2026 / VERSION 2

Recognised standard 16

The use and control of polymeric chemicals at coal mines

Coal Mining Safety and Health Act 1999

Resources Safety & Health Queensland

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1.0 Background

The Australian Coal Mining Industry has a history of safety and health incidents relating to the use of polymeric chemicals and as such the following comments are raised and support the fundamentals of this recognised standard (RS).

After a serious accident that occurred at the Anglo American Grosvenor mine on 6 May 2020 involving an ignition of methane gas and causing serious harm to five Coal Mine Workers (CMWs), the Minister for Natural Resources, Mines and Energy, the Honourable Dr Anthony Lynham MP, established a Board of Inquiry to investigate the serious accident, and various high potential incidents involving longwall-related exceedances of methane that occurred in the Queensland coal mining industry between 1 July 2019 and 5 May 2020.

The Board of Inquiry determined the following findings and recommendations relevant to the use polymeric chemicals in coal mines (Martin & Clough, 2021).

Finding 71

The probable ignition source for the methane deflagration on the longwall face was the Polyurethane resins (PUR) initiated heating of coal to thermal runaway, which ignited an explosible atmosphere behind the longwall in the vicinity of shield #111, resulting in a flame propagating onto the longwall face.

Finding 74

RS16 does not address the risk of spontaneous combustion resulting from polymeric chemicals heating coal to thermal runaway. It is essential that this risk be addressed in the standard.

Recommendation 13

Coal mines conduct a thorough risk assessment for the use of polymeric chemicals, especially PUR, which includes a consideration of the risk of spontaneous combustion of coal being initiated by the product, before introduction and application at site.

Recommendation 14

The industry undertake research into PUR to determine the extent to which their use poses a risk of initiating spontaneous combustion of coal.

Recommendation 15

Resources Safety & Health Queensland (RSHQ) takes steps to ensure that RS16 is reviewed through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, and that consideration is given to including a requirement within the standard that Site Senior Executives (SSE) ensure a risk assessment is conducted in respect of the potential hazard arising from polymeric chemicals heating adjacent coal, resulting in spontaneous combustion.

This standard has been developed giving consideration to the above findings and recommendations. In addition, the review of this standard has also considered exposure risks and in particular an assessment of the risks arising from inhalation of hazardous chemicals contained in the raw components of polymeric chemicals and those liberated during the mixing and curing process.

This has resulted in a risk-based review of the exclusion zones historically applied to the return side of the point of injection/application (nozzle). Ongoing atmospheric and biological monitoring requirements for coal mine workers (CMSs) operating within these zones are detailed in this RS to ensure that an acceptable level of risk is being maintained.

12 months following the gazettal of this RS, the RSHQ Coal Inspectorate will report this exposure data (de-identified) to the RS16 for consideration and review.

2.0 Purpose

The purpose of this RS is to state a way of achieving an acceptable level of risk and to provide direction for a Site Senior Executive (SSE) to develop, establish and maintain a system for the safe use of polymeric chemicals at coal mines. This includes but is not limited to the following:

- Preventing the use of inappropriate chemical formulations by detailing product testing requirements.
- Ensuring these products are only applied by trained, competent and capable organisations by specifying minimum competency requirements.
- Ensuring systems are in place to manage exothermic risk to an acceptable level and as low as reasonably achievable.
- Ensuring systems are in place to manage exposure risks to an acceptable level and as low as reasonably achievable.
- Ensuring systems are in place to achieve an acceptable level of risk for all other stages of the polymeric chemical process including storage, transportation and use (including clean up and demobilisation).
- Ensuring the appropriate selection, safe use and routine maintenance of equipment associated with the application of polymeric chemicals.
- Ensuring systems are in place to monitor the exposure and ongoing health of coal mine workers (CMWs) using or who could be reasonably expected to be exposed to these products.
- Ensuring appropriate records of all associated monitoring and the application of these products, are maintained.

Implementation of this standard must be undertaken in conjunction with reference to the relevant sections of the *Coal Mining Safety and Health Act 1999* (CMSHA) (State of Queensland, 2022) and Coal Mining Safety and Health Regulation 2017 (CMSHR) (State of Queensland, 2022).

3.0 Scope

Polymeric chemicals are used at coal mines for a variety of applications including but not limited to:

- Strata binding
- Strata sealing and consolidation
- Void/cavity filling
- Strata sprayed lining
- Emergency sealing
- Pumpable resin bolting systems.
- Installation of ventilation control devices (VCD)

This RS covers any application of polymeric chemicals at Queensland coal mines. This includes single use systems.

Foam filled tyres

This RS does not include the polymeric chemicals contained in ‘foam filled’ tyres.

Emergency sealing of a mine and mines rescue purposes

Sections *7.1, 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1.5* of this RS do not apply to the use of these products during the emergency sealing of an underground coal mine and for mines rescue purposes.

Off lease activities

This RS does not cover the manufacture, blending, storage or transportation of polymeric chemicals outside of the coal mining lease.

4.0 Approved use of polymeric chemicals in Queensland coal mines.

4.1 Polymeric chemicals approved for use

Polymeric chemicals may only be used at Queensland coal mines if:

a) They have been subjected to and meet the specific testing requirements, as detailed in Section 4.2 and Appendix A of this RS; and

b) They have been issued with a conditional licence to undertake a licensed activity as required under section 153 (2) (d) and section 154 (2) (d) of the New South Wales (NSW) Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (State of New South Wales, 2022); and

c) The polymeric chemicals must be used within the requirements of this RS, the conditions specified in the NSW licence and the mines Safety Health Management Systems (SHMS); and

d) The entity or service provider that supplies and/or applies polymeric chemicals at the mine, holds a current certification for ISO 9001 Quality Management Systems (International Organization for Standardization, 2015) relevant to the supply and/or application of materials to be polymerised at a coal mine.

Note: Where there is a difference between requirements in NSW licencing conditions and RS16, the requirements of RS16 must apply when using polymeric chemicals at Queensland coal mines.

4.2 Testing of polymeric chemicals

The purpose of testing in this RS is to identify risks to the health and safety of CMWs arising from the use of polymeric chemicals at coal mines. This RS requires specific testing requirements to understand risk factors and assist in the control of risk associated with;

a) Sparking caused by static electric charge/discharge,
b) Fire initiation,
c) Fire propagation, or
d) Exposure to atmospheric contaminants during application,
e) Mechanical properties/ characteristics.

Note: A static charge may build up with air movement over the curing/cured polymeric chemical and/or from the rubbing of the material against other materials. Risk varies with velocity, exposed surface area, humidity, temperature, etc. Polymeric chemicals that rely on low electrical resistance to dissipate accumulated charge need to be effectively earthed.

4.2.1 Conditions

1) All polymeric chemicals issued with a current NSW Licence and meet the requirements of this RS (section 4.1) do not require further testing.

2) All new polymeric chemicals that have not been subjected to the conditions of this RS must be tested in accordance with section 4.3.

3) Whenever there is a change to a polymeric chemical's composition, that has the potential to change the outcomes of the acceptance criteria of Appendix B, the polymeric chemical must be subjected to repeat testing in accordance with section 4.3.

4) Validation of the polymeric chemicals formulation and design must be undertaken every 5 years in accordance with **Table 1**.

Table 1: Testing matrix

Test	4.2.1 (1) Current products	4.2.1 (2) New products	4.2.1 (3) Changed products	4.2.1 (4) 5 year validation
Maximum exothermic temperature testing – **Small Scale**	N/A	X	X	X
Maximum exothermic temperature testing – **Large Scale (Injectables/Cavity)**	N/A	X	X	X
Electrical resistivity	N/A	X	X	X
Spark incendivity	N/A	X	X	X
Fire resistance	N/A	X	X	X
Fire propagation	N/A	X	X	X
Flash point	N/A	X	X	X
Oxygen index	N/A	X	X	X
Chemical characterisation of components	N/A	X	X	X
Spread of flame test	N/A	X	X	X
Microchamber head space test for airborne contaminants	N/A	X	X	X
Mechanical properties/ characteristics	N/A	X	X	X

Note: N/A – indicates not applicable
X – indicates must be tested

All testing must be conducted and reported by a testing laboratory that is both accredited and independent of the product manufacturer or supplier. The laboratory must demonstrate conformity with, and hold valid accreditation, in accordance with the requirements of ISO/IEC 17025 (International Organization for Standardization & International Electrotechnical Commission, 2017).

All testing must be conducted in accordance with the original equipment manufacturer (OEM) product design ratios as specified on the NSW Licence referred to in section 4.1 (b)(c) i.e. how the product will be applied in-situ.

4.3 Interpretation of testing results

For guidance on the interpretation of test results as required under this section, refer to Appendix B of this RS.

Tests are to be carried out with results supplied for the following:

- Maximum exothermic temperature testing (Small and Large-Scale – injectables/cavity fill) - Appendix A.1
- Electrical resistivity – Appendix A.2
- Spark incendivity – Appendix A.3
- Fire resistance – Appendix A.4
- Fire propagation – Appendix A.5
- Flash point – Appendix A.6
- Oxygen index – Appendix A.7
- Chemical characterisation of components – Appendix A.8
- Spread of flame test (Cavity and surface applied products) – Appendix A.9
- Microchamber head space test for airborne contaminants – Appendix A.10
- Mechanical properties/ characteristics – Appendix A.11

The SSE for a coal mine must ensure records of the testing and additional requirements detailed in section 4.0 of this RS are kept at the mine for all polymeric chemicals stored and applied at the mine.

5.0 System for the safe use and control of Polymeric chemicals

The SSE of a Coal Mine must ensure the risk to persons from polymeric chemical application is at an acceptable level. The SSE must develop and implement a system for managing polymeric chemicals at the mine.

5.1 Management of polymeric chemicals

The SSE for a coal mine must:

- Name the person who is responsible for establishing and implementing a system for managing polymeric chemicals at the coal mine and include the position into the management structure.
- State the responsibilities and competencies required for the person who is responsible for establishing and implementing a system for managing polymeric chemicals at the coal mine.
- Determine the competencies required, and the responsibilities, for each supervisory position at the mine responsible for storage, transport and use of polymeric chemicals.

The SSE for a coal mine must refer to RS22: Management structure for the development and implementation of the Safety and Health Management System (Resources Safety and Health Queensland, 2021) and the resource and infrastructure industry (RII) training package when determining the required competencies.

5.2 Supervising and controlling of polymeric chemicals at an underground coal mine

The underground mine manager (UMM) for an underground mine must ensure coal mining operations where polymeric chemical activities are taking place are supervised and controlled by a person holding:

a) A first class certificate of competency; or
b) A second class certificate of competency; or
c) An explosion risk zone controllers (ERZC) certificate of competency.

And who hold,

d) The endorsed components of the RII training package for supervision for apply and monitor of polymeric application plan.

5.3 Supervising and controlling of polymeric chemicals at a surface coal mine

The SSE for a surface mine must ensure coal mining operations where polymeric chemical activities are taking place are directly supervised and controlled by a person:

a) Who holds the endorsed components of the RII training package for supervision of storage, transport and use of polymeric chemicals.
b) Be appointed as a supervisor at the mine who is competent in the task they are supervising.

6.0 Training and competency

The SSE must ensure CMWs engaged for the purpose of using polymeric chemicals are trained and assessed as competent in the safe transportation, storage, use and disposal of these products as appropriate to the task they are performing. This training must include the safety and health hazards associated with the use of these products, including any uncontrolled releases of these products.

CMW awareness training must be conducted for all CMWs with potential to be exposed to polymeric chemicals.

The skills and tasks of the workers engaged by organisations that undertake the application of polymeric chemicals, fall into four (4) general roles:

- **Pump operators/decanters** – those CMWs directly associated with pumping, pump maintenance, and the open drum decanting of individual polymeric chemicals into the holding vessels.
- **Applicators/mixers** – those CMWs that operate the nozzle to mix, inject and/ or cavity fill polymeric chemicals at the point of application.
- **Transport and handling**– those CMWs who load and transport polymeric chemicals in their sealed containers (usually contained in locked bulk storage pods).
- **Supervision** – CMWs who are appointed to control and supervise the polymeric chemical work. This includes those who are appointed to be in control of activities in the explosion risk zone (ERZ) in which the work is being undertaken and those who are appointed as supervisors for the application of polymeric chemicals

The SSE must ensure training packages relevant to the above roles are developed and implemented into the mines training scheme. Site specific training packages must align with the endorsed components of the following units:

- RIIMCU218 Work safely with polymeric chemicals in underground coal mining
- RIIMCU312 Conduct polymeric chemical operations in underground coal mining
- RIIMCU313 Mix and pump polymeric chemicals in underground coal mining
- RIIMCU314 Transport and store polymeric chemicals in underground coal mining
- RIIMCU409 Apply and monitor polymeric chemical management plans

The mines training scheme must provide for refresher training for CMWs.

The SSE must ensure that records of this training are documented and available at the mine. This does not require CMWs to receive statements of attainment from an RTO.

7.0 General risk management requirements

Before a polymeric chemical is used at a coal mine for the first time, the SSE must ensure a risk assessment is carried out to identify:

- The hazards involved in transporting, storing and using each polymeric chemical; and
- The ways of effectively controlling the hazards associated with the use of each polymeric chemical at the mine.

The risk assessment must have regard to, but not limited to, the following matters:

- The types of the polymeric chemical and details for its intended use,
- The physical and chemical properties of the product including reaction temperatures,
- Exothermic hazards and controls (specific requirements outlined in Section 7.1),
- Spontaneous combustion risks (refer to relevant matters in RS24: Control and management of spontaneous combustion in underground coal mines (Resources Safety and Health Queensland, 2026)),
- Storage and transportation,
- Positioning of equipment and work locations,
- Communication requirements during application (e.g. DAC location),
- Management of personal heat exposure,
- The health hazards associated with exposure to polymeric chemicals. These will vary depending on:
  - The individual chemical ingredients and their properties,
  - The frequency and intensity of exposure,
  - The route of entry into the body (e.g. Ingestion, absorption or inhalation), and
  - The susceptibility of the individual exposed.
- Required ventilation quantities and arrangements to remove and/or dilute airborne contaminants,
- Operational hazards and control zones,
- Health surveillance of CMWs,
- Exposure monitoring requirements (biological and atmospheric),
- Uncontrolled release of chemicals (e.g. Spills, ruptured hoses, ruptured containers), and
- Emergency response.

The risk assessment must include an appropriate cross section of the workforce and must include content experts including an occupational hygienist and industrial chemist who has a sound knowledge of the chemical ingredients and health and safety hazards associated with the use of these chemicals. The risk assessment must also include a relevant cross section of CMWs involved in carrying out the tasks.

The SSE must use the outcomes of this risk assessment to develop a Standard Operating Procedure (SOP) for the safe use and control of each class of polymeric chemical used at the mine. The SOP must include but not be limited to the following:

- The controls identified in the risk assessment,
- Preventing the use of inappropriate chemical formulations,
- Mixing of incompatible products,
- Ensuring these products are only applied by trained and competent CMWs,
- Ventilation quantities and plan,
- Exposure monitoring requirements (refer 11.2 and Appendix C),
- Details of the operational control zones (OCZ) (refer 12.0),
- General arrangement illustrations for equipment set up locations,
- Volumes of product injected and hole spacing. **Note**: Volumes not to exceed quantities specified in Table 2,
- Exothermic temperature monitoring requirements (refer section 7.1.2),
- Personal protective equipment (PPE) requirements,
- Systems to monitor the health of CMWs,
- Spillage and emergency response requirements, and
- Communication plan.

7.1 Specific risk management requirements for exothermic hazards

During the application of polymeric chemicals there is potential for the exothermic reaction taking place to generate sufficient energy in the form of heat to create an unwanted thermal event by interaction with coal. This may create a potential ignition source or lead to a spontaneous combustion event.

The SSE must ensure that the mine's SHMS contains adequate risk control measures developed from an industry recognised risk assessment processes to ensure that:

- Coal with an artificially raised temperature (as a result of the use of polymeric chemicals) does not enter the goaf (and create an unacceptable level of risk), and that,
- Any polymeric chemical application at the mine does not cause an unacceptable level of risk when exothermic reaction occurs,
- Control measures must have regard to, but not limited to, the potential failure modes for exothermic hazards outlined in Appendix D.

Risk assessments must be conducted for each type of polymeric chemical used at the mine to ensure specific exothermic risks and hazards, relevant to individual products and type of application at the mine, are appropriately assessed and controlled. All conditions for the use of polymeric chemicals specified in any licence or approval must also be addressed in the risk assessment (refer section 4.1 (c)).

An appropriate risk assessment process should be conducted for each application of polymeric chemicals to ensure specific risks and hazards at the job location are appropriately assessed and controlled. This risk assessment must have regard to unique application conditions that may not have been considered in the management plan.

7.1.1 Volume application controls

Uncontrolled pooling and disproportionate accumulations of polymeric chemicals can significantly increase the risk of unconstrained exothermic reaction providing the potential for coal, other strata or reacted products to reach temperatures that may become an unacceptable level of risk.

In combination with the matters outlined in Appendix D, risk control measures should include but not be limited to:

- Maximum allowable volumes per hole for products to align with **Error! Reference source not found.**. (**Note**: the maximum volume does not include the chemical in the delivery lance to the packer),
- All polymeric application plan/s must be designed by a Registered Professional Engineer Queensland (RPEQ) Geotechnical Engineer and approved by the UMM and implemented by the ERZC for each application, in conjunction with appropriate monitoring practices in line with relevant trigger action response plans (TARP) and procedures.
- A pressure monitoring regime must be established in the polymeric application plan.

The establishment of a TARP must take into consideration measured pressure at the nozzle, for each independent injection point.

The established Trigger Action Response Plan (TARP) will outline pre-defined actions for personnel to take when conditions deviate from normal, escalating through levels (normal, elevated, critical) based on monitored triggers (Low injection pressures, visible migration of product to secondary holes, ground movement – Hydraulic jacking) to manage the risk of pooling effectively. The TARP must include:

  - Baseline pressure outlining the low-pressure threshold. This defines the free flow pressure after activation of a hydraulic packer or the effect of any device in the pressure circuit that impedes the flow (i.e. non- return valves, static packing devices, hydraulic hose diameter, injection nozzle fittings and injection lances).
  - Triggers to control the risk of pooling risk where maximum volumes are consistently injected into adjacent holes.
  - The maximum allowable injection pressure. This defines the nominated value to cease the application of product into the injection point.
  - Clear, documented steps for operators, supervisors, ERZ controllers and or managers.

Table 2: Quantity (Litres) of injection resins not to be exceeded per injection hole

Polymeric chemical exothermic reaction temperature range (ºc) *	Maximum allowable volume (L)
100 -150	180
70 – 99	300
50 – 69	500
< 50	As defined by the mines SHMS

*As determined by large scale test (refer Appendix A – A.1 Maximum exothermic temperature – A.1.2 Large scale method – Injectables)

Table 3: Quantity (Litres) of cavity fill product not to be exceeded within application area during a single application

Polymeric chemical Product Class	Maximum allowable volume (L)
Cavity fillers	No limit, as defined by the mines SHMS^

^ As determined by large scale test (refer Appendix A – A.1 Maximum exothermic temperature – A.1.3 Large scale method – Cavity fill)

Note: These volumes do not apply to single use systems of thin sprayed liners. Volume limits for single use systems must be determined through risk management and documented in the mine's SHMS.

7.1.2 Temperature monitoring and exothermic risk inspections

A competent person must be appointed by the UMM to carry out temperature monitoring to assist in the assessment of exothermic risk. The mines training scheme must determine the competency requirements as per any other monitoring device e.g. PGD.

A competent person must be appointed by the UMM to carry out inspections and assess the exothermic risk under CMSHR 2017 s305 (State of Queensland, 2022).

Procedure for carrying out inspections and monitoring exothermic risk

The UMM must develop a procedure for carrying out inspections to monitor exothermic risk during and after polymeric chemical application. The procedure must include:

- Zones and the items to be covered in each inspection,
- The quantity and location of temperature monitoring devices,
- A schedule and frequency for recording temperature data and general inspections,
- The defined triggers for ceasing temperature monitoring and/or commencement of production,
- Consideration of other devices such as thermal imaging cameras to monitor surface temperature of areas influenced by polymeric chemical application,
- Actions to be taken as a result of any excess heating observed including cessation of pumping and application of cooling water and stone dust,
- Recording of inspection findings (including temperature monitoring data).

7.1.3 Temperature monitoring devices

Polymeric chemicals that are injected or pumped into coal/strata and cavities that have the potential to artificially increase the temperature of coal or strata, as determined by test methods outlined in Appendix A, section A.1 Maximum exothermic temperature, must be monitored using a temperature monitoring device which meets the specifications below:

- Must be appropriate for use in the underground coal environments,
- Must possess a measurement accuracy of ±3°C, and

- Must be capable of continuous monitoring throughout the monitoring period. This may include real time or manual data acquisition at set logged intervals.

7.1.4 Positioning of monitoring devices

The quantity and position of temperature monitoring devices must be determined by the RPEQ geotechnical engineer and detailed in the approved polymeric application plan.

Examples of arrangements for installation of temperature monitoring devices are outlined in Appendix E.

General requirements for strata injection resins

Where required to be installed, temperature monitoring devices used for strata injection must be placed at a minimum:

- Within the injection hole, extending to the full depth of the injection hole, and
- In areas where potential pooling or disproportionate accumulations of polymeric chemicals are a potential risk.

General requirements for cavity fill products

Where required to be installed, temperature monitoring devices used for cavity fill applications must be installed.

- Within the body of the product nearest to the discharge point.
- Adjacent to the coal interface (block side) as close as practicable.

All other applications of polymeric chemicals

Temperature monitoring devices used for other applications (e.g. VCD construction and repair), must be installed as per the mines SHMS requirements giving consideration to:

- Product type,
- Volume of product applied,
- Proximity to high-risk areas e.g. Goaf,
- Testing data for exothermic properties as per large scale exothermic test (Appendix A – Test A.1.2 and A.1.3).

Note: Where a monitoring device fails before the acceptable temperature is reached a new monitoring device must be installed as close as practicable to the failed device. Consideration should be given for installing contingency temperature monitoring devices proactively to cater for potential device failure.

7.1.5 Recording and frequency of monitoring data

Monitoring frequency should align with the following principles:

- Record virgin rock/cavity (base line) temperature prior to commencement of injection.

- Temperature data must be recorded at commencement of injection then periodically until temperature is below the level determined in the mines SHMS for an acceptable level of risk.
- Temperature monitoring data must be recorded and maintained with the application report.

Note: If a monitoring device is suspected of providing erroneous data the SHMS must provide for a process to investigate and validate the data.

7.1.6 Determining acceptable temperature triggers to cease monitoring and/or resume production

The objective when establishing acceptable temperature triggers to cease monitoring and/or resume production during the application of polymeric chemicals is as follows:

- Following injectable resin activities, the objective is to reduce the temperature of the treated area, as low as reasonably achievable, with regard to the mine's spontaneous combustion PHMP.
- Following cavity fill applications, the SSE must ensure exothermic risk is managed to an acceptable level with consideration given to the exothermic behaviour of the product characterised from prescribed testing and in-situ monitoring detailed in this RS.

Process for establishing triggers

In establishing the trigger points for an acceptable temperature and time to cease monitoring and/or resume production, the SSE must conduct a risk assessment and develop a standard operating procedure (SOP) in accordance with section 10 of the CMSHR 2017 (State of Queensland, 2022).

The SSE must ensure:

- All current exothermic technical testing data and information for each polymeric chemical product is available and effectively communicated to the people involved in the risk assessment.
- Exothermic testing data must include in-situ temperature measurements obtained at the mine for each product type.
- The risk assessment must include a subject matter expert for the use of the product.
- The risk assessment team must include experience in spontaneous combustion management with relevant industry experience and competency, giving consideration to the coal type and properties.
- The risk assessment must include the ventilation officer (VO) for the mine.
- The risk assessment must include requirements for any additional gas monitoring for spontaneous combustion as a result of polymeric chemical application.
- The controls identified in the risk assessment are implemented into the mine's SHMS before the commencement of any polymeric chemical application.
- Persons appointed to carry out inspections to monitor exothermic risk are trained and assessed as competent to apply and monitor trigger point controls.

7.1.7 Ceasing exothermic temperature monitoring

The explosion risk zone controller (ERZC) for the district where the polymeric chemicals are being applied must review the exothermic monitoring data and determine if risk is acceptable to cease monitoring and/or commence production.

