures should be adhered to using approved reactive ground bulk explosive products as per section 8.5.

Throughout these processes, the following critical steps shall be followed at all times:

1. Verification of Explosive Delivery Vehicle Flush: The explosive supplier's explosive delivery vehicles and associated process equipment needs to be completely emptied and cleaned out prior to the use of inhibited bulk explosives or intermediates.

This can be achieved by either:

- Cleaning the Ammonium Nitrate Emulsion (ANE) tanks to a standard such that there will be less than 1% uninhibited ANE contamination when reloaded with inhibited ANE (including purging any ANE from the pump and associated pipe work).
- After non-inhibited ANE has been used in the explosive delivery vehicle, run the first load of inhibited product into a non-reactive blast area.

Note: Cross contamination must be considered when explosive delivery vehicles are transferred from other sites.

2. Explosive Delivery Vehicle Operator Awareness: Operators of the explosive supplier's explosive delivery vehicles should be fully aware of the correct inhibited explosives to be used.
3. Adherence to Sleep Times and Products: All sleep times and products specified in section 8.5 must be strictly followed.
4. Blast Guard Readiness: Blast guards must be fully briefed on their positions and remain contactable to execute blast clearance at any time.
    - Day Shift
        - Prior to the commencement of loading activities, a blast guard meeting is required to confirm operational readiness. This meeting is vital for addressing any potential hazards in accordance with the guidelines detailed in section 9.0.

- Night Shift
    - At the beginning of each shift, blast guards must be designated, followed by a pseudo blast guard meeting. This meeting is essential to confirm operational readiness to address any potential hazards, aligning with the protocols outlined in section 9.0.

5. Crew Awareness for Chemical Reactions: It's crucial for the blast crew to recognise the importance of quickly reporting any indications of chemical reactions. This includes signs like premature detonations, smoking or fuming blast holes, or molten/bubbling explosives. In these scenarios, an immediate evacuation to the designated blast boundary is essential. The execution of a full blast clearance shall be implemented as soon as practicable along with implementing protocols outlined in section 9.0. Additionally, if there are unstemmed holes, special attention must be given, as this may necessitate an expansion of the exclusion zone.
6. External Auditing: Audits conducted by parties external to the blast crew and team should be undertaken to ensure full compliance with the procedure.

8.5 Explosive Product Versus Temperature Versus Sleep Time Matrix – Reactive Ground

Mining Area	**Product**	**Sleep Time**			
		Ground (<50ºC)		**Hot Ground (>50ºC)**	
		Ambient Ground	**Heat Effected***	**50ºC - 70ºC**	**70ºC – 90ºC**
Reactive Ground	ANFO Fortan Coal 10, 11, 12 and 13 Aquacharge Coal Fortis Coal Fortan Coal 10F, 11F, 12F and 13F Aquacharge Clear Fortis Clear	**Do Not Load**	**Do Not Load**	**Do Not Load**	**Do Not Load**
	Fortan Eclipse 11, 12 and 13	7 days	8 hours	**Do Not Load**	**Do Not Load**
	Fortan Eclipse 13 and Fortis Eclipse	14 days	8 hours	**Do Not Load**	**Do Not Load**
	Fortan Vulcan 12	7 days	8 hours	8 hours	**Do Not Load**
	Fortan Vulcan 13	14 days	8 hours	8 hours	**Do Not Load**
	Fortis Vulcan	14 days	8 hours	8 hours	8 hours

* Heat effected ground is ground directly beside hot ground holes or holes that are showing an increasing temperature gradient

Table 3: Bulk Explosives – Reactive Ground Blasting Matrix

Product	Ground (<50ºC)		Hot Ground (>50ºC)	
	Ambient Ground	**Heat Effected***	**50ºC - 70ºC**	**70ºC - 90ºC**
Pentex Powerplus P (PPP) Primer Pentex G Primer	Sleep time as per bulk explosive	8 hours	8 hours	**Do not load**
Excel Enduradet Detonators i-kon	Sleep time as per bulk explosive	8 hours	8 hours	**Do not load**
i-kon III RX Detonators	Sleep time as per bulk explosive	8 hours	8 hours	8 hours
Cordtex TM 3.6W & 5W Detonating Cord	Sleep time as per bulk explosive	8 hours	8 hours	**Do not load**
1. Senatel Pyromex	Sleep time as per bulk explosive	8 hours	8 hours	8 hours
Cordtex Pyrocord Detonating Cord (In Hole)	Sleep time as per bulk explosive	8 hours	8 hours	8 hours

* Heat effected ground is ground directly beside hot ground holes or holes that are showing an increasing temperature gradient

Table 4: Bulk Explosives – Reactive Ground Blasting Matrix

11 Toolbox Talk

For blasts involving Elevated Temperature and/or Reactive Ground, which are infrequent and may occur months apart, a competency-based training Toolbox Talk is required for any personnel involved in loading. This shall be conducted before charging an Elevated Temperature and/or Reactive Ground blast. This session must comprehensively cover all key aspects of the planned blast, whether it involves Elevated Temperature, Reactive Ground, or both. Attendance is mandatory for all personnel that will be operating on the blast.

Document Reference - MAC-PRD-PRO-040