All monitoring devices must return to the temperature determined as an acceptable level of risk in the mine SHMS.

7.1.8 Polymeric application report requirements

The minimum requirements for polymeric chemical application reports must include the following information for each shift during each individual application:

Strata Injection reports

- Shift (day or night)
- Date
- Mine name
- Location of injection (area of the mine)
- ERZC name and sign off
- Applicator's supervisor name and sign off
- Applicator's operators' names
- Ventilation recording (m/sec & m^3/sec)
- General body temperature (wetbulb, dry bulb & NET ˚C) in each zone
- Pump plant number
- Site setup/chemical application checklist
- Site safety checklist
- Operational zoning checklist
- Chemical batch no recording
- Record of volumes pumped (shift total)
- Record of volumes pumped (total for each hole)
- Record location of holes & hole position, depth of hole
- Record start and finish times (each hole)
- Ratio control checklist
- Record injection monitoring data for each hole (pump pressures, pump speed, strata condition data, consumables used)
- Recordings of exothermic temperature monitoring results
- Diagram(s) with location of holes in relation to area being injected vs polymeric application plan
- Atmospheric monitoring records tube sampling (for phenolic resins)
- Zone access logbook (names of personnel, sign in/sign out times & location of tasks)
- Decommissioning checklist
- Pump maintenance record
- Sign off page completed by ERZC and applicator's supervisor

Cavity fill reports

- Shift (day or night)
- Date
- Mine name
- Location of application (area of the mine)
- ERZC name and sign off
- Applicator's supervisor name and sign off
- Applicator's operators' names
- Ventilation recording (m/sec & m3/sec)
- General body temperature (wetbulb, dry bulb & NET ˚C) in each zone
- Pump Plant number
- Site setup/chemical application checklist
- Site safety checklist
- Operational zoning checklist
- Chemical batch no recording/temperature check of A & B components
- Record of volumes pumped (shift total)
- Record of volumes pumped (each cavity/standpipe location)
- Record location of holes & hole position. Record start and finish times (each cavity/standpipe location)
- Diagram(s) with location of cavity in relation to area on face (Chock Number)
- Ratio control checklist
- Record void fill application monitoring data (pump pressures, pump speed, cavity condition data, consumables used, and exothermic temperature monitoring)
- Atmospheric monitoring records tube sampling (for phenolic foams)
- Zone access logbook (names of personnel, sign in/sign out times & location of tasks)
- Decommissioning checklist
- Pump maintenance record
- Sign off page completed by ERZC and applicator's supervisor

8.0 Plant and Equipment

The SSE must ensure the mines system for the safe use and control of polymeric chemicals provides for the plant and equipment used for the application of these products is designed, used and maintained in accordance with the manufacturers and/or suppliers requirements.

8.1 Selection and design of equipment

8.1.1 Storage & transport equipment

Containers used for the storage and transport of polymeric chemicals must:

- Be of a robust design to minimise the risk of structural failure during transport and storage,
- Be constructed of materials suitable for the chemicals being transported and stored,
- Provide for sufficient segregation of chemicals,
- Protect chemicals from water ingress,
- Provide means of keeping the chemicals secure from inadvertent removal from the storage and transport container (i.e. lockable), and
- Give consideration to spills and leaks in the design of equipment.

8.1.2 Mixing & pumping equipment

The use of hoses, piping and fittings must be undertaken in accordance with RS23: Fluid power safety in coal mines (Resources Safety and Health Queensland , 2021). This must include consideration of but not limited to the following to ensure equipment is fit for purpose:

- Prior to use all components (containers, pumps, hoses, O-rings, back-up rings, connectors, stand-pipes etc.) to be confirmed as being compatible with the chemicals being used.
- All fittings should be secured in place and have a safety factor of 4:1 on rated working pressure to the failure of the component to perform its function.
- All hoses should have a factor of safety of at least 4:1 on rated working pressure to burst pressure.
- All other components of the system should have a safety factor of at least 2.5:1 on rated working pressure to burst pressure.
- Wherever practicable, hoses should not be interchangeable between chemical components.
- Where hoses are to be interchanged, this must only be done following a risk assessment that gives consideration to the cleaning/flushing requirements, compatibility of the chemicals being used, and the potential impact of any reaction on the integrity of the hoses and fittings.
- All hoses used must be clearly identified.
- All hoses used for polymeric chemical application must be replaced no longer than seven (7) years from date of manufacture.
- Pumping equipment should be provided with a pressure relief safety valve on the pump that bleeds the over pressure back through the pumping system lines such that chemicals are not vented to atmosphere. This should be designed to handle maximum flow rate of pressure relief valve without back pressure effect.
- Evidence of pump relief valve settings, calibration and maintenance intervals to be documented.

- Consideration must be given to guarding and hose protection to the pumping and mixing systems to aid in prevention of potential operator contact with product from leaking/burst, damaged hoses, valves and fittings.

Additional information on aspects of hydraulic safety can be found in:

- RS23: Fluid power safety in coal mines, all relevant AS, ISO, SAE standards are referenced in RS23 to be followed (Resources Safety and Health Queensland , 2021).

8.2 Inspection and maintenance of equipment

The SSE must ensure a system is in place to perform routine operational inspection and maintenance to the equipment to ensure it remains in a fit for purpose state for the duration of its use at the mine.

A maintenance and servicing system must be established to allow early detection of any defect in plant or equipment which could result in a reduced level of operation or protection. The maintenance system must consist of a suitable combination of documented:

- Visual checks,
- Selection of suitable hose materials and fittings,
- Calibration of pump pressures and mixing ratios,
- Calibration of volumetric measuring devices,
- Periodic inspection of administrative and operational control measures,
- Testing and preventative service, and
- Separation guarding and hose protection.

Maintenance and servicing must be carried out by trained and competent personnel.

9.0 General requirements for hazardous chemicals and dangerous goods

Components of polymeric chemicals are hazardous chemicals and/or dangerous goods as defined by sections 54 and 55 of the CMSHR 2017 and as such the provisions of the regulations under section 56A to 56I and 57A to 57B apply (State of Queensland, 2022). In addition to this, the requirements of RS17: Hazardous Chemicals must be followed (Resources Safety and Health Queensland, 2019).

The mine's SHMS must include but not be limited to the following matters, with respect to the use of polymeric chemicals at the mine:

- Introduction to site process,
- Maintaining of a register of hazardous chemicals and dangerous goods used at the mine,
- Making readily accessible to CMWs using a hazardous chemical or dangerous good at the mine, a current copy of the Safety Data Sheet (SDS),
- Labelling requirements (e.g., clearly visible, including on locked pods),
- Safe transport requirements,
- Standard operating procedures for using, handling and storing hazardous chemicals and dangerous goods,
- Disposal requirements,
- Procedure for dealing with leaks and spills,
- Appropriate first aid measures recommended in the SDS for each hazardous chemical or dangerous goods used at the mine, and
- Keeping records that include location on site, quantity, disposal and spills.

9.1 Specific requirements for Storage

The mine's SHMS must ensure that polymeric chemicals are stored at the mine site in accordance with the manufacturer's requirements and any relevant AS for the storage of hazardous chemicals and dangerous goods. This includes requirements for:

- Temperature control,
- Ventilation,
- Spill containment/bunding
- Compatibility of chemicals,
- Appropriate signage,
- Access,
- Security,
- Emergency preparedness including fire response.

9.1.1 Underground Storage

Only sufficient polymeric chemicals for the planned application can be taken into the mine. Any materials that are not used as part of the planned application must be removed from the underground workings within 48 hours.

9.1.2 Product shelf life

The system must provide for a product management process to ensure that only polymeric chemicals within the manufacturer's prescribed shelf life are available for use at the mine.

9.1.3 Used polymeric chemical containers

Spent polymeric chemical containers are to be re-sealed immediately after use. These containers must not be used for any other material and the containers removed from underground in locked steel pods and disposed of as per the procedure.

9.1.4 Relevant Australian Standards

- AS/NZS 3833: 2007 "The storage and handling of mixed classes of dangerous in packages and intermediate bulk containers" (Standards Australia and New Zealand, 2007).
- AS/NZS 3780: 2008 "The storage and handling of corrosive substances" (Standards Australia and New Zealand, 2008). Specific considerations for disposal.

10.0 Health surveillance requirements

The purpose of health surveillance is to identify any changes to a worker's health at the earliest opportunity. This allows early intervention to protect workers' health and to ensure exposure controls and monitoring programs are effective. With respect to isocyanates, the primary objective is to monitor changes in respiratory function and to prevent progression to sensitisation of workers.

The SSE must ensure that personal exposure to polymeric chemicals is reduced to as low as reasonably achievable. This obligation includes the health surveillance of CMWs who apply polymeric chemicals containing isocyanates, and any others who are likely to be exposed during the application process.

For the purposes of Section 10.0 "apply" means:

- Operating pump, operating nozzle, supervising application (including ERZC).
- Handling the product, which includes handling or decanting opened drums of product.
- Setting up, cleaning/flushing hoses and demobilising equipment.
- Cleaning up spills (this may include transport workers), and
- Those involved in the direct supervision of the application activities.

Note: 'apply' does not include transportation of sealed polymeric chemical products.

10.1 Health surveillance for isocyanates

The employer must ensure health surveillance is completed for all CMWs who are exposed to, or likely to be exposed to, isocyanates, and provide this evidence to the SSE. Health surveillance must be carried out by, or under the supervision of, an appointed medical adviser (AMA) under the CMWs' Health Scheme (the Scheme). The Scheme has been optimised to detect occupational lung disease early and ensures health examinations are performed to the required standards by appropriately qualified and experienced medical providers approved and regulated by RSHQ. It also ensures medical records are stored and maintained in an appropriate form, enabling comparative assessment to previous results.

Employers must ensure they identify in the employer section of the health assessment form on ResHealth that isocyanates are one of the hazards to which the worker may be exposed. This will inform doctors that health surveillance for exposure to isocyanate is required.

Health surveillance for isocyanates must include the following components:

- Collection of demographic information and occupational and medical history.
- Standardised respiratory function test (spirometry).
- Respiratory questionnaire.
- Skin examination for work-related dermatitis.
- Follow-up tests or reviews, in accordance with the current Mine dust lung disease clinical pathways guideline, to investigate any abnormalities detected.

Previous work history with isocyanates and symptoms of sensitisation should be investigated and comparison with earlier health surveillance results may assist in identifying longitudinal decline and the development of occupational diseases, such as occupational asthma and work-related dermatitis.

Health surveillance needs to be carried out:

- Before a worker is exposed to isocyanates;
- Six (6) weeks after a worker has been exposed to isocyanates, or as close to the 6-week interval as practicable;
- At six-monthly intervals during periods of regular or repeated occupational exposure.

Note: Where exposure occurs intermittently or as discrete campaigns separated by prolonged periods without exposure, the employer should undertake a risk assessment, in consultation with the Appointed Medical Adviser (AMA), to determine the appropriate timing of further health surveillance. The risk assessment should take into account the worker's exposure history, previous health surveillance findings, relevant exposure and biological monitoring results, and the likelihood of future exposure.

Where monitoring after 12 months shows no adverse health effects, the AMA may choose to carry out annual health surveillance (Safework Australia, 2020).

Additionally, follow-up health surveillance must be conducted as soon as practicable if:

- a worker shows or reports adverse health effects or symptoms potentially related to isocyanate exposure, such as skin irritation or respiratory symptoms; or
- there has been a significant spill, loss of containment or other incident resulting in actual or suspected excessive exposure.

The AMA should determine the appropriate components of the assessment, including whether biological monitoring is indicated.

If workers change employers, previous health surveillance results may be relied upon, if in-date and the new AMA considers it appropriate. AMAs must ensure the next health surveillance for exposure to isocyanates is scheduled in accordance with the timeframe stated above.

11.0 Exposure monitoring requirements

11.1 Biological monitoring

Polymeric chemicals may enter the body through multiple routes of entry including:

- Inhalation
- Skin absorption
- Ingestion

It is therefore necessary to measure the worker in a way that can assess the total exposure from all routes of entry. This usually involves measuring the workers urine or blood for the presence of a certain chemical or a metabolite of a chemical.

Exposure through skin absorption is recognised to be the major route of entry when mixing and pumping polymeric chemicals. This is because of:

- The physical and chemical properties of the ingredients contained in polymeric chemicals typically used at coal mines,
- The work processes used to set-up chemical application systems, dispensing product, and the cleaning and flushing of hose lines, can increase the risk of skin contact,
- The availability of adequate ventilation in most locations where these products are applied underground will dilute vapours generated and reduce the inhalation risk.

For these reasons biological monitoring will provide a more reliable assessment of a CMW's exposure rather than personal atmospheric monitoring methods alone.

11.1.1 Biological monitoring requirements

The SSE must identify CMWs who are at an increased risk of exposure to polymeric chemicals and develop a documented biological monitoring program and procedure. This program must include CMWs involved in the use of bulk delivery and/or single use systems. The frequency of the biological monitoring must be risk based and consider the results of baseline and/or historical monitoring data. In addition, consideration should be given to taking biological samples when there has been significant spills and/or incidents (e.g. burst hoses) and CMWs have been potentially exposed to polymeric chemical products. The monitoring program should be reviewed and approved by a person with relevant experience and qualifications such as a certified occupational hygienist (COH) and/or an occupational physician.

Sample collection and analysis

Sampling and analysis is to be performed in accordance with documented national and/or international standard methods applicable to the specific chemical and/or metabolite.

Where this method specifies end of shift sampling, the SSE must ensure that samples are collected at the end of shift, or as soon as possible after returning to the surface, but no later than within 4 hours after exposure has ceased.

Analysis must be conducted by laboratories accredited by the National Association of Testing Authorities (NATA) for the type of analysis conducted.

Note: Samples must only be analysed for the target contaminant or metabolite related to the polymeric chemical process.

Sample storage and transport requirements

Samples must be stored and transported in accordance with guidelines provided by the laboratory conducting analysis, to align with the standard methods of sampling and analysis. Specimens must be kept cool after collection and during transport to maintain specimen integrity. Specimens should be transported to the laboratory as soon as practicable after collection. Reducing the time between sample collection and analysis will enable timely review of results and investigation of exceedances.

Biological monitoring questionnaire

The CMW being sampled should complete a biological monitoring questionnaire that records tasks performed during the shift and any potential sources of exposure (eg. spills or skin splashes). The sheet should also include specific questions to understand potential contribution from nonwork-related exposures (eg. diet, hobbies, home renovations etc).

An example of a biological monitoring questionnaire is provided in Appendix F.

Considerations for pre-campaign/pre-shift sampling

There may be occasions when it is beneficial to undertake biological monitoring pre and post shift (before and after application). Reasons for undertaking pre-shift or pre-campaign sampling include:

- Accounting for exposures that are non-work related sources such as dietary intake, home renovating or hobbies. Examples include spray painting with polyurethane-based paints, applying foam fillers/ sealants, diets high in seafood, certain medicines and vapes.
- Accounting for exposures that may have previously occurred on another mine site during a separate application.

Consideration should be given to monitoring CMWs who may be working adjacent to (although not directly involved with) polymeric applications, as a way to verify the ongoing effectiveness of the revised operational control zones (OCZ) (refer section 12.1 of this RS). For example, including CMWs in the area inbye the injection point and within 50 to 350 meters (m) beyond the restricted access zone (RAZ). In these cases, it may be beneficial to undertake pre-shift samples for CMWs working outside the revised operational control zones for the purpose of verifying control effectiveness.

11.1.2 Biological occupational exposure limits and guideline values

The values listed in **Error! Reference source not found.** have been established for the hazardous chemicals contained in polymeric resins and foaming products currently used in the coal mining industry. These values do not necessarily represent the difference between safe and unsafe conditions. Exceeding these values indicates that:

- Control measures may not be adequate,
- Work methods may be unsatisfactory, and
- Individual work practices or non-work related exposures may be contributing to exposure.

Table 4: Guideline biological limits for polymeric chemical ingredients.

Polymeric Chemical Group	Ingredient	Test	BOEL / BMGV
Polyurethane resins (PUR)	MDI/PMDI*	Urinary isocyanate metabolites	1µmol of isocyanate-derived diamine/mol creatinine in urine **(a)**
Urea silicate resins and foams			
Phenolic resins and foams	Phenol	Urinary phenol	2.1 mmol/L **(b)**

Notes about **Error! Reference source not found.**.

a) This value is a Biological Monitoring Guideline Value (BMGV) (Health and Safety Executive, 2025)

b) This value is a Biological Occupational Exposure Limit (BOELs) (Scientific Committee on Occupational Exposure Limits (SCOEL), 2014)

***** Additional isocyanate species have been detected in air during the application process. These species may also be absorbed through the skin. These species include methyl isocyanate and phenyl isocyanate. Current urine test methods may not be able to detect these species. This may result in an underestimation of actual exposure. Check with the laboratory to understand if these species can be measured and reported.

Additional chemicals to be included in the biological monitoring program

Additional biological monitoring must be considered for those chemicals, where microchamber testing (Test method A.10) identifies contaminant concentrations in the head space above the product surface, exceed 50% of the workplace exposure limits (WEL), and there are published validated methods for biological sampling and analysis available.

11.1.3 Requirements when biological monitoring result exceeds the relevant BOEL or BMGV

When biological monitoring indicates that a CMW's exposure exceeds the value for a substance stated in Table 4, the exceedance must be investigated in accordance with the mines biological monitoring procedure. The actions detailed in Table 5 are to be completed by the responsible person (s) and/or entity.

As a minimum, the investigation must consider at least the following:

- Date of sample.
- Review of the CMWs completed biological monitoring questionnaire (Example Appendix F).
- Work location.
- Environmental conditions (ventilation rates, wet bulb, dry bulb, effective temperature, presence of water).
- Details of the polymeric process (e.g. product type, volume of product pumped).
- Activities/tasks carried out (including times).
- Type of personal protective equipment used and for what activities/tasks.
- Controls in place to prevent exposure and if they were effective.
- Any incidents that occurred during the shift that likely contributed to exposure including skin contact (eg. spills, leaks, burst hoses, ruptured containers, failing of PPE devices).
- Adjacent activities contributing to exposure (eg. second pump or injection point within the same air split).
- Any other polymeric applications undertaken during the previous 3 days (including at other mines).
- Any other activities undertaken during the previous 3 days that may impact exposure. This should include both occupational and non-occupational activities (eg. using 2-pack polyurethane paints or expanding foams for home renovations/ restoration).
- Dietary intake (eg. high seafood diet may elevate urinary phenol levels above typical background).

Table 5: Actions and responsibilities to be undertaken when BOEL or BMGV is exceeded.

Action Required	Responsibility
The operating processes and practices contributing to the exposure are investigated and corrective actions implemented	SSE at site where exceedance occurred, and the organisation installing the chemical.
Changes to processes or additional controls are communicated to the workforce	SSE at site where exceedance occurred, and the organisation installing the chemical.
Resampling must be conducted at the next available opportunity. This should be on the individual(s) who recoded the exceedance (where possible) while using the same type of polymeric chemical.	SSE at site where the exceedance occurred.
Recording and documenting the exceedance review process	SSE at site where exceedance occurred.

11.1.4 Requirements for communicating biological monitoring results

The biological monitoring procedure must provide for the communication and interpretation of biological monitoring results. This must include the following:

- CMWs who participate in biological monitoring must be provided with a copy of their individual result.
- De-identified results from all biological monitoring must be made reasonably available to all CMWs at the mine.
- SSE is to ensure all results of biological monitoring are to be provided to the employer of the CMW who participate in the biological monitoring.

- The employer of CMWs participating in biological monitoring should provide all results to the respective AMA at regular intervals.

11.2 Atmospheric monitoring

Atmospheric monitoring should be conducted to assess the inhalation exposure risk to CMWs from airborne contaminants, during the application of polymeric chemicals. Personal exposure monitoring can be compared with workplace exposure limits (WEL), to assess the potential inhalation exposure risk. Static monitoring can be used to assess the effectiveness of any controls.

The results of atmospheric monitoring should also be reviewed to:

- Assess the effectiveness of ventilation controls.
- Determine the level of respiratory protection required.
- Validate the effectiveness of established OCZ.

It is important to understand the limitations of air monitoring when assessing exposure to polymeric chemicals. The following points should be considered:

- Atmospheric monitoring only considers exposure via inhalation. It does not consider skin absorption or ingestion.
- Static or fixed position monitoring does not reflect personal exposure and therefore cannot be compared directly with the WEL, to evaluate personal exposure risk.

11.2.1 Atmospheric monitoring requirements

The SSE must identify CMWs who are at an increased risk of exposure to airborne contaminants, resulting from the use of polymeric chemicals at the mine, including bulk delivery and single use systems (as stated in section 10 of this RS), and develop a documented atmospheric monitoring program and procedure.

This program must include the minimum monitoring requirements listed in **Error! Reference source not found.** and incorporate any additional contaminants identified from microchamber testing (Appendix A - 10).

Table 6: Minimum atmospheric monitoring requirements

Product type	Airborne Contaminant	Monitoring Type	Sample Method	Frequency	Purpose
Polyurethane & Urea Silicate resins	Isocyanate	Personal exposure sampling	Asset*	Baseline & Periodic ^^	Exposure assessment
		Fixed position (static)	Asset*	Within the first 12 months of use and at least 5-yearly to coincide with licence renewal and/or when a	Validate control zone effectiveness

Product type	Airborne Contaminant	Monitoring Type	Sample Method	Frequency	Purpose
				new product is introduced.	
Phenolic based resins	Phenol, Formaldehyde	Fixed position (static) (at the pump)	Colorimetric detector tube#	During every application (at start) and repeat if there are notable changes in ventilation	Validate ventilation effectiveness

* Samples collected using ASSETTM EZ4-NCO dry sampler device (or equivalent sampler type), suitable for the collection and analysis of isocyanate polymers, monomers and oligomers.

The performance and accuracy of colorimetric detector tubes is dependent on the operating range for temperature and humidity, specified in the manufacturer instructions. The absolute humidity limits (mg/L) typically specified for Formaldehyde tubes will preclude their use in some underground coal mine locations. In these situations, the formaldehyde tube should be fitted with a de-humidifier pre-treatment section during use. Alternatively, the absolute humidity (mg/L) levels can be measured using water vapour detector tubes prior to using the formaldehyde tube, to ensure it is being used within the operating range specified. This should not be confused with relative humidity (% RH) that is measured using wet and dry thermometers or a sling psychrometers.

^^ The frequency of the personal exposure sampling must be risk based and consider the results of baseline and/or historical monitoring data. The monitoring program should be reviewed and approved by a person with relevant experience and qualifications such as a certified occupational hygienist (COH) and/or an occupational physician. This includes the monitoring conducted in the zone 50-350m return side of the injection point as per 12.3.3 and 12.3.4.

Additional monitoring requirements

Additional monitoring must be conducted for those products, where microchamber testing (Test method A1.10) identifies contaminant concentrations in the head space above the product surface, exceed 50% of the WEL, and there are published validated methods for sampling and analysis available.
For example, there are a range of methods available to support either static or personal exposure sampling and analysis of specific volatile organic compounds (VOCs) including but not limited to formaldehyde, where these are identified in the microchamber test.

Where monitoring involves the use of sampling methods other than direct reading detector types (e.g. colorimetric tubes) and requires laboratory analysis to determine airborne concentrations, the following applies:

- The monitoring program should be reviewed and approved by a person with relevant experience and qualifications such as a COH (or equivalent);
- The collection of airborne samples should be conducted by a competent occupational hygiene technician;
- Sampling and analysis must be performed in accordance with a published and validated method;

- Sample analysis must be conducted by a NATA certified laboratory, which may or may not include NATA accreditation for the specific analytical method; and
- Sampling equipment must be fit for purpose and calibrated with records of calibration available on request.

The frequency of personal exposure monitoring must be risk based and include a baseline and periodic sampling program, consistent with the approach outlined in RS14: Monitoring respirable dust in coal mines (Resources Safety and Health Queensland, 2021).

- Sufficient sample numbers should be collected in order to support the statistical analysis of results.

Further guidance on the requirements for atmospheric monitoring is provided in Appendix C.

Direct reading detectors (colormetric tubes)

Where direct reading detectors (e.g. Colormetric tubes) are used to measure airborne concentrations, the following applies:

- Sampling and interpretation of results should be conducted by an ERZC;
- Sampling must be conducted in accordance with detector manufacturer instructions;
- Sampling equipment is fit for purpose and within calibration. This must be checked prior to use for each shift;
- Measured airborne concentrations are recorded on the ERZC Statutory report and/or polymeric chemical application report for the shift.

Note: It is important to understand that colorimetric tubes have various advantages and limitations that must be considered when assessing exposure risk. These are detailed in **Error! Reference source not found.**.

Table 7: Advantages and limitations of colorimetric use

Advantages	Limitations
Light and portable	Not as accurate as other methods
Tubes available for a wide range of substances	Subject to cross sensitivity
Relatively inexpensive	Environmental factors such as water vapour and humidity may impact performance
Relatively easy to use	Shelf life
No laboratory analysis required	Some tubes have special storage requirements
Direct feedback of results	

11.2.2 Workplace exposure limits (WEL) for airborne contaminants

Airborne concentrations of the individual chemical ingredients contained in polymeric chemicals formulations, should not exceed the limits specified in Table 8.

The limits specified in Table 8 are only applicable for assessing the potential inhalation exposure to workers, from airborne contaminant concentrations measured in the workplace.

These WEL are based on conventional work schedules (i.e. an 8 hour working day and 5 day working week). Where extended shifts or non-standard rosters are worked (i.e. greater than 8 hours a day, 40 hours a week), the exposure limits should be adjusted as follows:

- In consultation with a COH or equivalent;
- Using a recognised method, in accordance with published guidance (Australian Institute of Occupational Hygiene, 2016).
- There are no adjustments to STEL exposure limits where extended shifts are worked; and
- WEL are not increased where the hours worked are less than 8 hours per day or 40 hours per week.

Table 8: WEL for individual chemical ingredients in polymeric chemicals (Safework Australia, 2025)

Chemical	TWA (mg/m^3)	STEL (mg/m^3)	Notation
Isocyanates, (poly) (as -NCO)*	0.02	0.07	DSEN RSEN Sk
Methyl isocyanate**	0.047	0.14	
Phenyl isocyanate**	0.024		
Phenol (Carbolic acid)	4	-	Sk
Formaldehyde	1.2	2.5	DSen

*** The limit for 'Isocyanates' applies to all types of isocyanate compounds that are present and refers to the total mass concentration of the isocyanate (-NCO) functional groups, when combined from all types of isocyanate compounds. It is not the mass concentration of the individual molecules combined.**

**** The limits for Methyl- and Phenyl- isocyanates apply separately to each of these compound types, and refers to the mass concentration of the molecule. It is not the mass concentration of the isocyanate (-NCO) functional group.**

Table 9: Explanation of Notations (Safework Australia, 2025)

tation	Definition	Further information
Sk	Absorption through the skin may be a significant source of exposure.	Extra control measures should be used to minimise the risk of skin contact. These control measures could include gloves, protective clothing, safety eyewear and closed systems to transfer liquids or gases.
DSEN	Substances that cause sensitisation through dermal (skin) absorption are given the notation 'DSEN'. Substances that cause sensitisation through respiratory tract absorption are given the notation 'RSEN'	Sensitisation can occur even when workers are exposed to low levels of a chemical over extended periods of time. Once sensitised, a worker may react to the chemical, even when airborne concentrations of the chemicals are below the exposure limit. In these circumstances, sensitised workers must not be exposed further to the substance.
RSEN		

Investigating and reporting requirements

When personal exposure monitoring indicates that a CMW's exposure exceeds the WEL for an airborne contaminant stated in Table 8, the exceedance must be investigated and actions undertaken in accordance with the requirements specified for biological monitoring in section 11.1.3. This includes requirements for exceedance investigation and reporting being documented in the monitoring procedure.

The results of personal exposure monitoring must be communicated to CMWs in accordance with the requirements specified for biological monitoring in section 11.1.4.

12.0 Operational control zones (OCZ)

The mines SHMS must provide for OCZ to prevent personal exposure to polymeric chemicals and to prevent exposure to other hazards including but not limited to fluids under pressure.

These OCZ must be detailed in the mines system for the safe use of polymeric chemicals and clearly demarcated by signage as described in section 12.4 of this RS. The statutory official (ERZC) for the district has the responsibility of establishing and enforcing these zones.

12.1 Certain zones and areas to be identified and treated as OCZ

OCZ for the application of polymeric chemicals using bulk handling systems are defined as:

- **Pump Zone (PZ):** All those points within a 10-metre radius of the pump in which containers (including intermediate bulk containers (IBC)) of polymeric chemicals are being set up, calibrated, pumped or demobilised. Where the pump is located on the surface of the mine and the polymeric chemicals reach the workings of a mine via a borehole – all those points within a 10-metre radius of the pump and within a 10-metre radius of the bottom of the borehole will be treated as a PZ.
- **Injection Point (IP):** All those points within a 10-metre radius of the site where polymeric chemicals are injected, sprayed or applied free flow for the purpose of void filling, consolidation, lining of or the sealing of strata.
- **Zone of Operations (ZOO):** The operational area between the pump zone (PZ) and injection point (IP) where active hose lines run in the ventilation path between the pump and the nozzle. When these lines are de-energised or disconnected and capped this ceases to be a ZOO.
- **Restricted Access Zone (RAZ):** All points up to 50 metres on the return airway side of the nozzle. The RAZ ceases when the pump is de-energised and confirmed by the ERZC.

The OCZ described above are represented in schematic diagrams included as Appendix G. There may be other scenarios and locations where polymeric chemicals are applied in coal mines that are not represented by these diagrams. In these circumstances the SSE is to ensure that the principles and the definitions of the OCZ detailed in 12.0 of this RS are applied and maintained.

12.2 Persons allowed to enter operational control zones

- **Pump Zone (PZ) -** The only persons allowed to enter the PZ while the lines are energised or the chemical containers are open and unsealed, will be the pump operator/s and individuals directly associated with the decanting and/ or transfer of polymeric chemicals. The responsible statutory official appointed to the zone may enter this zone at any time.
- **Injection Point (IP) -** The only persons allowed within this zone during the injection or free flow application of polymeric chemicals will be the injection point/ nozzle operator(s) and the responsible statutory official (ERZC) appointed to that zone. The ERZC appointed to the zone may enter this zone at any time.

Note: It is understood that other individuals may need to inspect the injection or void filling site (e.g. Geo technical engineer, UMM, Longwall Superintendent). These individuals may enter the IP zone following sign on and permission from the ERZC. In addition, they must be trained and authorised and comply with all requirements under this RS (e.g. PPE, biological monitoring and health surveillance).

- **Zone of Operations (ZOO) –** Access to this zone must be restricted at all times whilst the pump is operating and the spraying, injection or free flow application of polymeric chemicals is taking place. The only CMWs able to enter and remain in the active ZOO are those CMWs directly related to the strata consolidation or recovery process. (e.g. drilling of injection holes, inspection of the associated strata, installation and downloading of temperature monitoring devices). These works and activities must be covered by an appropriate level of risk management. Notwithstanding the above, these CMWs will need to comply with restrictions and exclusions applied to the other operational control zones (e.g. IP, PZ and RAZ).

- **Restricted Access Zone (RAZ) –** This zone will be treated strictly as an exclusion zone while the pump is energised. No CMWs, including statutory officials can access this area while the pump is energised.

12.2.1 Two pumps operating in the same air split

In the situation where two (2) pumps are located in the same air split, the area between the pumps will be treated as a ZOO.

The use of two (2) pumps can only be considered where each individual pump and nozzle has a trained, competent and authorised operator dedicated to each pump and/or nozzle.

12.3 General requirements for CMWs working in or accessing through OCZ

12.3.1 Working in OCZ (including inspecting and supervising)

Persons working and supervising in these zones must:

- Be appropriately trained and possess the relevant competencies to undertake tasks relating to the polymeric chemical application process (refer section 6.0),
- Wear the required PPE detailed in the mines system, and
- Participate in health surveillance, biological and personal exposure monitoring as per the procedure developed and documented in the mine's SHMS.

12.3.2 CMWs required to pass through operation control zones

For any other CMWs (including other mine officials), required to pass through these zones, the following requirements must be in place:

- Permission from the ERZC responsible for this district has been granted,

- The application lines must be de-energised,
- Familiarisation training in the hazards associated with polymeric chemicals has been completed,
- Wear the required PPE and participate in health surveillance and biological monitoring, deemed appropriate for the level of exposure risk (giving consideration to the frequency and duration of the time spent in this zone).

12.3.3 Activities permitted on the return side of the RAZ boundary (beyond 50m to 350m on the return side of the injection point).

The only tasks and activities that can be carried out on the return side of the RAZ boundary (i.e. a point 50 meters from the injection point or nozzle) whilst the pump is operating and injection or application is taking place are those directly related to the strata recovery and strata support activities. These tasks are:

- All tasks related to the pumping and injection or free flow application of polymeric chemicals .
- Drilling of injection holes,
- Inspection of the associated strata
- District inspections by ERZC ,
- Installation and downloading of temperature monitoring devices, and
- Any other strata control activities (e.g. tailgate support).
- For any other tasks required to manage a principal hazard at the mine, these need to be risk assessed to determine acceptability of inclusion.

12.3.4 Additional requirements for CMWs performing activities on the return side of the RAZ boundary from 50 m to 350m.

To support the reduction in the RAZ from 350 meters to 50 meters, the following additional requirements are in place:

- Requirement to undertake periodic fixed position and / or personal monitoring on workers in this zone as outlined in Table 6.
- Requirement to undertake biological monitoring of workers in this zone.
- Requirement to undertake health surveillance.
- Requirement to report any and all monitoring data (atmospheric and biological) to the RSHQ coal inspectorate collected in this zone at monthly intervals.
- Requirement to be trained in endorsed components of RII MCU 218

12.4 Signage and demarcation of operational control zones

The demarcation and signing of the zones described in section 12 of this RS will be the responsibility of the ERZC responsible for that zone. The signage and demarcation must be installed in accordance with the standards detailed in the mines SHMS.

As a minimum the signage must detail:

- Time and date polymeric chemical application activities commenced,
- Type of chemical application (injection, cavity fill or sprayed lining),
- Approximate location of the IP,
- Name of the ERZC appointed to the district and the supervisor appointed to the application,
- Any relevant safety information (e.g. hazards, PPE requirements).

An example of a sign is provided in Appendix H of this RS.

13.0 Heat exposure

The requirements for assessing and controlling exposure to heat are prescribed in the CMSHR 2017 (sections 369 and 370) (State of Queensland, 2022) and in RS18: Management of heat in underground coal mines (Resources Safety and Health Queensland, 2021), and further guidance is provided in Guidance Note QGN 32: Managing exposure to heat in surface coal mines and surface areas of underground coal mines (Resources Safety and Health Queensland, 2022). These require procedures to be developed and documented within the mine's SHMS to manage the risk of heat exposure. Additionally, there is a requirement to consider factors including the type of clothing worn, that may impede the body's capacity to dissipate heat while working in hot and humid conditions.

Heat management plans and heat trigger action response plans (TARPs applied in underground coal mines are based on the use of 'Normal Effective Temperature' (NET) calculations, which have been derived for lightly clothed workers. This is critical for triggering the activation and escalation of TARP response plans to protect CMWs from heat related illness.

Full length disposable overalls are the typical choice of personal protective clothing worn to provide skin barrier protection while handling polymeric chemicals. The wearing of semi-impermeable clothing such as disposable overalls, impedes the body's ability to thermoregulate through evaporative sweat loss and this significantly increases the risk of heat stress.

The use of heat TARPS which are based on NET calculations do not provide adequate protection for CMWs, while they are wearing full length disposable overalls, such as required for polymeric chemical applications.

Separate and additional heat exposure controls must be applied to CMWs wearing impermeable or semi-impermeable protective clothing while performing physical work in hot and humid conditions (wet bulb temperature > 27° C), and this must be developed and documented in the mine's SHMS. This should include:

- Limiting the wear time for these garments, to ensure health-based limits for increased core body temperature are not exceeded. The maximum wear time between rest breaks and the minimum duration of rest breaks should be specified.
- Applying hydration protocols in accordance with RS18: Management of heat in underground coal mines (s 4.2.3) (Resources Safety and Health Queensland, 2021), and monitoring the hydration levels of individuals, prior to and after product application.
- Escalating the heat TARP trigger level when CMWs are wearing full length protective clothing.
- Provision to deliver first aid treatment to heat affected persons in-situ, where work is being conducted remotely and the estimated travel time for emergency response exceeds thirty minutes. For example, consider supplying a portable 'heat stroke kit' to be available at the work location, to enable rapid body cooling treatment, while waiting for emergency response to arrive. This kit to be comprised of a 5L water bottle, portable esky containing ice and towels, and instructions to apply the ice towel rapid cooling method (Brearley, 2024 ; Resources Safety and Health Queensland, 2022).
- An example Heat TARP for wearing impervious coveralls during polymeric chemical applications underground has been provided for guidance and is attached in Appendix I. This example has been derived from TARPs used at underground coal mines.

Consideration should be given to sourcing and introducing garments which provide adequate barrier protection from the types of spillage and splash exposure scenarios likely to contribute to skin contact during handling of polymeric chemicals, while at the same time facilitating ventilation and evaporative sweat loss from the skin.

14.0 Firefighting equipment

Appropriate firefighting equipment must be available at the locations of polymeric chemical application and storage. This equipment will be of a type such that it can adequately control the class of fire that may be involved in any outbreak of fire at the application site of the mine where these chemicals are stored. Additional information can be obtained from the SDS for each chemical component.

15.0 Single use systems

Single use systems include but are not limited to items such as portable canisters of polymeric chemicals used for temporary sealing of ventilation devices and cartridge type delivery systems used for plugging gas drainage holes.

These products must be subjected to and meet the requirements of the test methodologies detailed in Appendix A and Appendix B of this RS. The SSE must maintain a copy of the test reports verifying completion and compliance with these tests.

Note: Test A 1.2, A 1.3 do not apply to single use systems (Maximum exothermic temperature – Large Scale Test)

Prior to the use of these products at the mine, a risk assessment must be undertaken and a procedure developed which must include but not be limited to the following items:

- Limiting chemical exposure risks via all routes of entry,
- Ventilation requirements,
- OCZ to consider the mode of delivery and potential for exposure to airborne contaminants,
- Requirements for PPE (giving consideration to nature of the task, exposure frequency and duration),
- Consideration of the exothermic risk and potential for artificial heating of coal where applicable,
- Maximum volumes of product that can be dispensed in a location during an application,
- Exothermic temperature monitoring and workplace inspection requirements,
- Requirements for firefighting,
- Transport, storage, use and disposal requirements,
- Requirements for health surveillance and biological monitoring,
- Requirements for atmospheric monitoring,
- Requirements for training of CMWs.

The risk assessment for developing the procedure must be undertaken with an appropriate cross section of the work force and must include relevant content experts including an occupational hygienist, VO and representative from the chemical supplier/applicator.

16.0 Ground consolidation products that do not meet the definition of a polymeric chemical.

There may be other products used at coal mines that do not meet the definition of a polymeric chemical although exhibit similar hazards properties. When using these products, the SSE must conduct a risk assessment, equivalent / relevant product testing where necessary to address any safety (exothermic) and exposure hazards that may result from the use of these products. This must include but not be limited to the following:

- The chemical composition of the ingredients and the byproducts of reaction, and any exposure risks.
- Hazardous chemical provisions (SDS, labelling),
- Minimum ventilation requirements,
- PPE requirements,
- Personal monitoring requirements (atmospheric and biological),
- Management of heat exposure,
- Health surveillance requirements,
- Polymeric application plan,
- Reaction temperatures and exothermic risk factors,
- Exothermic temperature monitoring requirements,
- Maximum volumes to be applied,
- Supervision and inspections,
- Product and application quality control requirements,
- Mechanical strength properties,
- Transportation,
- Maintenance of plant and equipment,
- Storage and disposal requirements,
- Training requirements,
- Record keeping,
- Emergency response (fire and spillage).

17.0 Record keeping

The SSE must keep records relating to the use of polymeric chemicals at the mine. These records must include and are not limited to the following:

- Copies of product testing reports and certificates.
- Copies of licences issued by the NSW Mine Safety Regulator for the use of these products.
- Copies of risk assessments detailing the safe use of the product as required under the site's SHMS.
- Copies of any personal and biological monitoring results.
- Copies of application reports for each application, including exothermic temperature monitoring.
- Copies of records relating to training and competencies as detailed in section 6.0 of this RS.
- Copies of maintenance and calibration records as detailed in section 8.0 of this RS.
- Copies of records relating to hazardous chemicals as detailed in section 9.0 of this RS.

The SSE must make available on request, copies of records/ documents for all polymeric chemicals stored or applied at the mine, to any CMW, Industry Safety and Health Representative (ISHR) or Inspector of Coal Mines.

With respect to exposure monitoring results, these records must be de-identified unless they the individual exposure record of the CMW requesting the records.

17.1 Biological monitoring and health surveillance

The SSE is to ensure that records pertaining to all biological and personal atmospheric monitoring are to be kept by the mine for a period not less than 30 years.

The employer is to ensure that all records pertaining to health surveillance are to be kept by the employer for a period not less than 30 years.

17.2 All other records

All other records listed above must be kept for 7 years after the record is made.

18.0 Audit and review process

The SSE for the coal mine must develop and maintain an audit and review program to ensure effective implementation of this RS.

18.1 Review

The site's procedures for the use of polymeric chemicals must be periodically reviewed and modified (if required). Document the frequency, the person(s) responsible and the trigger(s) for the review of the procedure (e.g. significant industry incidents, repeated exceedances of BOEL or BMGV, introduction of different chemical supplier or products).

18.2 Audits

The mine must develop auditing procedures and schedules to ensure that the use of polymeric chemicals is conducted in accordance with this RS and the site's procedures.

The details of these audits must be documented.

19.0 Definitions

AMA	Appointed Medical Advisor
AS	Australian Standard
Biological monitoring	Monitoring a person for a level of a hazardous chemical, metabolites of the hazardous chemical, or a level of another substance that is an indicator of exposure to the hazardous chemical.
Biological monitoring guideline value (BMGV)	Biological monitoring guideline value are not health based. If they are exceeded it does not always mean ill health will occur, but it does indicate that control of exposure may not be adequate.
Biological occupational exposure limits (BOEL)	Biological occupational exposure limits are set at a level at which there is no indication from scientific evidence available that the substance being monitored is likely to be injurious to health.
Cavity filling	The pumping of a polymeric chemical into a large void or cavity. When mixed with a catalyst the resin undergoes rapid expansion to form dense foam that plugs the cavity, stabilises debris and prevents gas accumulation in the void.
CMSHA	Coal Mining Safety and Health Act 1999
CMSHR	Coal Mining Safety and Health Regulation 2017
CMW	Coal Mine Worker(s)
CMWHS	Coal Mine Workers' Health Scheme
COH	Certified Occupational Hygienist
DAC	Telephonic two-way communications used in underground coal mines
ERZ	Explosion Risk Zone
ERZC	Explosion Risk Zone Controller
Health surveillance	Health surveillance is the periodic medico-physiological examination of exposed workers with the objective of detecting early changes from baseline, protecting health and preventing disease.
IBC	Intermediate Bulk Containers
Injection Point (IP)	All those points within 10-meter radius of the site where polymeric chemicals are injected or free flow for the purpose of void filling, consolidation or injection into strata.
In-situ	Refers to something that is in its original place or position.
ISHR	Industry Safety and Health Representative
Isocyanates	Isocyanates are a group of highly reactive organic compounds that can easily become volatile and enter the atmosphere as a vapour. They may also be absorbed directly through the skin. They are common components in the production of polyurethane foams and 2-pack spray coatings

Mechanical Property Testing	A suite of tests undertaken to understand the mechanical properties of these products to inform the Geotechnical engineers, including but not limited to physician and binding strength, viscosity and foaming factors.
Micro Chamber Testing	A chemical speciation test undertaken to identify contaminants that may be released at potentially harmful levels in the immediate head space above raw and reacting products.
MDI	Methylene diphenyl isocyanate.
NATA	National Association of Testing Authorities
NET	Normal effective temperature
NSW	New South Wales
OCZ	Operational Control Zones
OEM	Original Equipment Manufacturer
PPE	Personal Protective Equipment
Phenol – formaldehyde resins and foams (Phenolic Resins)	Phenolic resins are a two component system with Part A being the phenol and formaldehyde and Part B comprising an acid. Phenolic resins are formed by cross linking phenol and formaldehyde in the presence of an acid to form a polymer. The acid mixture generally comprises a mixture of some of the following: acetic, sulphuric, phenol sulphonic and phosphoric acid.
PMDI	Polymeric MDI is a mixture of MDI and larger molecular weight oligomers of MDI. This is the isocyanate formulation typically found in polyurethane and urea silicate resins.
Polymeric chemicals	Polymeric Chemicals refer to a group of products used extensively throughout the underground coal mining industry for various types of strata stabilisation, cavity filling and sealing applications. For the purpose of this recognised standard a polymeric chemical is any material that is polymerised underground, including its constitute components but excluding polyester resin capsule used in strata support.
Polyurethane resins (PUR)	Polyurethane resins are often referred to as PUR. These resins are formed by mixing a diisocyanate and a polyol in the presence of a catalyst. Isocyanates are low molecular weight compounds which are highly reactive. The diisocyanate used in the manufacture of polyurethane resins is methylene biphenyl diisocyanate (MDI).
Pump Zone (PZ)	All those points within a 10-metre radius of the pump in which containers of polymeric chemicals are being set up, pumped or demobilised.
ResHealth	ResHealth is the online system for the health assessment process under the Coal Mine Workers' Health Scheme. All health assessments must be completed on ResHealth.
Restricted Access Zone (RAZ)	All points for 50 metres on return airway side of ZOO whilst the product pump is energised. The RAZ ceases when pump is de-energised and confirmed by the ERZ Controller.

RII	Resource and Infrastructure Industry
RPEQ	Registered Professional Engineer Queensland
RS	Recognised Standards state ways of achieving an acceptable level of risk for people working in coal mines. Operators can manage the risk in a different way but must be able to show that the method used is at least equivalent to the method in the recognised standard
RSHQ	Resources Safety Health Queensland
Sensitising agents (sensitisers)	Exposure to some chemicals can result in an individual becoming sensitised. Once this has occurred the individual may experience adverse reaction to further exposures well below the exposure standard for that substance. Isocyanates are known sensitisers.
SHMS	Safety Health Management System
Safety Data Sheet (SDS)	SDS are documents that provide critical information about hazardous chemicals. This includes ingredients, health and safety information, emergency procedures.
SSE	Site Senior Executive
Silicate resins	The chemical formulations of silicate resins are more complex than those of PUR. It essentially involves the mixing of an isocyanate (polymeric MDI) with a water-based sodium silicate solution. The resultant exothermic reaction cures to form a strong binding resin.
Skin absorption	Some substances can enter the body through direct contact with the skin. This is known as skin absorption.
Spirometry	Spirometry is a common pulmonary function test that measures lung function by assessing how much air can be breathed in and out, as well as how quickly it can be exhaled.
Strata stabilisation	Involves the injection of a polyurethane or phenolic resin and catalyst under high pressure through drilled holes in the strata. The resin migrates through the cracks and fissures in the strata to form strong and flexible bonds that stabilize the surrounding ground.
TARP	Trigger Action Response Plan
TDI	Toluene diisocyanate
TMD	Temperature Monitoring Device
UMM	Underground Mine Manager
Virgin Rock Temperature	Virgin rock temperature is the undisturbed natural temperature of rock at depth, before any human, drilling or mining influence.
VCD	Ventilation Control Device
VO	Ventilation Officer
VOC	Volatile Organic Compounds
WEL	Workplace Exposure Limit

Zone of operation (ZOO)	The operational area between the pump zone and injection point where active hose lines run.

Appendix A: Testing Criteria

Maximum exothermic temperature – A.1

Electrical resistance – A.2

Spark Incendivity – A.3

Fire resistance – A.4

Fire propagation – A.5

Flash point – A.6

Oxygen index – A.7

Chemical characterisation of components – A.8

Spread of flame test *(Cavity and Surface applied products)* – A.9

Microchamber head space test for airborne contaminants - A.10

Mechanical characteristics – A.11

A.1 Maximum exothermic temperature

A.1.1 Small Scale Method

1. Principle

To establish the maximum exothermic temperature when the supplied components of a polymeric resin are combined. The temperature rise of a 200 ml mixture of the components is measured within a container using a calibrated/validated temperature monitoring device.

Ambient laboratory temperature to be 23 °C ± 2 °C

2. Apparatus

1) Three (3) containers (plastic or paper) of approximately 170 mm high x 95 mm top diameter x 65 mm bottom diameter that can be readily removed from the cured product.
2) Calibrated digital temperature monitoring device with an accuracy of ±2 °C
3) Stopwatch/timer
4) Temperature/humidity monitoring device
5) OEM-supplied applicators (gun and canisters) or mixing devices and OEM product design ratios for specific polymeric chemical (in accordance with the supplier's technical data sheet)

3. Test specimens

Prepare three (3) individual 200 ml mixtures, using the (OEM) product design ratios of the individual components. Apply only one of the 200 ml mixtures to a container.

4. Procedure

1) Three (3) sets of two (2) temperature monitoring devices are attached to a wooden rod (of approximately 3-5 mm in diameter) at approximately 5 mm and 25 mm from the end of the rod. The temperature monitoring devices (TMD) are positioned in the test container approximately 5 mm and 25 mm from the bottom of the container, with 25 mm being the approximate midway point of the 200 ml test mixture. Refer to Figure 1 and Figure 2.

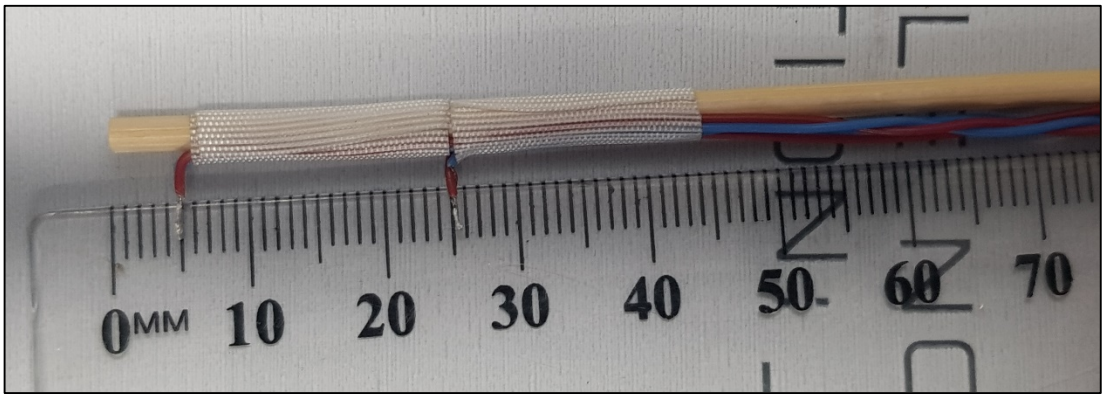


Figure 1: Wooden rod with 2 temperature monitoring devices at 5 mm and 25 mm from the end (bottom)

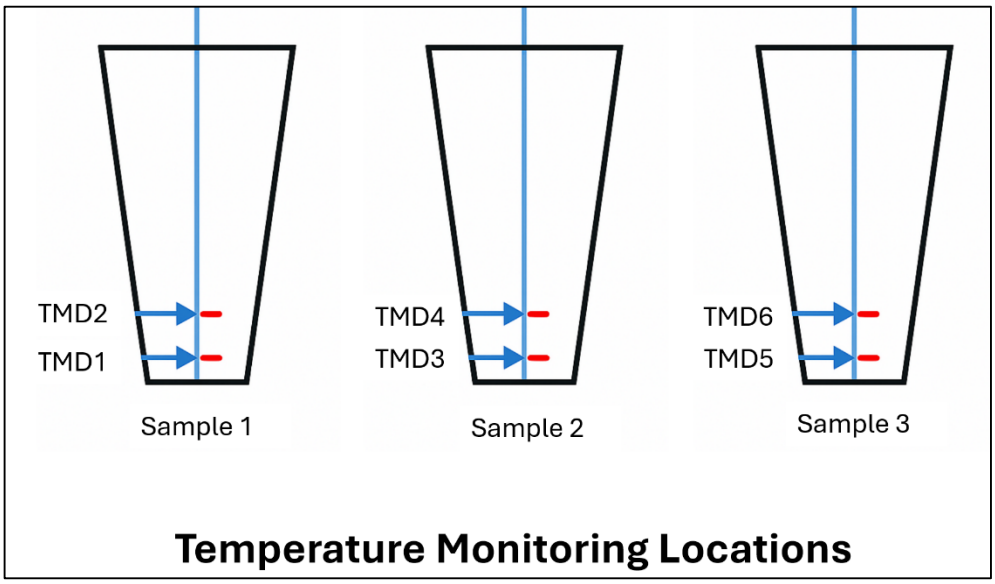


Figure 2: Test cups with the rod, support bar and temperature monitoring device locations

2) The supplied components are combined using the OEM applicator or device, in accordance with the supplier's technical data sheet.
3) The exothermic temperature rise is recorded and monitored by a digital temperature monitoring device. The ambient temperature and humidity of the testing laboratory are also recorded and monitored.
4) Observe any temperature over the setting/curing time and, in particular, any sharp rise in the initial reaction.
5) Repeat steps 2 to 4, at least twice.
6) Record the average the maximum exothermic temperature for each duplicate and note, with emphasis on any sharp temperature rises.

5. Requirement

The heat evolved from any mixing process must result in a maximum temperature not greater than 150 °C.

A.1.2 Large Scale Method - Injectables

1. Principle

To measure the exothermic reaction temperature of the resin or foam when the supplied components are mixed and the chemical reaction occurs. This test measures the following:

1) Maximum temperature reached.
2) Temperature rise time from 25 °C to the maximum temperature and,
3) Temperature decay time from the maximum temperature back to 25 °C.

Ambient test environment temperature must be 25 °C ± 2 °C to commence the test, with a fluctuation of 25 °C ± 15 °C during the entire test duration.

Note: This test does not apply to single use systems.

2. Apparatus

1) Three (3) test vessels (concrete pits) with internal dimensions 600 mm x 600 mm x 600 mm
2) Calibrated digital temperature monitoring device with an accuracy of ±2 °C.
3) Stopwatch/timer
4) Temperature/humidity monitoring device
5) OEM-supplied pump and mix ratio setup for specific polymeric chemical (in accordance with the supplier's technical data sheet)

3. Temperature Monitoring Device Placement

Details of the pit setup and temperature monitoring device locations are shown in Figure 3, identifying the modifications for each pit to fulfil the testing requirements and data capture.

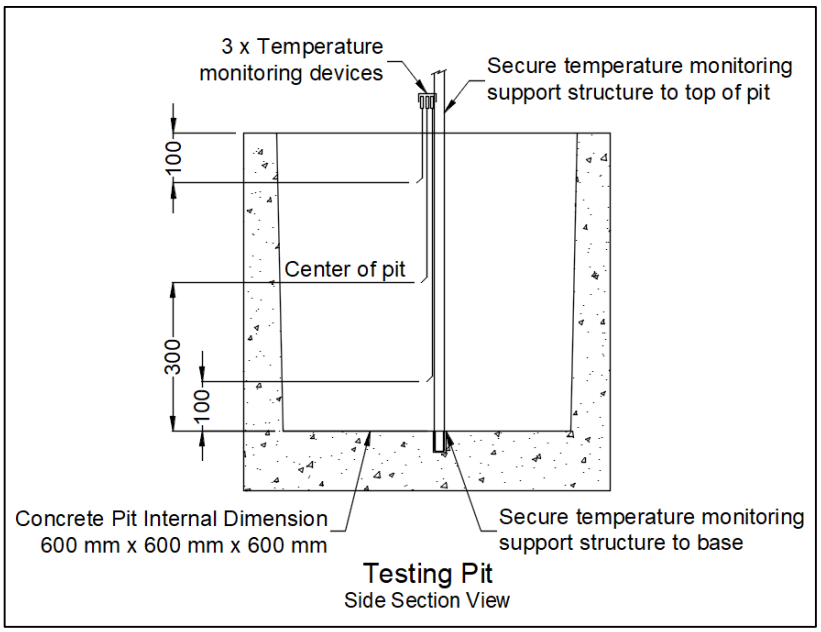


Figure 3: Details of Pit Setup

4. Test Samples

1) The temperature monitoring devices are located along the vertical centreline of the pit and extended into the pit to the following locations:

i. Temperature Monitoring Device #1 (TMD#1) is located 100 mm above the inside pit bottom.

ii. Temperature Monitoring Device #2 (TMD#2) is located 300 mm above the inside pit bottom.

iii. Temperature Monitoring Device #3 (TMD#3) is located 500 mm above the inside pit bottom.

2) Fill the pit to the required amount for the polymeric chemical, which is the maximum permitted quantity (derived from the temperature results of test A1.1 small scale and the corresponding litres stipulated in Table 3 for the temperature range) or until the pit is full (for polymeric chemical products that have a maximum permitted quantity over the pit volume of 216 litres).

5. Procedure

1) Polymeric chemical raw products are required to have a stable temperature of 25 °C before injection (IBC quantities of polymeric chemical require a minimum of 6 days in a temperature-controlled environment)
2) Start the test area temperature and humidity data logger.
3) Set the temperature monitoring device sampling rate to 5 seconds *(until the maximum exothermic temperature has been achieved and the data indicates that the product is cooling and in the decay cycle).*
4) Start the data acquisition system for a minimum of 5 minutes before the chemical pumping commences.
5) Pump some of the product into a waste drum to prime the system.
6) Start pumping the chemical mixture into each pit.
7) Record the time when the pumping starts and stops for each pit.
8) Once the product is cooling and in the decay cycle from Step 3, set the temperature monitoring device sampling rate to record 1 sample per minute for the remaining test duration.
9) The test duration ceases once the last temperature monitoring device in the pit returns to the injection temperature of 25 °C.

6. Requirements

The heat evolved from any mixing process must result in a maximum temperature not greater than 150 °C.

A.1.3 Large Scale Method – Cavity Fill

1. Principle

To measure the exothermic reaction temperature of the resin when the supplied components are mixed and the chemical reaction that occurs. This test measures the following:

1) Maximum temperature reached.
2) Temperature rise time from 25 °C to the maximum temperature and,
3) Temperature decay time from the maximum temperature back to 25 °C.

2. Apparatus

1) Three (3) test vessels (concrete pits) with internal dimensions 900 mm x 900 mm x 1200 mm
2) Calibrated digital temperature monitoring device with an accuracy of ±2 °C.
3) Stopwatch/timer
4) Temperature/humidity monitoring device
5) OEM-supplied pump and mix ratio setup for specific polymeric chemical (in accordance with the supplier's technical data sheet)

3. Temperature Monitoring Device Placement

Details of the pit setup and temperature monitoring device locations are shown in Figure 4 identifying the modifications for each pit to fulfil the testing requirements and data capture.

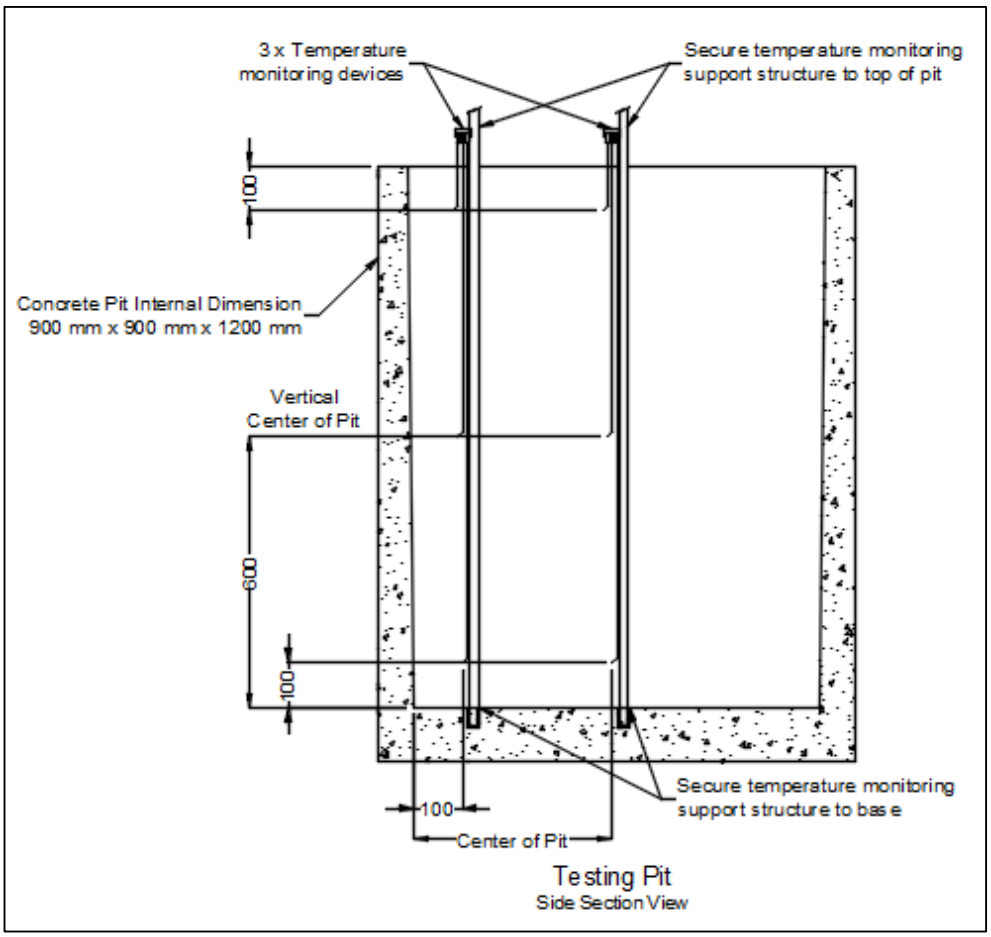


Figure 4: Details of Pit Setup

4. Test Samples

1) The temperature monitoring devices are located along the vertical centreline of the pit and extended into the pit to the following locations:
   i. Temperature Monitoring Device #1 (TMD#1) is located 100 mm above the inside pit bottom and in the centre of the pit.
   ii. Temperature Monitoring Device #2 (TMD#2) is located 600 mm above the inside pit bottom and in the centre of the pit.
   iii. Temperature Monitoring Device #3 (TMD#3) is located 1100 mm above the inside pit bottom and in the centre of the pit.
   iv. Temperature Monitoring Device #4 (TMD#4) is located 100 mm above the inside pit bottom and 100 mm in from the pit wall.
   v. Temperature Monitoring Device #5 (TMD#5) is located 600 mm above the inside pit bottom and 100 mm in from the pit wall.
   vi. Temperature Monitoring Device #6 (TMD#6) is located 1100 mm above the inside pit bottom and 100 mm in from the pit wall.
2) Fill the pit with mixed product until it reaches the top face of the pit.

5. Procedure

1) Polymeric chemical raw products are required to have a stable temperature of 25 °C before injection (IBC quantities of polymeric chemical require a minimum of 6 days in a temperature-controlled environment)
2) Start the test area temperature and humidity data logger.
3) Set the temperature monitoring device sampling rate to 5 seconds *(until the maximum exothermic temperature has been achieved and the data indicates that the product is cooling and in the decay cycle).*
4) Start the data acquisition system for a minimum of 5 minutes before the chemical pumping commences.
5) Pump some of the product into a waste drum to prime the system.
6) Start pumping the chemical mixture into each pit.
7) Record the time when the pumping starts and stops for each pit.
8) Once the product is cooling and in the decay cycle from Step 3, set the temperature monitoring device sampling rate to record 1 sample per minute for the remaining test duration.
9) The test duration ceases once the last temperature monitoring device in the pit returns to the injection temperature of 25 °C.

6. Requirements

The heat evolved from any mixing process must result in a maximum temperature not greater than 150 °C.

A.2 Electrical resistance

A.2.1 Method

Electrical resistivity testing determines a material's resistance to the flow of electrical charge. It assesses the risk for static build-up and ensures materials are suitable for use in environments like explosive atmospheres, preventing potential fires or explosions.

1. Principle

To measure the surface electrical resistance of samples of the cured resin in accordance with AS1334.9:2016 revised – Determination of electrical resistance of conveyor belting (Standards Australia, 2016) or ISO 284:2025 Conveyor Belts – Electrical conductivity – Specification and test method (International Organistation for Standardization, 2025), as stated in AS4606:2012 – Grade S fire resistant and antistatic requirements for conveyor belting and conveyor accessories (Standards Australia, 2012). The testing procedure and criteria have been adapted for the testing of polymeric chemicals, as no such standard exists currently.

Ambient laboratory temperature to be 23 °C ± 2 °C and 50 % ± 5 % humidity

2. Apparatus

A megohmmeter with a nominal open voltage of 40 to 1000 volts DC *(not permitting a current greater than 10 mA or energy dissipation of more than 1 W in the test piece),* and a resistance range of 50 k ohm to 200 G ohm is required to measure the surface resistance in this procedure.

3. Test specimens

Two sheets of cured resin with the dimensions of no less than 300 mm x 300 mm. The thickness of the specimens must be sufficient to ensure they remain self-supporting during transport and handling within the test laboratory. The test specimens must include at least one surface that is as flat as reasonably practicable for testing purposes (The use of a mould is recommended to assist in achieving this).

4. Procedure

The electrical resistance test is conducted on both sample sheets of cured resin positioned on a clean base sheet of polyurethane (or other material with resistivity not less than polyurethane). Testing is performed on:

1) supplied sample, and
2) conditioned sample at 23 °C ± 2 °C and 50 % ± 5 % humidity no less than 2 hours.

Measurements must be taken from both the upper and lower surfaces of each sheet.

5. Requirement

The mean value for the electrical resistance on both the upper and the lower surfaces of the cured material must not be greater than 300 Megaohms.

A.3 Spark Incendivity

1. Purpose

Spark incendivity testing evaluates a material's ability to create a spark with enough energy to ignite a flammable mixture, primarily to prevent explosions in industries handling combustible materials like powders or in flammable atmospheres. This testing ensures worker safety by identifying materials that can cause electrostatic discharges and become ignition sources, allowing for the selection of safer materials or proper grounding procedures.

Note: This test is adapted from IEC 61340-4-4 for materials that do not comply with surface resistivity testing (International Electrotechnical Commission, 2018).

2. Method

Samples with earthing points can be tested with or without the point connected. These items are only required to pass testing with the earth connected.

3. Test Piece

A sample between 0.1 to 0.5 m^2

4. Apparatus

1) An ignition probe and gas control equipment that meets Clause 7.2 of IEC 61340-4-4 (International Electrotechnical Commission, 2018).
2) Supplies of air and ethylene.
3) Equipment to apply a static charge to the sample in excess of 30 kV (e.g. van de Graff Generator)
4) Test stand to support the sample. Metal components must be over 100 mm away from the sample.

5. Procedure

The procedure must be as follows:

1) Hang the test piece from the support stand. Items that are designed to be earthed in normal use must be earthed. Items that are designed not to be earthed in normal use must not be earthed.
2) Apply an electric charge to the sample.
3) Apply gas to the probe for 30 seconds and move the probe to approach the sample at a rate of approximately 0.75 m/s until it touches the sample.
4) Where the gas ignites, the test is recorded as an ignition and failure.

5) Repeat the test:
    i. 50 times each side of a flat sample, or
    i. a total of 100 times for other samples, or
    ii. until ignition occurs.

6. Requirements

There must be no ignition.

A.4 Fire resistance

A.4.1 Method

1. Principle

Blocks of cured resin are positioned on a piece of cement sheeting with a circular hole 50 mm in diameter. Each block is tested by the direct application, through the hole, of the flame from a standard LPG burner, which has been adjusted to 1000 °C +/- 50 °C. A series of increasing flame times is used.

2. Apparatus

1) LPG of at least 95 % purity
2) LPG burner of diameter 11 mm
3) Stand for supporting the cement sheet
4) Stopwatch/timer

3. Test specimens

Six (6) cured resin samples are in the form of 50 mm x 50 mm x 50 mm blocks.

4. Procedure

1) The test block of cured resin is positioned across the hole on the cement sheet.
2) The LPG burner is lit, and the flame is checked by a digital thermometer and adjusted to ensure the flame temperature is 1000 °C +/- 50 °C.
3) The burner is positioned perpendicularly underneath the test block.
4) The burner flame is allowed to impinge on the test block for an initial period of 20 seconds and then withdrawn.
5) Observe any flame and/or glowing after the burner has been removed.
6) Observe any smoke, particularly the colour.
7) Determine the persistence of flame, glow and smoke.
8) Repeat, using a burner flame application time of 60 seconds.

9) Repeat steps 1 to 8 for a further 5 test blocks.
10) Average the persistence of flame, glow and smoke after the burner is removed.

Note of caution:
The products of combustion may be highly toxic, and extreme care must be taken to prevent the inhalation of fumes.

A prime area of concern is the testing of PUR containing isocyanates, usually in the form MDI (biphenylmethane-4, -4-disocyanate). No testing will be undertaken on resins containing TDI (toluene diisocyanate), because of the extreme toxicity of this component, prohibits its use in coal mines and reclaim tunnels in coal mines. In any case, fire testing must be conducted in a fume cupboard with sufficient draught and ventilation to quickly remove any vapours.

5. Report

The following information must be reported:

1) Whether burning occurred and, if extensive, emphasise:
    a. the colour of smoke, if any
    b. the average persistence time for flame, glow and smoke.

6. Requirement

The material will fail if any of the following occurs:

1) After exposure of 20 seconds, the mean persistence time of the flame or glow is >10 seconds.
2) After exposure of 60 seconds, the mean persistence time of the flame or glow is >30 seconds.

A.5 Fire propagation

A.5.1 Method

1. Principle

A test strip of cured resin is held vertically and tested by the application of the flame from an LPG burner. The burner is adjusted to 1000 °C +/- 50 °C.

2. Apparatus

1) LPG burner of diameter 11 mm
2) Stand for supporting the test strips
3) Stopwatch/timer
4) LPG gas of at least 95 % purity

3. Test specimens

Six (6) cured resin samples are in the form of 150 mm x 13 mm x 13 mm strips.

4. Procedure

1) The test strip is held vertically at one end by a clamp.
2) The LPG burner is lit. The flame temperature is checked with a digital thermometer and adjusted to 1000 °C +/- 50 °C.
3) Position the burner perpendicularly underneath the vertical test strip.
4) The burner flame is allowed to impinge on the test strip for a minimum period of 10 seconds and then withdrawn.
5) Observe any flame or glowing and the extent of melting of the material.
6) Determine the persistence of flame and glow after the burner removal.
7) Repeat steps 1 to 6 using a burner flame application time of 20 seconds.
8) Repeat steps 1 to 7 for the other 5 strips.
9) Average the persistence time of flame, glow and the amount melted by the flame, after the removal of the flame.

Note of caution:
As with the flame resistance test, extreme care must be taken to prevent the inhalation of any fume.

5. Report

The following information must be reported:

1) Whether burning occurred and, if extensive, emphasise:
    a. The average persistence time for flame, glow and smoke.
    b. The average amount (%) of material consumed/melted.

6. Requirement

The material will fail if any of the following occur:

1) After a 20 second exposure, the mean persistence time of flame or glow >10 seconds.
2) After an exposure time of 20 seconds, the material has been completely consumed.

A.6 Flash point

1. Principle

The flashpoint of each component of the resin mixture is determined in accordance with AS 2106.2-2005 Rec:2016 Methods for the determination of the flash point of flammable liquids (closed cup) - Part 2: Determination of flash point - Pensky-Martens closed cup method (Standards Australia, 2005).

2. Procedure

Each component of the resin is tested in duplicate.

3. Requirement

Each component of the resin must have a flashpoint >38 °C.

A.7 Oxygen index

1. Method

The test method followed is ISO 4589-2:2017 (International Organization for Standardization, 2017)

From page 2 of the method, the following definition applies:

Oxygen index: The minimum concentration of oxygen by volume percentage, in a mixture of oxygen and nitrogen introduced at 23 °C +/- 2 °C that will just support combustion of a material under specified test conditions.

2. Test specimens

A minimum of twenty (20) strips of cured resin of dimensions 150 mm x 13 mm x 13 mm.

3. Requirement

The oxygen index of any polymeric material proposed for use in coal mines must be at least 28 %.

A.8 Chemical characterisation of components

1. Principle

The chemical nature of the components is examined by Fourier-transform infrared (FTIR) spectroscopy to:

1) Detect the presence of toluene diisocyanate (TDI), or any other substance prohibited for use/storage at coal mines.
2) Establish a reference library of any liquids proposed for said mines.

Note: This test is **only** required for isocyanate-based resins and foams. This includes single use systems.

2. Apparatus

FTIR spectrometer

3. Procedure

As per equipment manual.

4. Requirement

Typical example: Any substance used/stored at a coal mine must not contain any isocyanate in the form of TDI.

A.9 Spread of flame test *(Cavity and Surface applied products)*

A.9.1 EN 12881.1:2015 Method C

1. Principle

A test strip of cured resin is held horizontally and tested by the application of the flame from a Propane burner consisting of 6x 3 kW type 1 burners. The burner gas flow rate is adjusted to 565 ± 10 g over 50 minutes with a test chamber air speed of 1.0 ± 0.05 ms−1.

Ambient laboratory temperature to be 24°C +/- 2 °C

2. Test specimens

3 samples of cured resin with dimensions 1500 ± 2 mm x 220 ± 2 mm x 50 ± 2 mm.

3. Procedure

1) Weigh the propane gas bottle prior to the test.
2) Set the air velocity to 1.0 ± 0.05 m/s using the anemometer.
3) Record the temperature of the exhaust air for between 2 min and 5 min to give a measure of the ambient air temperature.
4) Set the gas flow to approximately 350 l/h and light the burner. Start the timer. Adjust the gas flow to 345 ± 5 l/h. Record the maximum and minimum temperature of the flame across the 6 burners, at the height where the sample will be positioned during the test.
5) After 50 minutes, turn off the gas to the burner and allow the test piece and trestle to cool. Terminate the test early if the extent of the fire appears to be a danger to persons or equipment.
6) Re-weigh the gas bottle at the end of the test and confirm that the mass of gas consumed during the test is equivalent to 565 ± 10 g over 50 minutes. If it is not, adjust the flow rate accordingly and repeat the test.
7) Remove all product remaining on the trestle and allow it to cool to ambient temperature. Detach any friable material and weigh the belting.

4. Termination of tests

- Normal termination

A test will be terminated, and will be deemed to be terminated normally, when a period of at least 10 minutes has elapsed after all flaming and glowing on the test piece and debris has ceased.

- Premature termination

Any test terminated for safety reasons must be deemed to be terminated prematurely and must be recorded on the test report as 'test terminated prematurely.

5. Measurements of damage to test pieces

1) Length of the sample undamaged
2) Length of sample consumed by mass (measure sample mass before and after testing)
3) Maximum temperature rise over ambient

6. Requirement

Test report in compliance with EN 12881.1:2015 for consideration and to be read in conjunction with test results from testing conducted in Appendix A.4 and A.5 of the RS.

A product is considered to have passed if it is not fully consumed during the test and it self-extinguishes within 10 minutes from when the burner flame is turned off.

A.9.2 EN 12881.1:2015 Method D

1. Principle

A test strip of cured resin is held horizontally and tested by the application of the flame from a Propane burner. The burner is adjusted to 950 °C +/- 10 °C with a test chamber air speed of 0.5 ± 0.1 ms−1.

Ambient laboratory temperature to be 24°C +/- 2 °C.

2. Test specimens

5 samples of cured resin with dimensions 1200 ± 2 mm x 120 ± 2 mm x 50 ± 2 mm conditioned at 20 °C +/- 5 °C for a minimum of 24 hours.

3. Procedure

1) Before starting each individual test, the empty test chamber must be adjusted so that the appropriate temperature of the wall is obtained. The ambient temperature must also be measured.
2) Set the air velocity in the test chamber to 0.5 ± 0.1 ms−1 using an anemometer; this setting is not changed for the duration of the test.
3) Remove the burner from the test chamber, set the required gas flow and ignite. Adjust the supply of air to the burner such that the yellow edge to the flame disappears and the blue cone is approximately 10 mm. The temperature 40 mm above the centre point of the ceramic sieve must be measured.
4) Reposition the burner beneath the test sample for 15 minutes, after which the burner must be removed and the test piece and trestle allowed to cool. Terminate the test early if the extent of the fire appears to be a danger to persons or equipment.

4. Termination of tests

- Normal termination

A test will be terminated, and will be deemed to be terminated normally, when a period of at least 5 minutes has elapsed after all flaming and glowing on the test piece and debris has ceased.

- Premature termination

Any test terminated for safety reasons must be deemed to be terminated prematurely and must be recorded on the test report as 'test terminated prematurely.

5. Measurements of damage to test pieces

1) Minimum length of sample undamaged for each test piece
2) Mean Length of samples undamaged from the five tests

6. Requirement

Test report in compliance with EN 12881.1:2015 for consideration and to be read in conjunction with test results from testing conducted in Appendix A.4 and A.5 of the RS.

A product is considered to have passed if it is not fully consumed during the test and it self-extinguishes within 5 minutes from when the burner flame is turned off.

A.10 Microchamber head space test for airborne contaminants

1. Principal

All polymeric chemical products must be tested to identify potential airborne contaminants that may be released and contribute to an inhalation exposure risk during application.

The head space immediately above the product(s) including any separate components, must be sampled and analysed using the micro-scale chamber test method.

The purpose of this testing is to identify contaminants released at concentrations which may potentially exceed the action level recommended for good occupational hygiene practice (50% of the WEL), and to inform a review of exposure control effectiveness.

Note. Concentrations of contaminants measured in the head space above products using this test method, are not representative of concentrations in ambient air, and cannot be interpreted or used for the purpose of assessing occupational exposure at the mine.

2. Microchamber test method

As a minimum, the microchamber test equipment and sampling method should conform with the requirements specified in ASTM D7706-17 Rapid Screening of VOC Emissions from Products Using Micro-Scale Chambers (ASTM International, 2023).

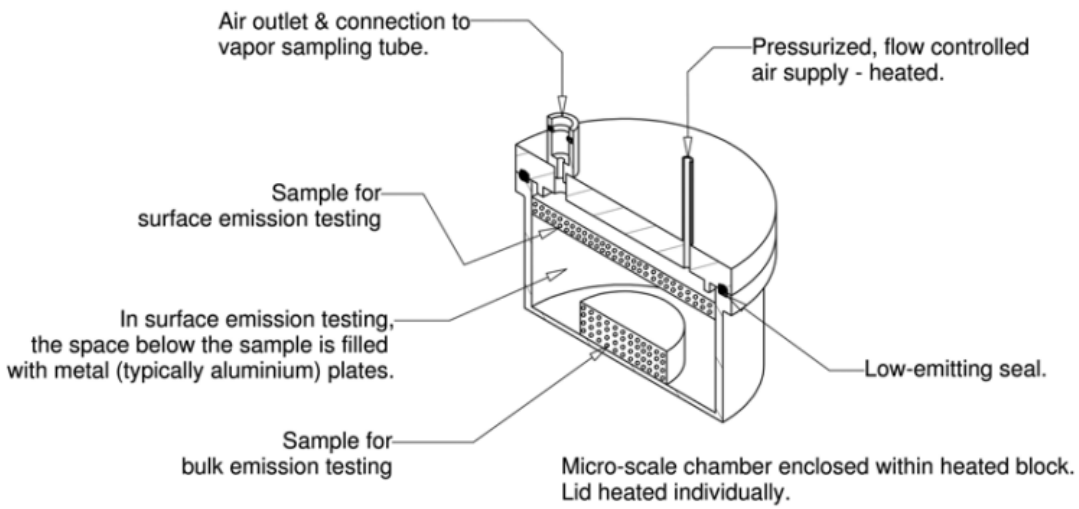


Figure 5: Typical microchamber apparatus showing key components (ASTM International, 2023)

Samples should be drawn from the head space chamber and directed to analytical instruments for detection and determination of mass concentration.

3. Testing Criteria

Testing must be conducted on each separate component part that is used during the products application, in the raw state before they are mixed together. Testing must also be conducted during the polymerisation reaction, by sampling immediately after the component parts are mixed together. For this test, the component parts must be mixed in the ratio at which they are designed and intended for application in coal mines.

The minimum testing parameters for each product have been summarised in Table 10 below.

- Three (3x) separate repeat tests are to be conducted for each condition and product component(s).

Table 10: Sample and analysis testing parameters

Test Conditions	Raw product (Unreacted) Part A	Raw product (Unreacted) Part B	Polymerisation (Mixed Products) Part A & Part B	
Temperature (°C)	30	30	30	30
Time (mins)	0 - 60	0 - 60	1 - 5	30 – 60
Analysis	Polyurethane & Urea silicate products: VOC + Isocyanates +SDS[1]			

Test Conditions	Raw product (Unreacted) Part A	Raw product (Unreacted) Part B	Polymerisation (Mixed Products) Part A & Part B
	Phenolic resin products: VOC + Aldehydes & ketones + SDS[1]		
	Other products: VOC + SDS[1]		

Note[1]. Analysis of contaminants listed as hazardous ingredients in the product SDS.

4. Sample Analysis

Samples should be analysed using national/international methods for analysis applicable to the contaminants of interest. Methods applicable to the typical contaminants identified in polymeric chemical products are summarised in Table 11.

The concentration of contaminants detected must be calculated as the arithmetic average of concentrations measured for the three (3) repeat tests that are within +/- 20%.

Table 11: Analytical methods

Contaminant	Analytical method
Isocyanates	ISO 17734-1:2026 Determination of organonitrogen compounds in air using liquid chromatography and mass spectrometry Part 1: Isocyanates using dibutylamine derivatives (or equivalent) (International Organization for Standardization, 2026)
Aldehydes	NIOSH 2016 Formaldehyde (National Institute for Occupational Safety and Health, 2016) & NIOSH 2018 Aliphatic Aldehydes (or equivalent) (National Institute for Occupational Safety and Health, 2018)
VOCs (screen)	NIOSH 2549 Volatile Organic Compounds Screening (or equivalent)

For other contaminants not included in Table 11, refer to published analytical methods including but not limited to the following:

- UK HSE - ‘Methods for the Determination of Hazardous Substances (MDHS);
- OSHA – ‘Sampling and Analytical Methods’; or
- NIOSH – ‘Manual of Analytical Methods’ (NMAM).

5. Reporting

The following information must be reported.

Where the average concentration of a contaminant measured in the microchamber tests, is equal to or greater than 50% of the contaminant WEL:

- The contaminant name and mass concentrations detected;
- The corresponding product, component, and test conditions; and
- The WEL for the contaminant.

6. Periodic review

The analysis results of testing and the requirements to report these, should be reviewed when the WEL changes, for any contaminants detected in the micro chamber testing.

Product testing must be repeated at a minimum of 5 yearly intervals, and scheduled to align with the review of license testing, or earlier if the following occurs:

- The composition and/or list of hazardous ingredients in the product changes significantly;
- New ingredients are added; or
- The ratio of mixing changes.

A.11 Mechanical characteristics

Testing for the mechanical characteristics of the polymeric chemicals must include the following;

- Compressive Strength (MPa).
- Modulus of Elasticity (GPa).
- Tensile Strength (MPa).
- Flexural Strength (MPa).
- Shear Strength (MPa).
- Adhesive or Bond Strength (MPa).
- Viscosity (for pumping distance and migration of the product into the fissures).
- Foam Factor (ratio of starting volume to final volume – for economic and pressure of injection reasons).

The following testing methodologies (or similar via gap analysis) must be used;

- Unconfined Compressive Strength (UCS) (MPa)
- Modulus of Elasticity (GPa) by AS 4133.4.3.2:2013.
- Indirect Tensile Strength/Brazilian Test (MPa) by AS 1012.10-2000
- Flexural Strength/Modulus of Rupture (MPa) based on ASTM C78-02 / AS 1012.11-2000.
- Adhesive or Bond Strength (MPa) by ASTM D4541-22
- Density by AS 4133.2.1.2-2005.
- Fracture Toughness – by ASTM E1820 (For polymerics of sprayed-on liner application only)

This information needs to be considered by the Geotechnical engineer at the mine when designing the polymeric application plan.

Appendix B: Testing criteria interpretation table

Table 12: Testing criteria interpretation table

Test	Pass Criteria	Remarks
A.1.1 Small Scale Method	Exothermic temperature < 150 °C	Products that do not meet the pass criteria must not be used.
A.1.2 Large Scale Method - Injectables	Exothermic temperature < 150 °C	Products that do not meet the pass criteria must not be used.
A.1.3 Large Scale Method – Cavity Fill	Exothermic temperature < 150 °C	Products that do not meet the pass criteria must not be used.
A.2 Electrical resistance	Mean value on both the upper and lower surfaces of the cured material < 300 Megohms	Informative only. Consideration must be given to assess the risk for static build-up and ensure materials are suitable for use in the application environment, preventing potential fires or explosions. Refer to RS01: Underground electrical equipment and electrical installations Section 4.20 The Control of Undesirable Static Electricity (Resources Safety and Health Queensland, 2024).
A.3 Spark Incendivity	No ignition observed	Informative only. Consideration must be given to assess the risk for static build-up and ensure materials are suitable for use in the application environment, preventing potential fires or explosions. Refer to RS01 Section 4.20 The Control of Undesirable Static Electricity (Resources Safety and Health Queensland, 2024).
A.4 Fire resistance	After exposure of 20 seconds, the mean persistence time of the flame or glow <10 seconds. After exposure of 60 seconds, the mean persistence time of the flame or glow <30 seconds	Products that do not meet the pass criteria must not be used.
A.5 Fire propagation	After a 20 second exposure, the mean persistence time of flame or glow <10 seconds. After an exposure time of 20 seconds, the material has not been completely consumed.	Products that do not meet the pass criteria must not be used.

Test	Pass Criteria	Remarks
A.6 Flash point	Each component of the resin must have a flashpoint >38 °C	Products that do not meet the pass criteria must not be used.
A.7 Oxygen index	Oxygen index of any polymeric material must be at least 28 %.	Products that do not meet the pass criteria must not be used.
A.8 Chemical characterisation of components	Any polymeric chemical component does not contain isocyanate in the form of toluene diisocyanate (TDI).	Products that do not meet the pass criteria must not be used.
A.9.1 EN 12881.1:2015 Method C *Cavity and surface applied products only*	If the sample is not consumed during testing and it self-extinguishes within 10 minutes from when the burner flame is turned off.	For Cavity and Surface applied products: informative only for guidance to manage application risk
A.9.2 EN 12881.1:2015 Method D *Cavity and surface applied products only*	If the sample is not consumed during testing and it self-extinguishes within 5 minutes from when the burner flame is turned off.	For Cavity and Surface applied products: informative only for guidance to manage application risk
A.10 Micro chamber head space test for airborne contaminants	Where microchamber monitoring detects contaminant concentrations in the headspace above 50% of the WEL, additional atmospheric and biological monitoring requirements apply.	Additional atmospheric monitoring must be conducted for those products, where microchamber testing identifies contaminant concentrations in the head space above the product surface, exceed 50% of the WEL, and published validated methods for sampling and analysis are available. Additional biological monitoring must be conducted for those products, where microchamber testing identifies contaminant concentrations in the head space above the product surface, exceed 50% of WEL, and there are published validated methods available for detecting the relevant metabolite(s) in biological samples.
A.11 Mechanical characteristics	-	Informative only for Geotech design

Appendix C: Atmospheric monitoring

1. Purpose and Background

This appendix provides guidance to Occupational Hygienists for assessing the level of airborne emissions and the potential for exposures during polymeric chemical applications in the underground environment.

This includes both personal exposure and fixed position (static) monitoring.

2. Target Contaminants

Different classes of polymeric chemicals will contain different chemical ingredients of interest. These ingredients represent different exposure risks and each require specific sampling collection media and analysis methods.

Polyurethanes (PUR) & Urea Silicate Resins (USR)

These products include injectable resins, spray linings and single use foaming systems. The principal target contaminant in this class of product are the isocyanates species, specifically methylene diphenyl diisocyanate (MDI). Sampling methods must be capable of detecting and reporting:

- Methylene diphenyl diisocyanate (MDI) - (primary monomer 4,4-MDI),
- MDI prepolymers (MDI trimer and MDI tetramer),
- Toluene diisocyanate (TDI),
- Phenyl-isocyanate, (present in trace amounts as a contaminant)
- Methyl-isocyanate (present in trace amounts as a contaminant).

Note: Toluene diisocyanate (TDI) is prohibited from being used in polymeric chemical formulations. Chemical characterisation testing required under Appendix A, specifically screens for TDI. If airborne assessment detects TDI during analysis, this should be closely investigated.

Isocyanates **must** be sampled using the ASSET EZ4NCO Dry Sampler supplied by Sigma Aldrich and analysed by SGS Australia (Melbourne laboratory). This methodology must be used for the following reasons :

- This is the only method currently recognised and readily available that reliably identifies phenyl isocyanate and methyl isocyanate in personal air monitoring samples,
- The range of analytes quantitated by the method,
- The ability of the method to differentiate and separately report MDI monomers and pre-polymers,
- Low limit of reporting.
- Report individual concentration of each isocyanate (as NCO) and combined total concentration of isocyanates (total NCO).

The sampling technician will need to consider the anticipated task duration and make adjustments to sample flow rate and run time, in order to collect the minimum volume required for analysis, when formulating the sample plan.

Phenolic resins and foams

These products include cavity filling foams and injectable resins. The principal target contaminants in this form of product are phenol (benzenol/carbolic acid/hydroxybenzene) and formaldehyde.

There are multiple recognised and validated methods available for the collection of these contaminants. Examples include:

- NIOSH 2016, NIOSH 2541 - Formaldehyde
- USEPA TO5 – Aldehydes and ketones
- NIOSH 2539 – Aldehydes Screening
- OSHA 32 – Phenol & Cresol

3. Sample handling and transportation requirements

The handling, shipping and transportation requirements specified in the sample method for specific contaminants should be reviewed and verified with the laboratory conducting the analysis, to ensure sample integrity is not compromised. For example, when sampling for Formaldehyde using NIOSH 2016, caps must be placed on the cartridge, and they must be shipped on ice. Whereas when sampling for formaldehyde using NIOSH 2541, routine handling and shipping is all that is required.

4. Reporting

The recording and reporting of airborne monitoring results should include the following information as a minimum.

Task/process Information

- Task being performed by applicators,
- Location in the mine,
- Copy of the Applicator's application report,
- Chemical delivery system (i.e., 20L drums or IBC),
- Environmental monitoring:
  - Ventilation (velocity and quantity)
  - Temperature (wet bulb + dry bulb)
- Observations by OH Technician regarding:
  - Specific type of PPE used by workers (i.e., RPE type, glove type, suit type etc),
  - Worker compliance with PPE protocols, including respiratory and skin protection,
  - Spillage/leakage/backflow/hose damage at both the pump and the injection point,
  - The extent of potential for worker skin contamination.
- Position of static sample locations, sampler distance from injection point etc

Sample & Analysis Information

- Names of hygienist and sampling technicians
- Sampling and analytical deviations from this sampling protocol (i.e., flow rate, sample duration etc)
- Details of any invalid samples and reasons for invalidation,

- Sampling and analytical methods used,
- The reporting of results must include a copy of the analysis report issued by the NATA laboratory.

5. Personal exposure monitoring to evaluate inhalation risk to workers

Personal exposure samplers must be positioned in the workers breathing zone during actual application of polymeric chemicals. This is the only process that can allow for direct comparison against the WEL.

Where contaminants can be absorbed through the skin, atmospheric monitoring is only representative of exposure via inhalation and may not be representative of the total exposure to a CMW.

Personal monitoring should include the pump operator and the nozzle operator, however other CMWs participating in the application process should also be considered, particularly those involved in the temperature monitoring and clean-up process.

Persons participating in the personal exposure monitoring for airborne contaminants should also undergo pre and post biological sampling for the target contaminant, where practicable.

6. Fixed position (static) monitoring to evaluate emissions and verify effectiveness of operational control zones (OCZ)

Collection of static location measurements at set distances inbye of the injection point (IP) or pump zone (PZ) provides a means to review and confirm the effectiveness of existing operational control zones (OCZ).

These results cannot be compared directly against the WELs but can be used to provide a qualitative estimate of the potential inhalation exposure risk at various distances.

The coal inspectorate and Queensland coal industry conducted a focused campaign of fixed position (static) sampling, to review the appropriateness of restricted access zones (RAZ) that were being applied across the industry, in accordance with the licence conditions issued by the NSW regulator, for polymeric products.

The results of this monitoring was used to inform the review of this RS including modifications to the zone boundaries. This same sampling protocol should be applied to verify the ongoing effectiveness of these control zone boundaries, in practice.

A list of typical polymeric chemical applications and guidance for the setup and positioning of fixed position (static) monitors is provided in the examples below and represented in figure 6,7,8,9,10.

6.1 Void Filling

Conditions:

The polymeric injection point remains in a static location for the duration of the sampling.

Example situations:

- Longwall face cavity fill (see Figure 8) **Note**: Where ventilation is homotropal belt road, a third array of static samples are to be collected at locations ‘G’ & ‘H’ at a distance of 10 m from the pump,
- PUR/USR Seal consolidation/lining (see Figure 9).

Sampling at distances of 10m and 30m on the return side (downwind) from the emission source (nozzle).

Sampling array to be at head height (approx. 1.6 to 1.7m).

Sampling array to be at 3 positions – middle of passageway and samples either side at ½-way between middle of passage and sidewall.

6.2 Resin injection – Movement MG to TG

Conditions:

- Movement sequence of injection holes is with the air flow and towards sampling static sampling array.
- No more than 10m of movement in a period of approximately 1hr.

Example situations:

- Longwall face injection (see Figure 6). **Note**: Where ventilation is homotropal belt road, a third array of static samples are to be collected at locations 'G' & 'H' at a distance of 10m from the pump.
- PUR/USR Seal consolidation/Lining (see Figure 9)

Sampling at distances of 10m and 30m on the return side (downwind) from the initial position of the emission source (nozzle).

Sampling array to be at head height (approx. 1.7m)

Sampling array to be at 3 positions – middle of passageway and samples either side at ½-way between middle of passage and sidewall.

6.3 Resin injection – Movement TG to MG

Conditions:

- Movement sequence of injection holes is towards the air flow and away from sampling static sampling array
- No more than 10m of movement in a period of approximately 1 hr)

Example situations:

- Longwall face injection (see Figure 7) **Note**: Where ventilation is homotropal belt road, a third array of static samples are to be collected at locations 'G' & 'H' at a distance of 10 m from the pump.
- Longwall pre-consolidation (see Figure 10).

Sampling at distances of 10m and 30m downwind from initial position of the emission source (nozzle)

Sampling array to be at head height (approx. 1.6 to 1.7m)

Sampling array to be at 3 positions – middle of passageway and samples either side at ½-way between middle of passage and sidewall.

6.4 Spray Seal Lining/Resin Injection for Seal Consolidation

Conditions: Limited movement of the application point for the duration of the sampling.

Example situation - PUR/USR seal consolidation/seal lining (see Figure 9)

Sampling at distances of 10m and 30m 'inbye/ downwind' from the emission source (nozzle)

Sampling array to be at head height (approx. 1.6m to 1.7m)

Sampling array to be at 3 positions – middle of passageway and samples either side at ½-way between middle of passage and sidewall.

6.5 Diagrams showing sample locations for fixed position (static) monitoring

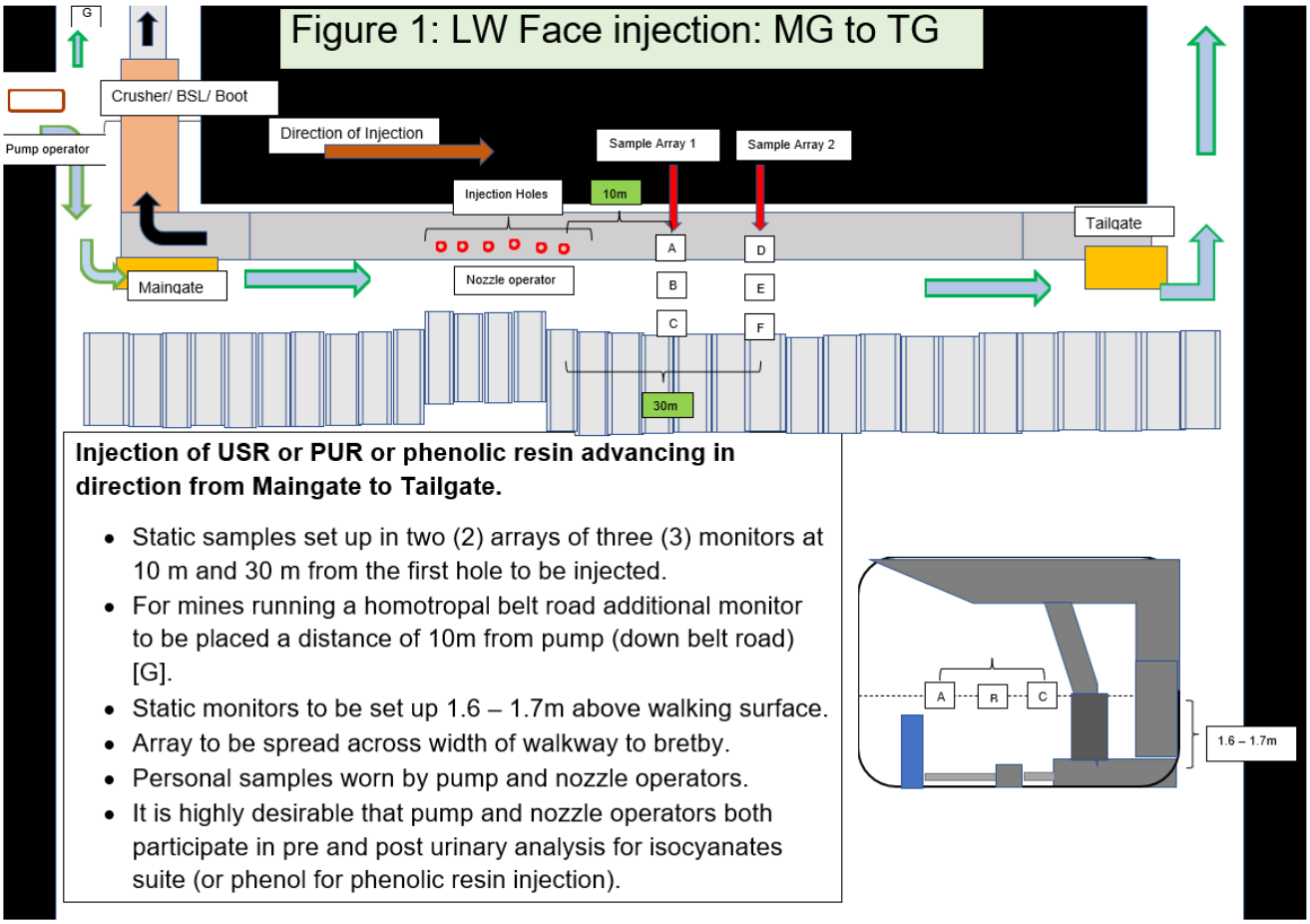


Figure 6: Example fixed position (static) monitoring: LW Face injection: MG to TG

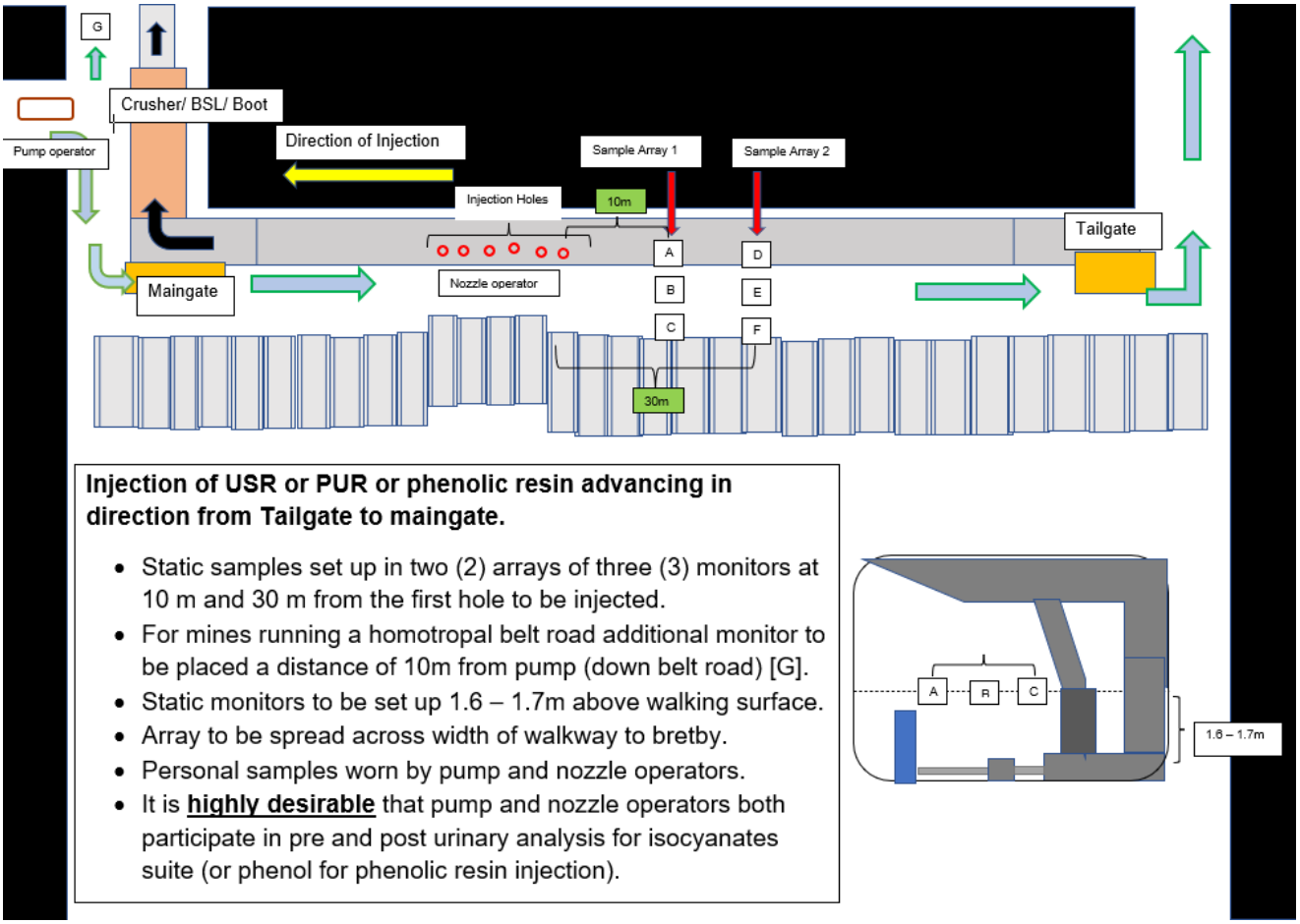


Figure 7: Example fixed position (static) monitoring: LW Face injection: TG to MG

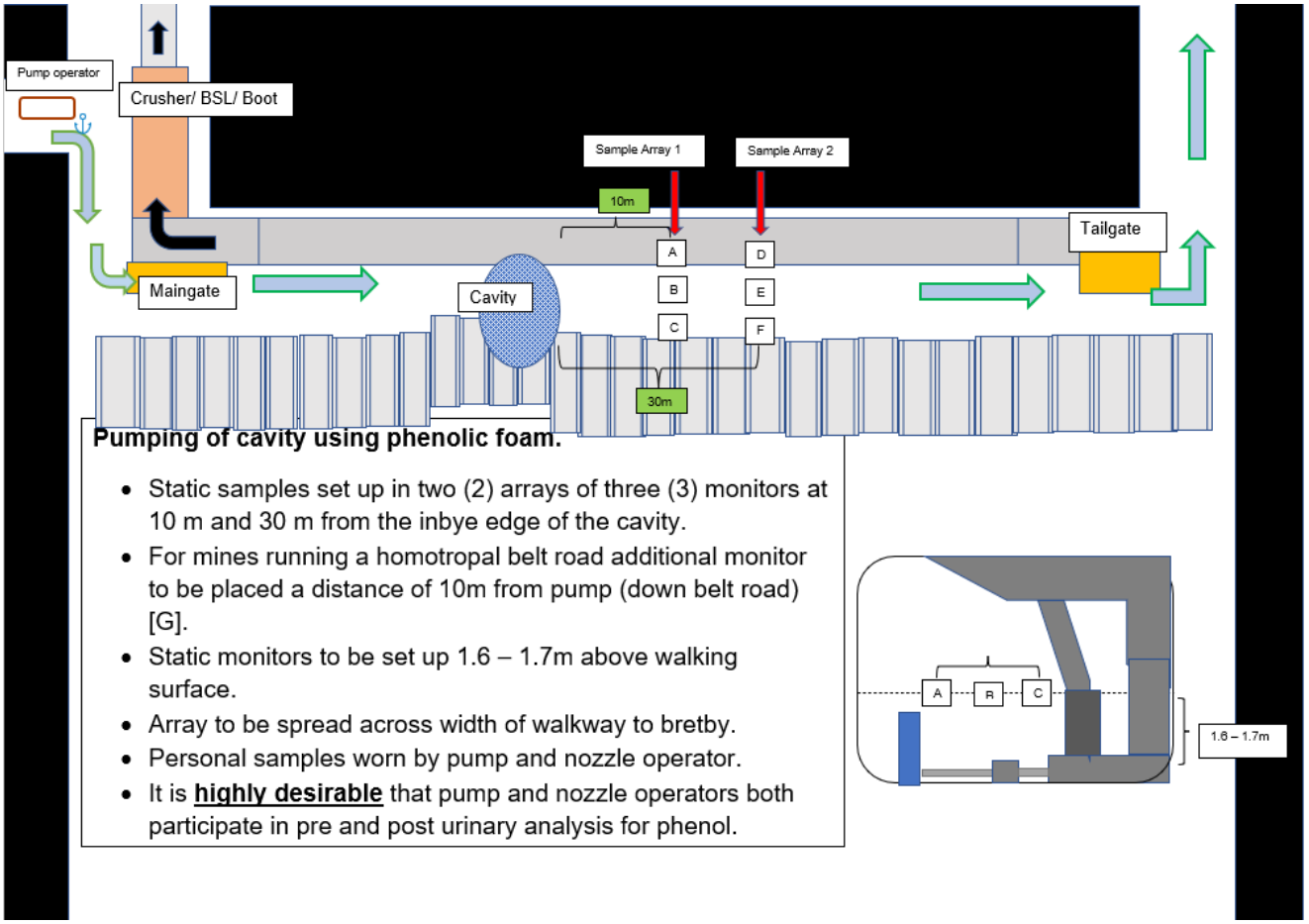
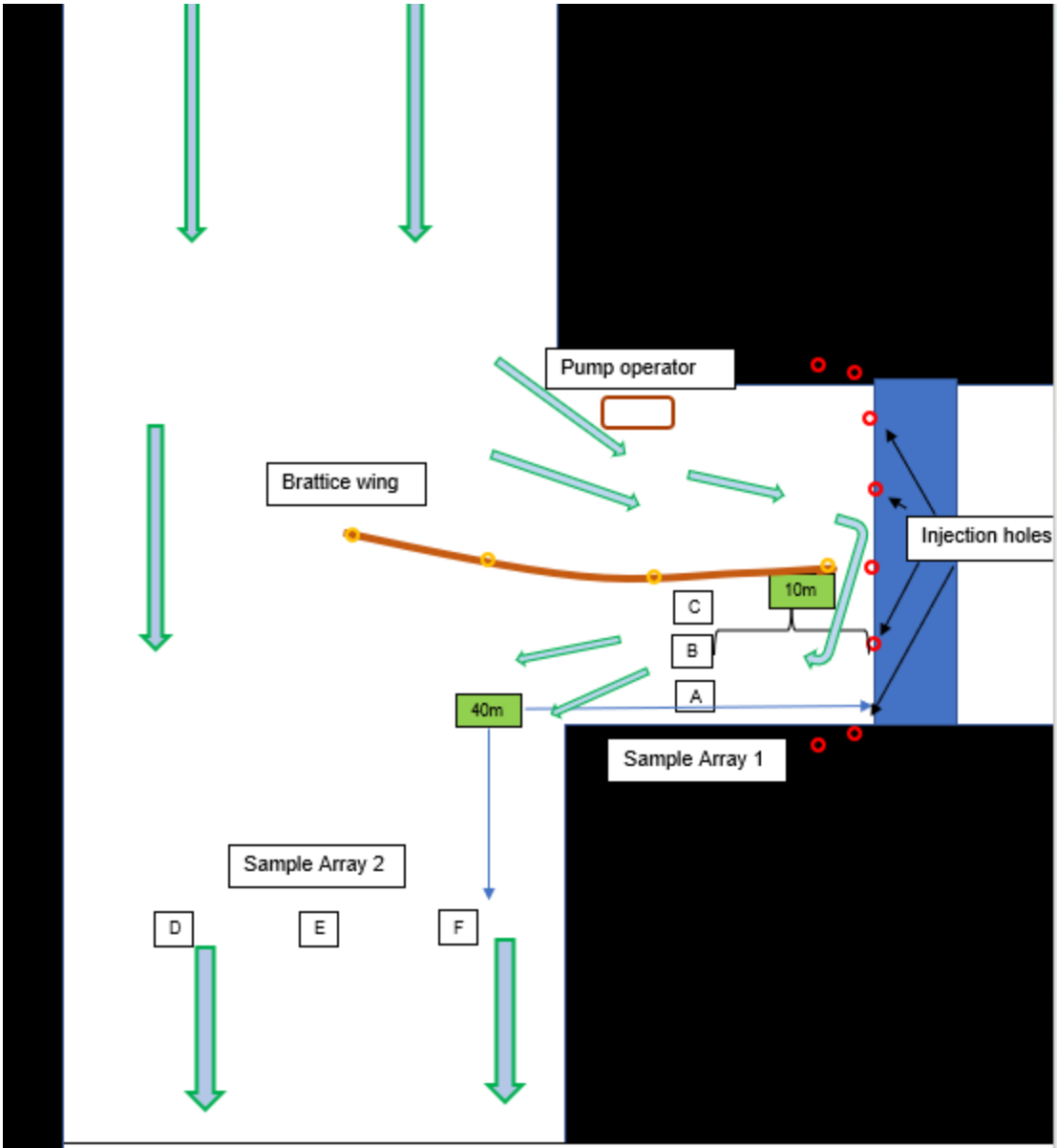


Figure 8: Example fixed position (static) monitoring: LW Face cavity fill



Seal consolidation (USR or PUR) / lining (USR).

- Static samples set up in two (2) arrays of three (3) monitors at 10 m and 30 m from the inbye edge of the cavity.
- Static monitors to be set up **1.6** m above ground level
- Personal samples worn by pump and nozzle operators.
- It is **highly desirable** that pump and operators both participate in pre and post urinary analysis for isocyanate suite.

Figure 9: Example fixed position (static) monitoring: PUR/USR seal consolidation/lining

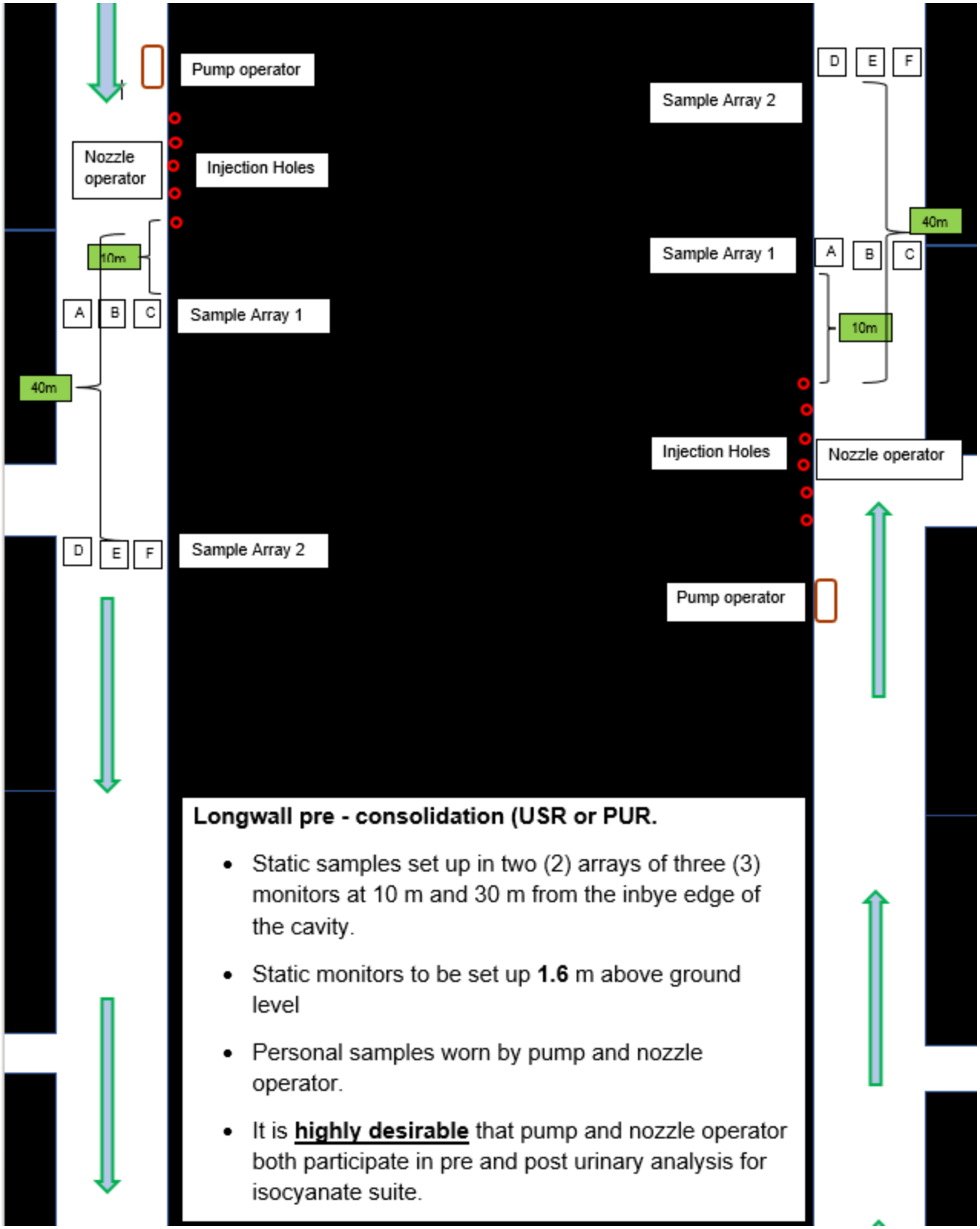


Figure 10: Example fixed position (static) monitoring: LW Face pre-consolidation USR/PUR

Appendix D: Exothermic hazard considerations

Table 13 provides guidance for matters to be considered when analysing and assessing the risk of an exothermic reaction creating an unwanted thermal event with coal or polymeric chemical creating a potential ignition source or combustion event.

The points listed in the Table 13 were developed by an industry polymeric chemical working group applying a hazard analysis process. The information contained in Table 13 should not be considered an absolute list of potential risks and the mines risk management process must consider any additional risks relevant to their operation or otherwise known.

Table 13: Exothermic Hazard Considerations

EXOTHERMIC HAZARD CONSIDERATIONS	Considered? Yes ✓ No ✕
Exothermic Risk of Polymeric Chemical Product	
• Product has unacceptable exothermic properties	
o Product not designed for coal application	
o Products chemical properties have changed	
o Chemical applied in a way that does not suit a coal mine	
o Not effectively tested for its exothermic risk	
➢ The current testing process isn't representative of the actual application	
➢ Testing process does not test variable volumes	
➢ True temperature decay time may not be representative	
➢ Product not tested in conjunction with coal	
Competence and Quality Assurance of Polymeric Chemical Applicator	**Considered? Yes ✓ No ✕**
• The polymeric chemical applicator does not have the appropriate competence systems in place	
• Applicator does not have the competence to apply and manage risk of product	
• Insufficient numbers of competent persons to safety apply	
• Applicators have no quality assurance process to apply system processes	
• Applicators competencies are not maintained	
Integration of Supplier and Applicator SHMS (Safety and Health Management System)	**Considered? Yes ✓ No ✕**
• Polymeric Chemical supplier and applicators SHMS is not effectively integrated into the mines SHMS.	
Unacceptable pooling and disproportionate accumulations of polymeric products	**Considered? Yes ✓ No ✕**
• The technical skills and knowledge of the appointed RPEQ Geotechnical Engineer relevant to polymeric chemical application and exothermic risks of proposed products.	
• Appropriateness of polymeric chemical product selection for type of application not appropriately considered e.g.,	
o Product being applied adjacent to goaf and will enter the goaf.	
o Product application in areas where large splays and cavities exist and loss of control of product	
• The exothermic risk profile of the polymeric chemical products i.e.	
o Known maximum temperature of each product in the allowable maximum per hole volume	
o Known time product remains at maximum temperature in the allowable per hole volume	
o The decay rate and time for product return to test start temperature	
• Loss of control of product volumes during application e.g.	
o Ineffective monitoring and control of product quantity when pumping	
o Ineffective product ratio control	
o Potential for cross contamination of products elevating exothermic temperature.	
o Injection pressures not effectively monitored and appropriate triggers established to identify potential product pooling.	
• Inappropriate hole design not accounting for potential product migration into areas where product can accumulate. E.g.	
o Inappropriate use of generic plans for variable situations and scenarios	
o Holes designed without proper scope	
o Inadequate Geotechnical inspection leading to inappropriate hole design	
• Application of hole design or pattern is not effectively applied and does not account for potential migration into known areas where product can accumulate.	
o Ineffective monitoring and supervision of hole design application.	
o Misinterpretation of design/plan	

EXOTHERMIC HAZARD CONSIDERATIONS	Considered? Yes ✓No ✕
o Ineffective validation of plan design to actual	
o Equipment limitations or not fit for purpose	
o Design does not take into consideration face conditions change	
• Product volumes are not considered for the area or zone of influence	
o Expansion characteristics of polymeric chemical products is not considered	
o Volume not considered in conjunction with hole design. E.g. Spacing to volume ratio.	
o No consideration of exothermic risk in conjunction with volumes and holes	
o No limitation on hole density	
o No ratio of product to volume of coal and strata	
o There's misinterpretation of metrics. E.g. Litres, Kgs	
Product applied not as designed causing unacceptable exothermic reaction	**Considered? Yes ✓No ✕**
• Application process is not followed as required by the Mines SHMS	
o CMW's have Inadequate required competencies	
o Ineffective supervision due to inadequate competency	
o Equipment not appropriately maintained or used correctly	
o Failure to identify equipment malfunction	
o Using or unavailability of consumables	
o Environmental factors causing fatigue, lapses, exhaustion	
o Not adherence on procedural requirements	
o No quality assurance process of product performance	
Selection of product, not fit for purpose. E.g. Using PUR as a cavity filler and not a consolidator	**Considered? Yes ✓No ✕**
• Deliberately using the wrong product	
• Exothermic risk of product not understood for application	
o Inadequate specialist expertise around selection	
o Ineffective testing of each product	
o Ineffective introduction into the mines safety health system	
• Products not effectively assessed for their appropriate application (physical chemical properties)	
o During application product isn't effective with no identified trigger for review or change.	
o Site based risk management process doesn't effectively determine the exothermic Hazard	
• Appropriate product not available onsite leading to use of an inappropriate product.	
o Ineffective system for accessing multiple products	
o Infrequent use no access arrangements with supplier	
o Shortage of product supply	
• Shortage of storage on sites	
o Ineffective storage capability	
o Out of age stock	
o Ineffective ordering system	
Incompatible products elevating exothermic	**Considered? Yes ✓No ✕**
• Two different products inadvertently mixing during consolidation process	
o Area previously consolidated with a product but not identified it's incompatible	
o Residual water present from previous grouting activities	
o Risk of incompatible product mixing not understood	
o Parallel application of multiple products	
o Compatible components being utilised for incompatible products	
o Production pressures pressing required wait times for products to become being prior to application of other products	
o Ineffective storage and transporting system leading to delivery of incorrect product to pump site.	

EXOTHERMIC HAZARD CONSIDERATIONS **Product is not suitable for unidentified environmental risks. E.g. Water, voids**	Considered? Yes ✓No ✕
• The area of application is not sufficiently geologically mapped	
o Not inspected and assessed by Geotechnical engineer.	
o Geological hazard plan does not overlay the mine plan containing boreholes etc	
• Boreholes including UIS & SIS within the injection zone not identified	
o Not considered as part of the plan design	
o Holes not identified on polymeric application plan	
• Water introduced or remnant not identified	
o Gas drainage and other dewatering activities not considered in the design	
• Strata or geological structures and other pathways connectivity to the goaf	
o Cavities and structure adjacent to the block are not appropriately identified and mapped	
Ineffective monitoring of control effectiveness of exothermic temperatures (as required by current licencing conditions).	**Considered? Yes ✓No ✕**
• Monitoring requirements not clearly defined	
o Requirement for application of polymeric chemicals does not clearly define a method for monitoring the exothermic temperature induced	
• Temperature monitored has not occurred for a sufficient time to determine if risk is acceptable to cease monitoring and resume production	
o Temperature monitoring required time based on technical data	
o Polymeric chemicals not monitored due to perception of risk	
o Monitoring devices compromised prior to completion of monitoring period.	
o Production requirements override monitoring controls	
o Insufficient competent people to maintain monitoring	
o Monitoring equipment cannot sustain time	
• Appropriate Temperature monitoring devices are not available for use at application site	
o It hasn't been a determined or mandated requirement in SHMS	
o Unavailability of devices and types	
o Lack of awareness of appropriate temperature monitoring devices	
o Risk is not understood at the place of application	
• Parameters for exothermic monitoring not defined	
o Didn't understand the areas for monitoring. Do not understand how to monitor or the relevance of thermal runaway	
o A monitoring plan has not been developed	
o No defined metrics or tarps	
o Limitations of monitoring devices not understood for the application	
• The product does not require exothermic monitoring	
o It's not appropriately tested to see if it does require exothermic monitoring	
o Does not create unacceptable exothermic conditions	
o The risk hasn't been defined for exothermic risk. Eg maximum temperature and decay time	
• The acceptable temperature parameters for resumption of production not defined.	
o Thermal runaway risk hasn't been appropriately determined for artificial exothermic influence	
• The system for monitoring temperature is not representative of exothermic conditions	
• No defined stop point	
• Variation of mining geological conditions. Geological operating conditions. Changing the acceptable temperature parameters to resume production	
o Change in propensity coals propensity due to coal combustion	
o Identify reactive ground potential	
o Slow retreat tarps	
o Potential spontaneous combustion already occurring	
o Oxidation already in process	

EXOTHERMIC HAZARD CONSIDERATIONS	Considered? Yes ✓ No ✕
o Coal pre-condition from previous polymeric campaigns	
o Mine pressure differential impacting	
o Change of supplier and or product type	

Appendix E: Exothermic temperature monitoring device placement

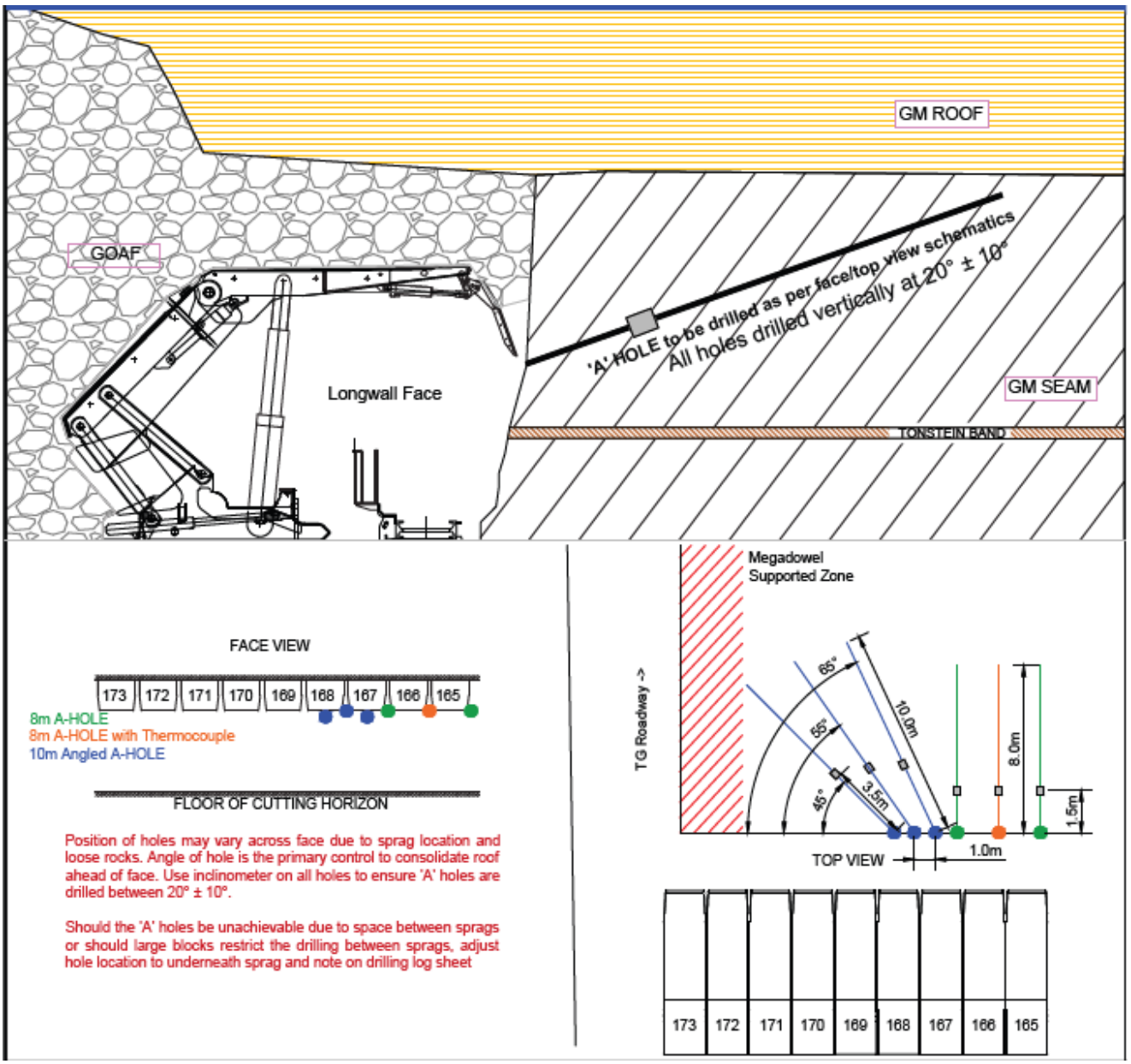


Figure 11: Example of placement of thermocouples during resin injection

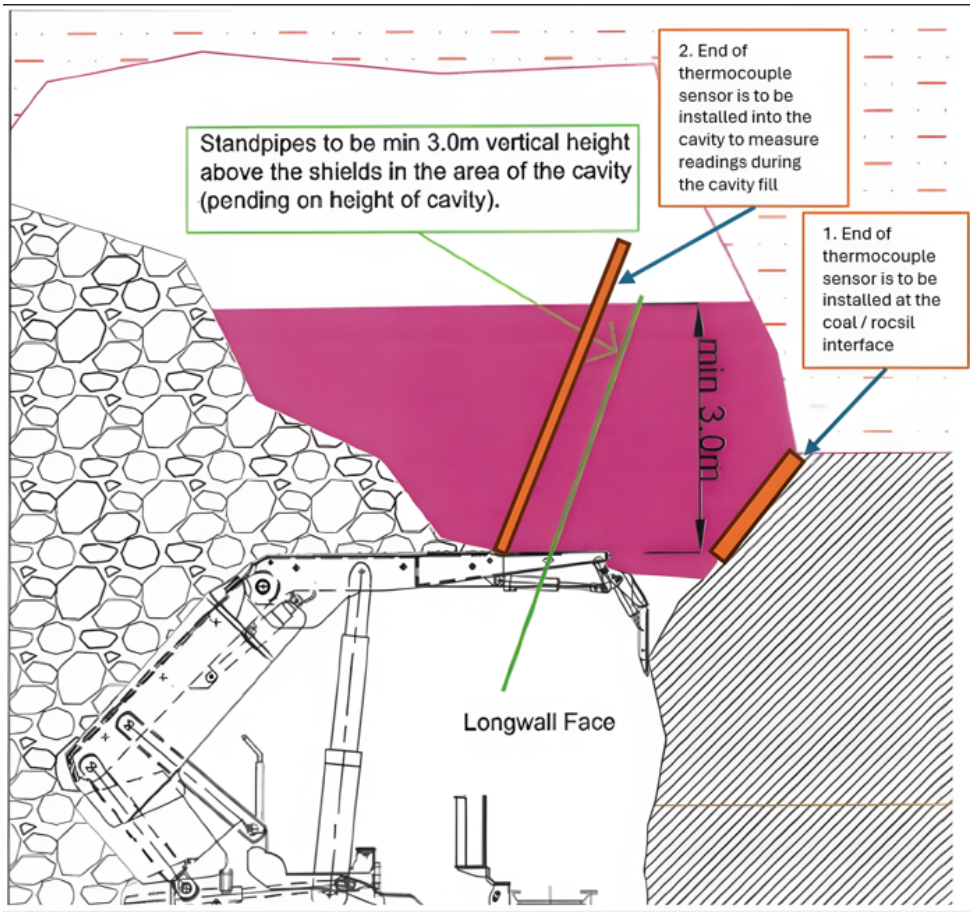


Figure 12: Example of placement of thermocouples during cavity fill application

Appendix F: Example of biological monitoring questionnaire

Employee details:					
Shift date:		Employee name:		Employee ID:	
Crew:		Company:		Days into roster:	

Polymeric chemical use:			
Product/s used:			
Location of injection:			
Reason for injection:			
Volume pumped on shift:		Shift report number:	

Employee chemical use:					
Task	Tick if task done	Start time	End time	Total time spent doing task (hrs)	Any comments on exposure? (e.g. skin contact etc)
Transporting chemicals/drums					
Injection/Nozzle operator					
IBC bulk chemical set up					
Manually decanting-tipping chemicals/drums					
Drilling holes for injection					
DAC					
Pump operator					
Pump assistant					
ERZC inspections					
Working in ZOO					
Working in RAZ					
Other:					

Additional tasks/comments:

Employee details:			
PPE use:			
Chemical overalls	Worn / Not worn	Type	
Chemical gloves	Worn / Not worn	Type	
Respirator	Disposable ½ face / re-usable ½ face / P2 / P3 / A B E	Model	
Hard hat Sweatband replaced?	Yes / No		
Please provide information requested. If unsure, please discuss with your supervisor			

1.0 Valid sample:	**(If yes, please comment below)**
Pre-shift sample provided before the start of the shift?	Yes / No
Showered before providing post-shift sample at end of shift?	Yes / No
Mid-stream urine sample provided?	Yes / No
What time were the chemical products handled during the shift?	Time:
Any exposure to polymeric chemicals offsite during the previous 24hrs? (e.g. spray painting, foam fillers, resins, 2-part mixtures etc)	Yes / No
2.0 Controls: Please comment on the following exposure controls	**(Please also provide comment)**
Zones (RAZ, ZOO, etc.) demarcated with tape/ signage?	Yes / No
Ventilation rate?	Adequate / Inadequate / N/A
Did any unusual events take place which may contribute to a higher or lower exposure than normal? (e.g. unusual conditions, activities, spill, etc)	Yes / No
Equipment failed/damaged causing spill and/or leak? (e.g. “o” rings, damaged hoses, overpressure, pump/gun nozzle fail, hose couplings etc)	Yes / No
Spillage during decanting at containers?	Yes / No
Any residual products left following spill/leak?	Yes / No
Do you believe you had contact with the products via skin exposure?	Yes / No
Do you believe you had contact with the products via inhalation?	Yes / No

Employee details: Comments on controls AND/OR additional comments

Please sign here as acknowledgement that the above information is an accurate reflection of the conditions present during the sampling period, to the best of your knowledge.

Name_____Signature_____Date_____

Appendix G: Examples of Operation Control Zones

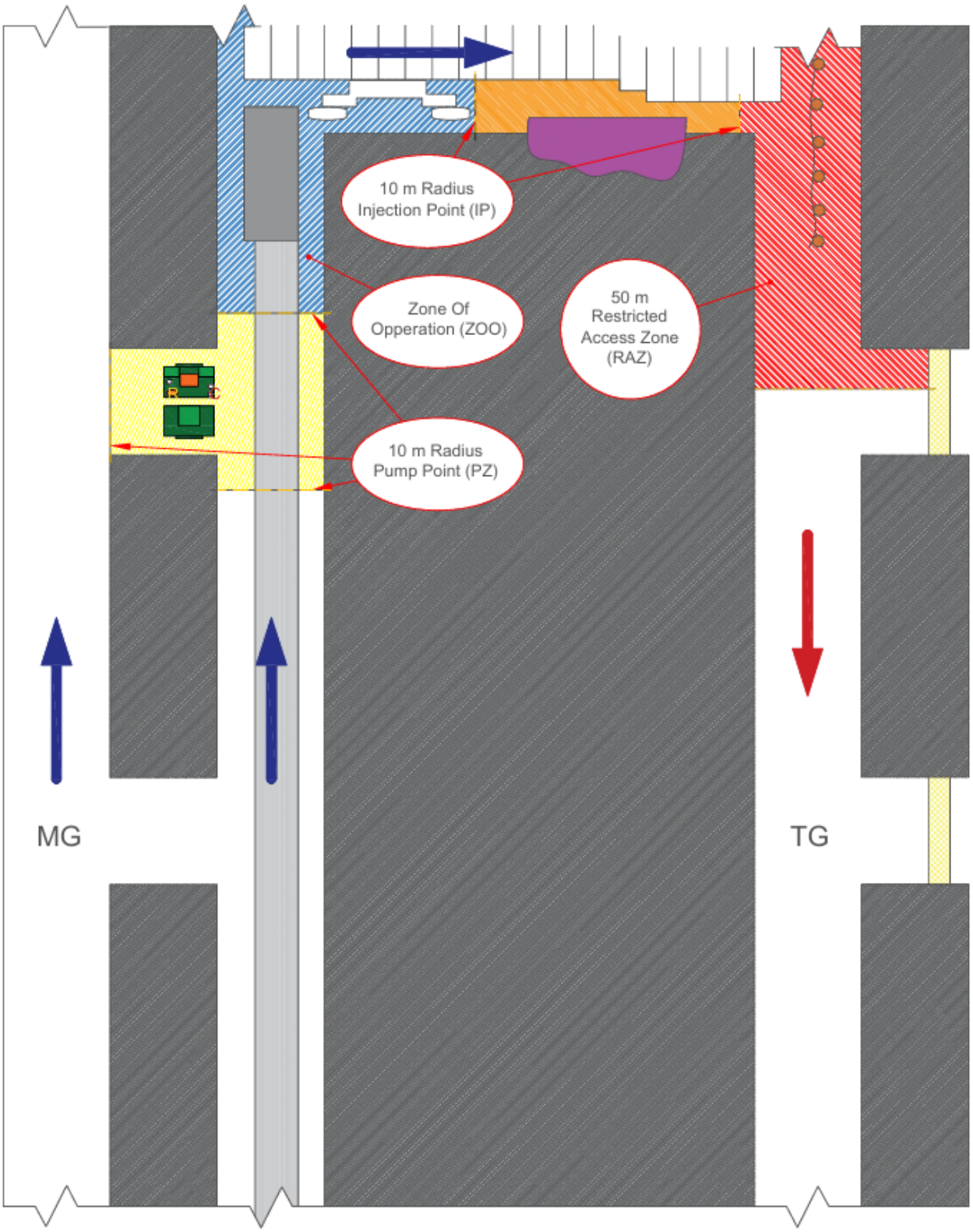


Figure 13: OCZ for pumping from the Maingate (single pump)

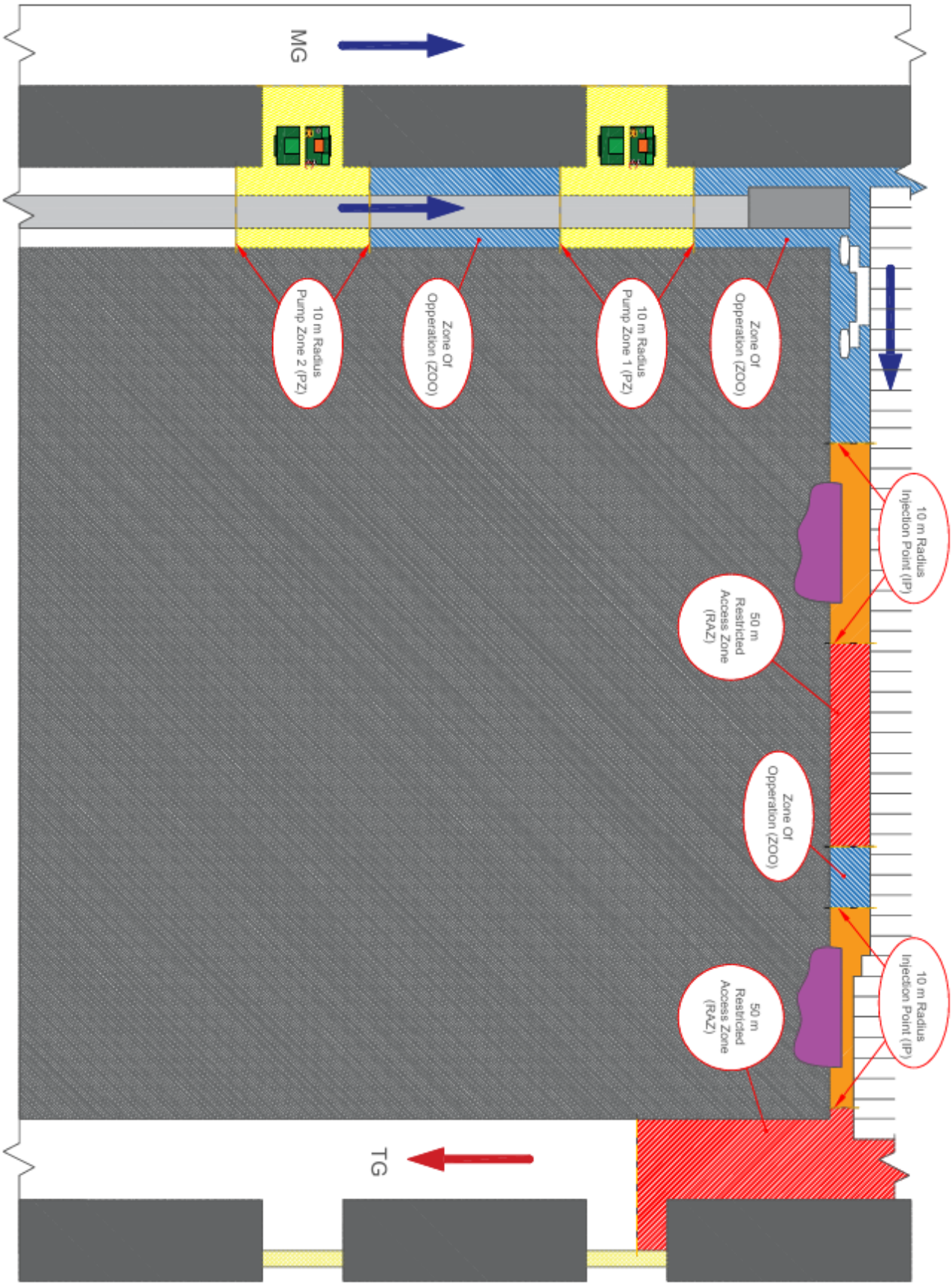


Figure 14: OCZ for pumping from the Maingate (two pumps)

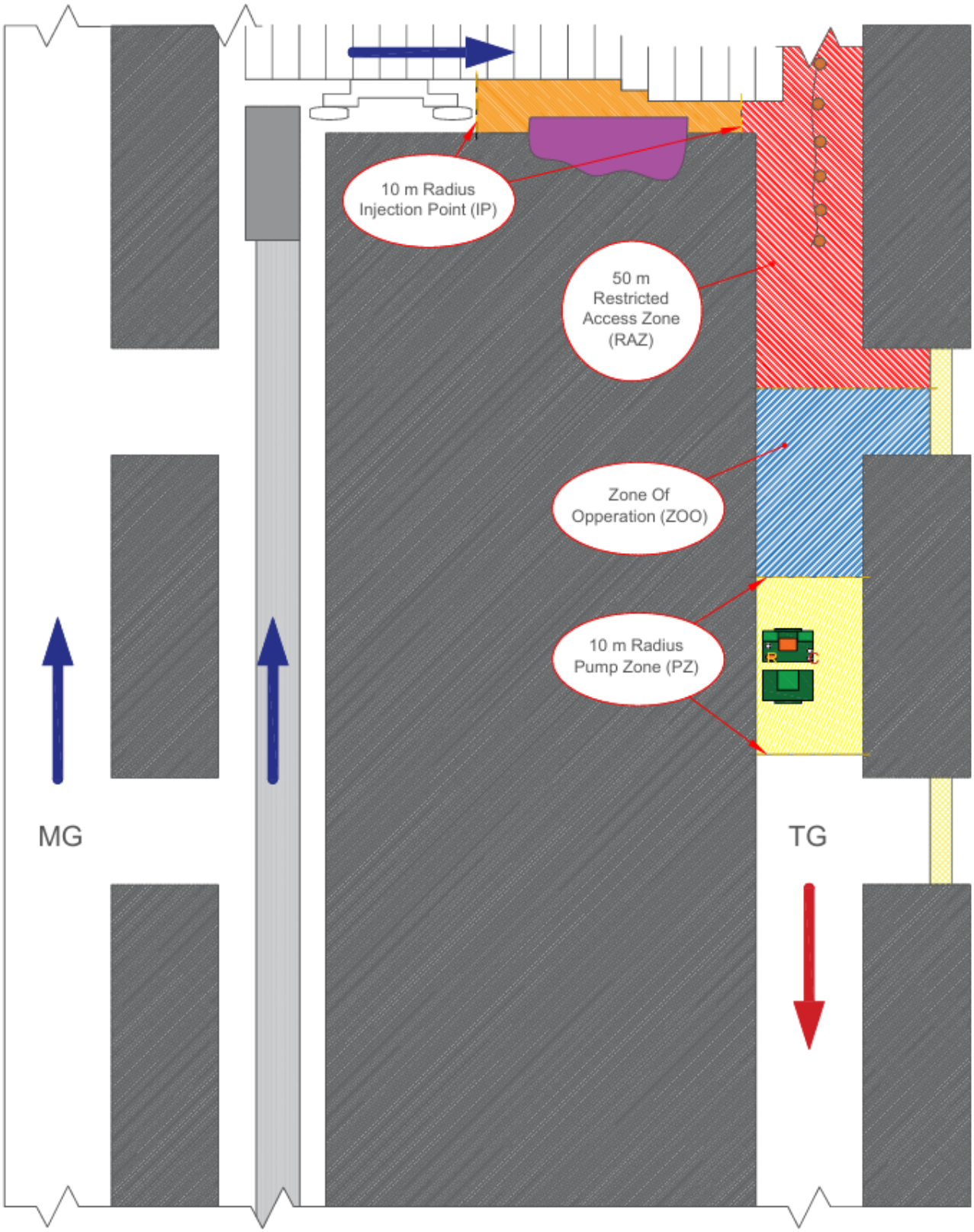


Figure 15: OCZ for pumping from the Tailgate (single pumps)

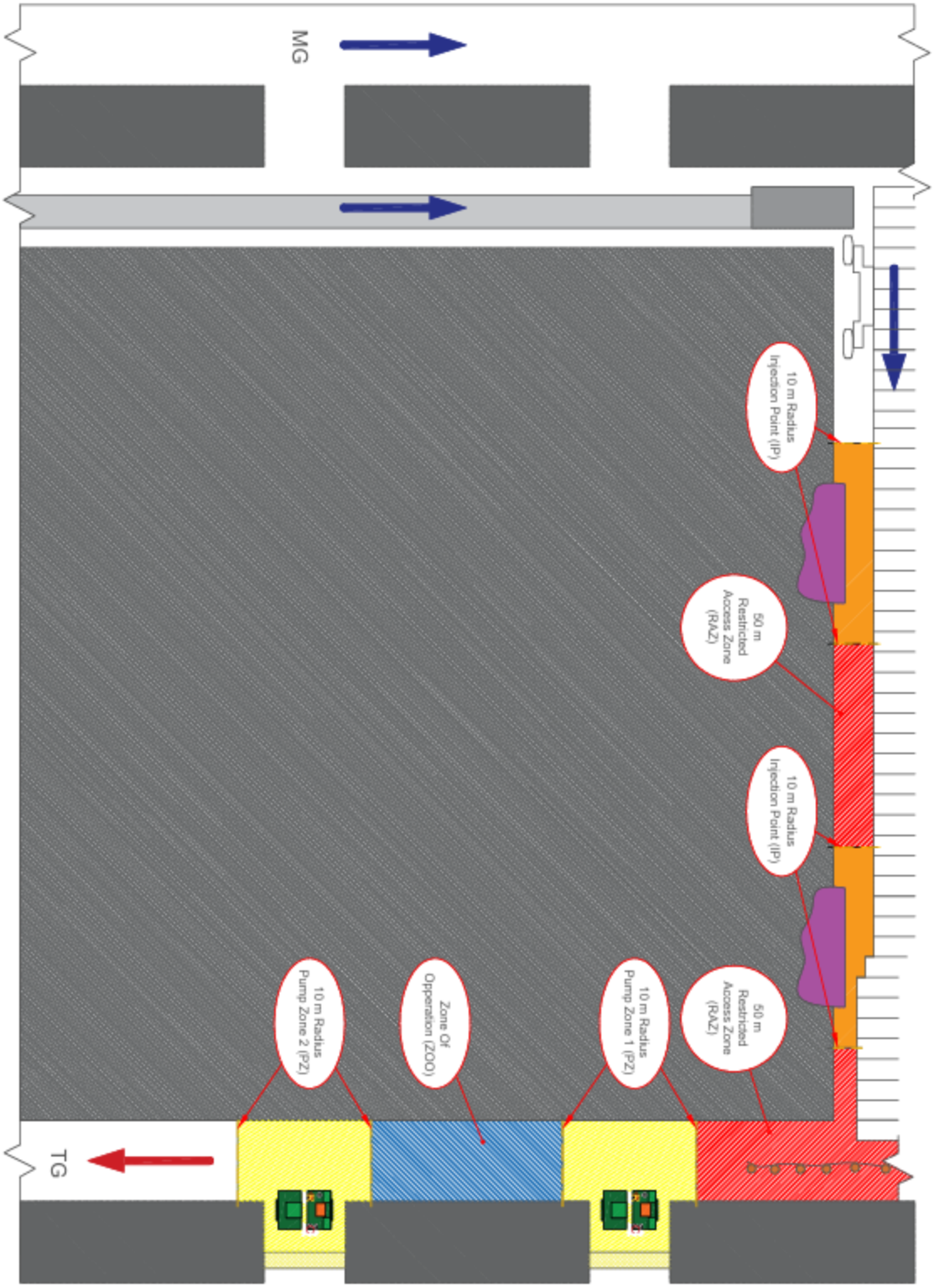


Figure 16: OCZ for pumping from the Tailgate (two pumps)

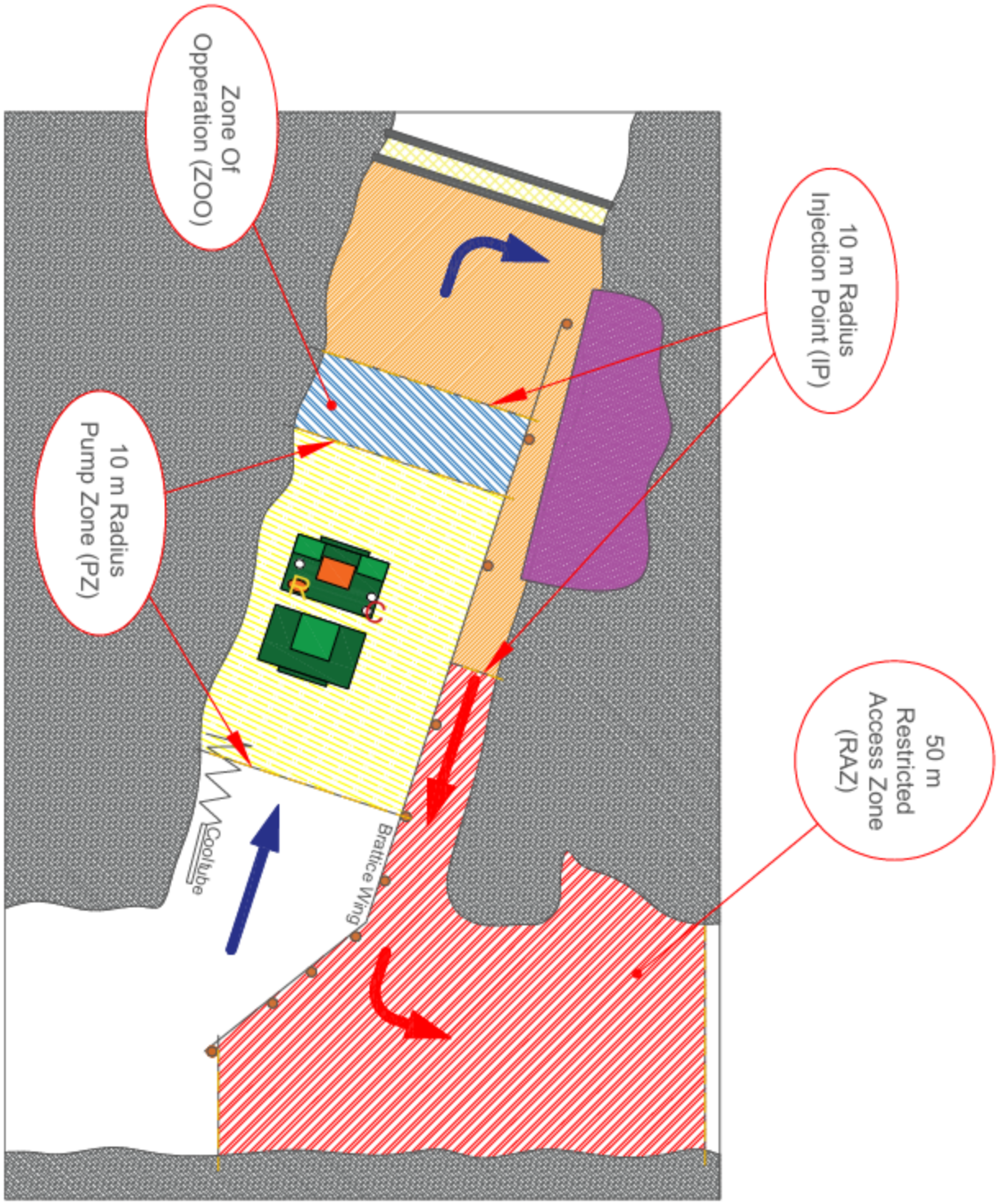


Figure 17: OCZ for pumping in a cut through (seal construction of consolidation)

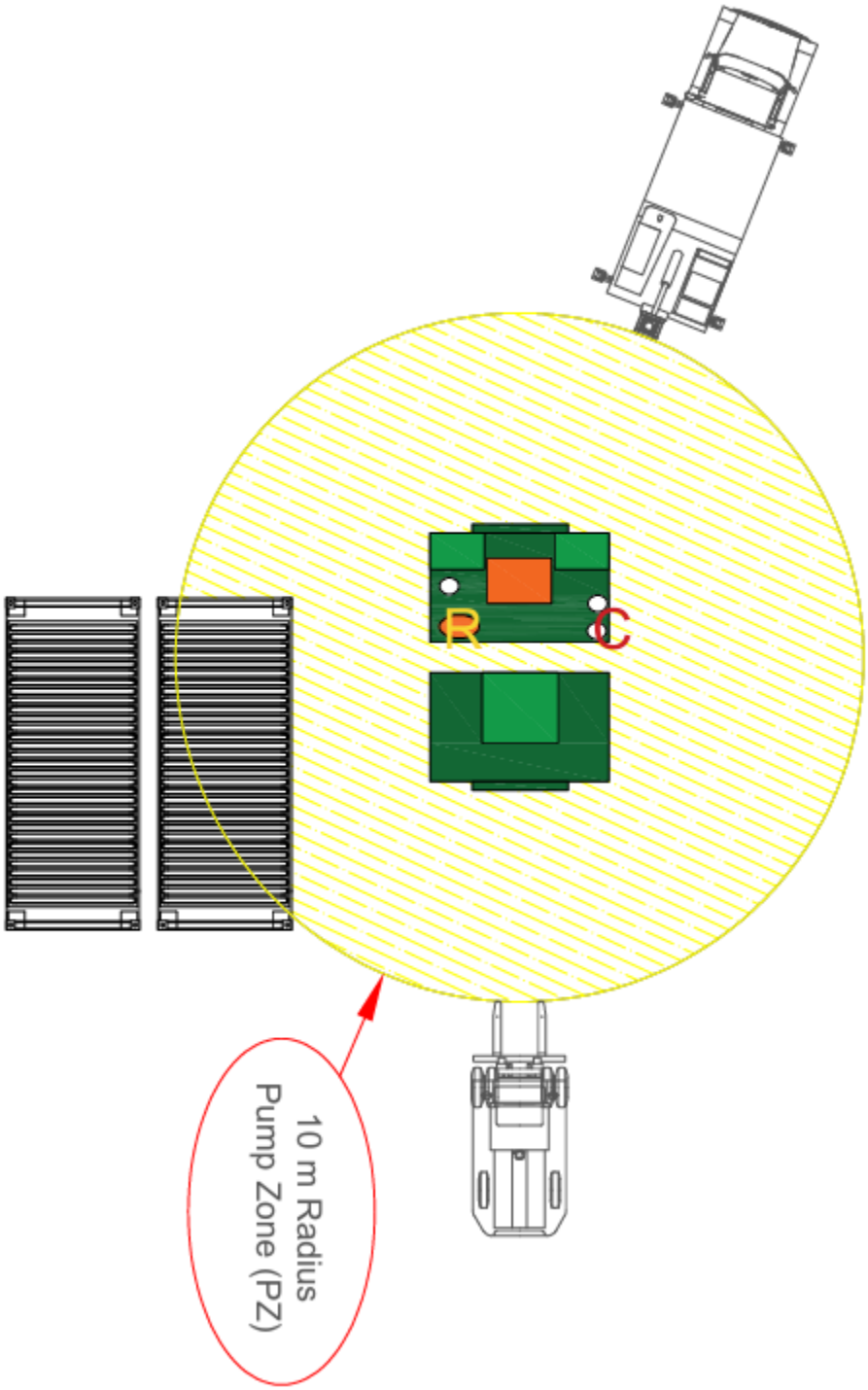


Figure 18: OCZ for Pump Zone (PZ) surface to seam application

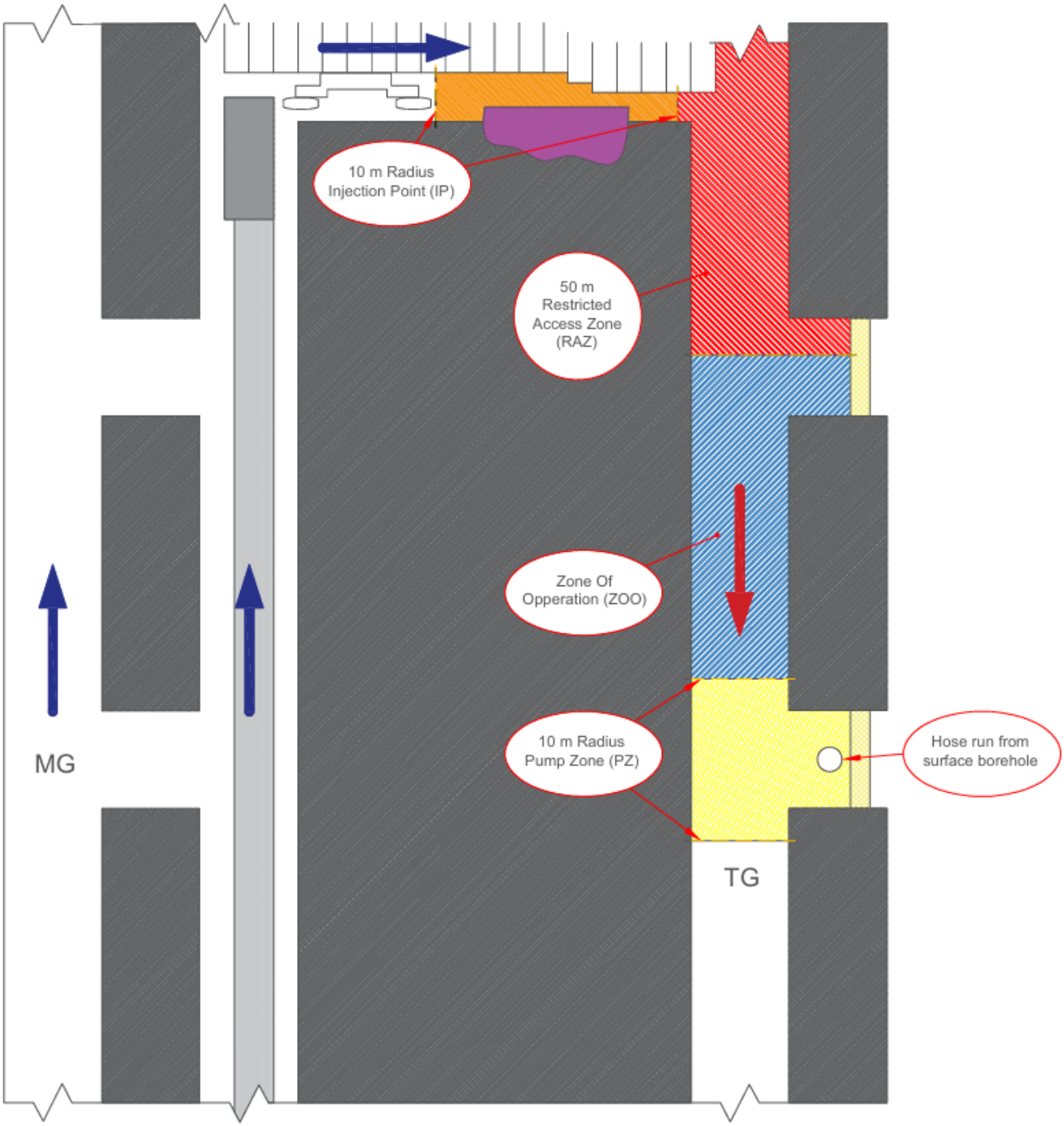


Figure 19: OCZ for when pumping surface to seam from borehole in Tailgate

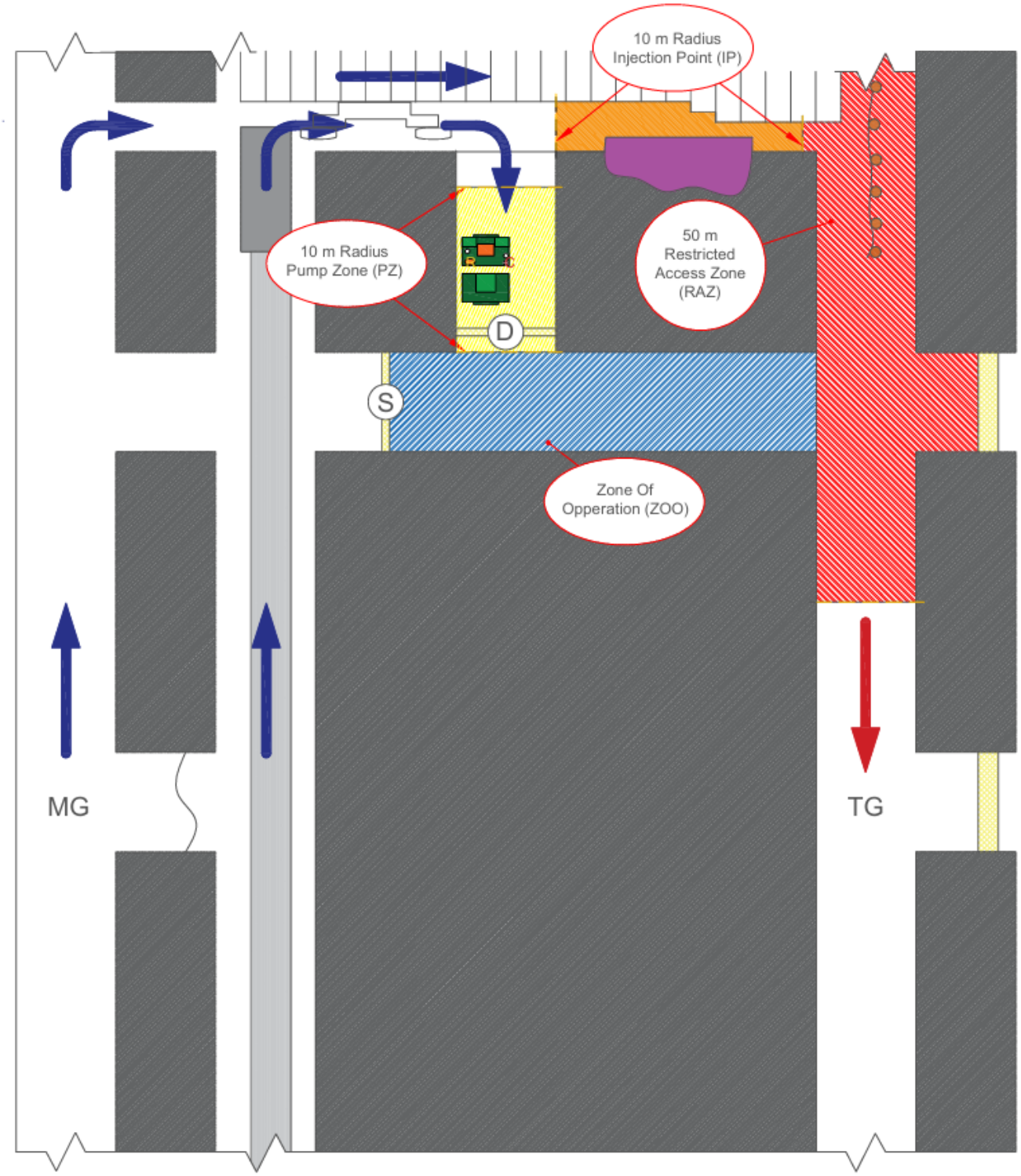


Figure 20: OCZ for when pump is in chute road

Appendix H: Example of demarcation signage

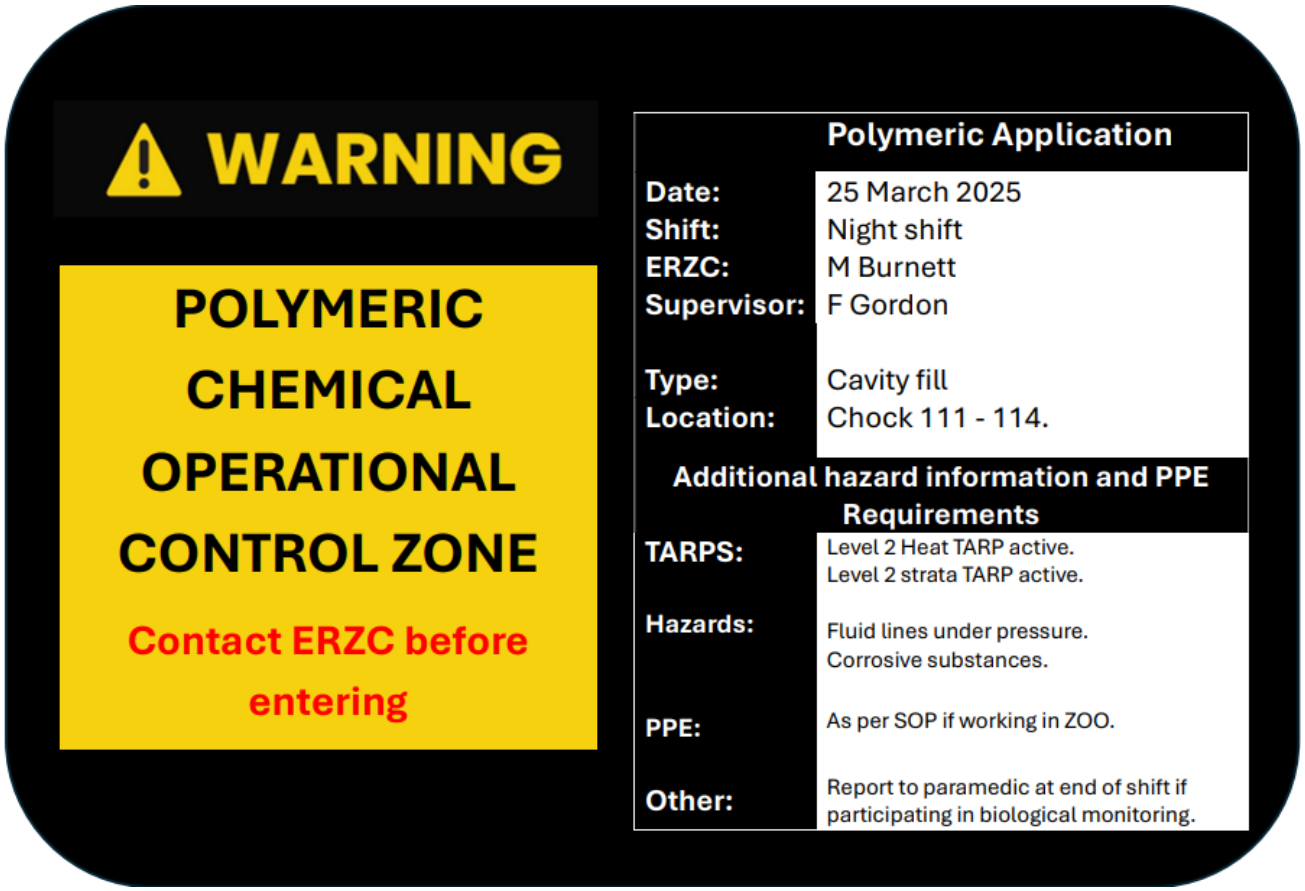


Figure 21: Example of demarcation signage

Appendix I: Example of a heat TARP when wearing impervious overalls

TARP Level	Normal status	Level 1	Level 2	Level 3
Conditions - while wearing impervious coveralls	NET < 27.2℃ OR Ventilation > 0.7 m/s	NET < 27.2 ℃ - ≤ 28.3 ℃ OR Ventilation ≥ 0.5 - 0.7 m/s	NET < 28.3 ℃ - ≤ 29.4 ℃ OR Ventilation ≥ 0.3 - 0.5 m/s	NET > 29.4 ℃ OR Ventilation < 0.3 m/s
Hydration – test result	≤ 100 mOsm	N/A	N/A	> 100 mOsm
ROLE	Response required			
Deployment – individual wear times	Max 3 hour deployment. - longer deployment times at discretion of workgroup in consultation with ERZC. - second deployment at discretion of workgroup in consultation with ERZC.	Max 2 hour deployment. - longer deployment times at discretion of workgroup in consultation with ERZC (for light work such as walking / standing without manual handling). - second deployment at discretion of workgroup in consultation with ERZC.	Max 2 hour deployment. - second deployment at discretion of workgroup in consultation with ERZC	Nil deployment Permit to work in Level 3 heat zone - Restricted access for tasks including to reduce TARP level
Rest periods between deployments	Min 30 minute rest period at cool refuge, between deployments, with coveralls completely removed.	Min 30 minute rest period at cool refuge, between deployments, with coveralls completely removed.	As per Level 1.	N/A
Ability to redeploy	Hydration test result ≤ 100 mOsm Self-Assessment Questionnaire (score ≤ 10)	Hydration test result ≤ 100 mOsm Self-Assessment Questionnaire (score ≤ 10)	As per Level 1.	N/A
All CMWs	• Maintain hydration • Pre-shift & pre-deployment hydration testing • Self assessment questionnaire • Report heat symptoms	• As per Normal state	• As per Level 1	• Cease work activities and follow ERZ instructions • No entry without formal authorisation • Unacclimatised person must not work in Level 3 zone. • Commence hydration activities
ERZ Controller	• Measure & record ET and ventilation o Communicate TARP Level o Check personnel are hydrating & taking rest periods	• As per Normal conditions • Ensure rest breaks as per Level 1 conditions (above) are followed.	• As per Level 1 conditions • Ensure rest breaks as per Level 2 conditions (above) are followed.	• Check & record ET and ventilation • Withdraw persons to cooler place • Communicate TARP level to CMWs and UMM • Activate Permit to work in Level 3 heat zone

This TARP provides guidance on the wearing of protective coveralls, during the application of polymeric products when packaged in bulk IBC containers and minimal manual handling is required such as walking and pulling hoses (ie low-moderate physical work load). It should not be used for applications involving moderate-high physical work loads such as the manual handling and decanting of separate product drums.

Every effort should be made to reduce the TARP level by adjusting ventilation and temperature conditions, wherever practicable, when CMWs are required to wear full length impervious overalls.

THIS TARP DOES NOT OVERRIDE YOUR ABILITY TO MANAGE YOUR WORKLOAD AND WELLBEING. No single heat index can accurately account for the numerous variables associated with heat stress assessment, and for that reason, they should not be used as safe/unsafe limits. CMWs that are wearing high levels of PPE that restrict sweat evaporation or heat loss (Coveralls) must manage their hydration levels, work load and rest period to prevent heat illness.

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