Developing and Reviewing Emergency Preparedness Response Plans for Tailings Dams

J van der Merwe[1] and S Dennis[2]

1.Consultant, NSW Mines Rescue Consulting, Woonona NSW 2518.
John.vandermerwe@rescue.coalservices.com.au
2.Consultancy Manager, NSW Mines Rescue Consulting, Woonona NSW 2518.
scott.dennis@rescue.coalservices.com.au

ABSTRACT

Tailings Storage Facilities (TSFs) present significant risks to both communities and the environment when designed, operated or maintained inadequately.

This paper outlines the key components required to develop an effective Emergency Preparedness and Response Plan (EPRP), including Dam Break Assessments, Trigger Action Response Plans (TARPs), and emergency preparedness procedures integrated with site-specific crisis and incident management frameworks. The approach aligns with the Global Industry Standard on Tailings Management (GISTM)[1] and ISO 22325 Guidelines for Emergency Management.[2]

Drawing on international experience, the paper also highlights potentially overlooked elements in TARPs and Incident Action Plans that can critically affect response effectiveness in the event of a dam failure. The paper aims to support mining operations in strengthening emergency preparedness and ensuring alignment with global best practices.

INTRODUCTION

The Global Industry Standard on Tailings Management (GISTM) requires an Emergency Preparedness and Response Plan (EPRP) as a key component of its framework to ensure the safety of workers, the mine, communities, and the environment. The EPRP should include Trigger Action Response Plans (TARPs), which consider the engineering design, the Operations, Maintenance, and Surveillance manual (OMS), and emergency preparedness and response measures. These emergency response measures should align with the operating company's incident and crisis management standards and should be developed based on credible failure modes and worst-case Dam Break Assessments (DBAs).

The overall process for developing an EPRP can be summarised in the following flow chart, shown below in Figure 1.

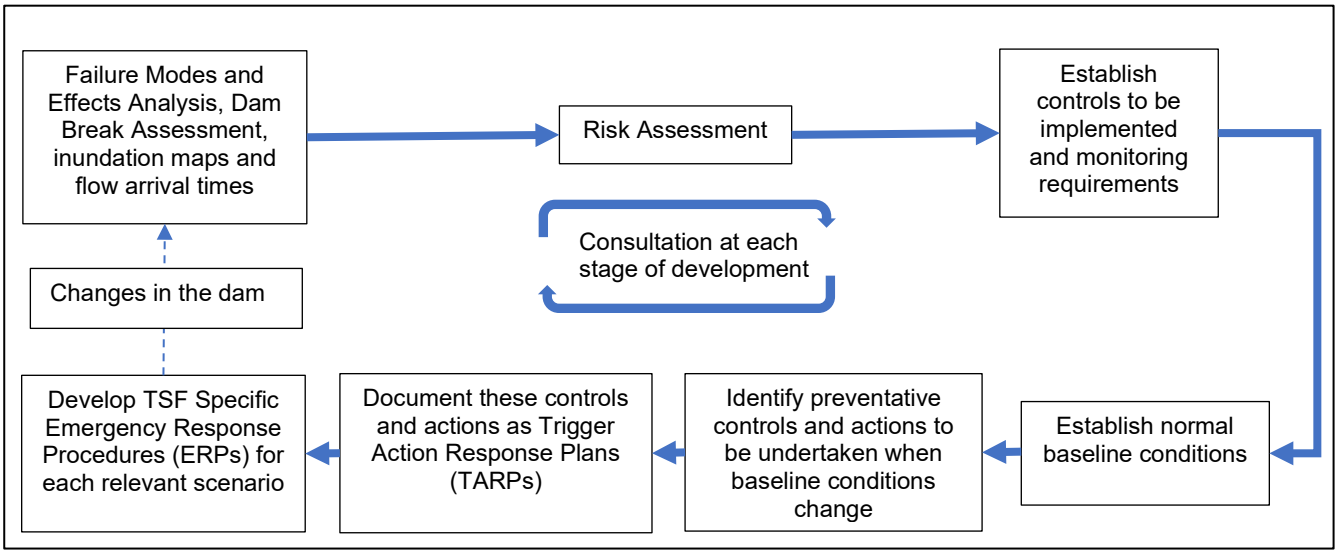

Figure 1: Emergency Preparedness and Response Plan Development Flow Chart

[1] Global Industry Standard on Tailings Management, August 2020.
[2] ISO 22325:2016 Security and resilience — Emergency management — Guidelines for capability assessment

EMERGENCY PREPAREDNESS

Dam Break Assessment

Dam Break Assessments (DBA), or breach analyses, should be modelled by TSF operators based upon credible failure scenarios. These assessments should extend beyond the operation's boundary, and establish the full potential impact of a dam failure. Recognised industry best practice requires the inclusion of both sunny day failure scenarios and rainy-day failure scenarios (Major flood event) for each credible failure mode.[3] The DBAs should then inform the EPRP about the potential extent of inundation, the flow arrival time, and the potential depths.

When dams are planned to be raised, the DBAs should be updated to consider the new maximum height of the dam. This element may be overlooked with an obvious focus on the engineering design of the dam to prevent failure in the first place. Alternatively, if the full design life of the dam is known, a DBA can be modelled for the full life of the dam.

Using the DBA, it is important to consider the timing of the inundation for both dam workers and any potentially impacted community. If it is identified that people cannot be safely evacuated from where they would reasonably be expected to be working or living, they must be removed during the escalation phase of an emergency. In this case, the TARP system must call out these locations in early triggers and establish the requirements to remove affected persons, and set up exclusion zones.

Dam Failure Risk Assessment

Emergency planning involves identifying foreseeable emergency scenarios that could occur at the operation and then undertaking a risk assessment to identify the potential hazards, the associated consequences, and to identify and implement effective controls.

A structured risk assessment should be undertaken to evaluate potential hazards, their consequences, and to determine and implement appropriate control measures.

The risk assessment should be conducted by assessing each potential failure mode and determining applicable control measures, monitoring and inspection requirements. This should include specifying inspection frequencies and ensuring that all controls, both preventative and responsive, are clearly defined. The activation of the incident management team and associated command structure should also be considered as part of the identification of preventative and mitigative controls.

Every TSF is unique, with differing topography, surrounding infrastructure, and surrounding communities, with differing dam break scenarios. As such, TSF operators must prioritise elimination and engineering controls (in line with the hierarchy of controls) to ensure that the dam is managed to prevent worst-case scenarios from eventuating.

However, the adoption of these engineering controls should not stop mines from identifying catastrophic risk scenarios and implementing mitigating control measures should these catastrophic events occur. As such, the risk assessment should also separately assess hazards assuming that they are out of control and the situation has already reached the emergency threshold.[4] These controls can be documented in a separate table within the risk assessment and do not necessarily need to be risk-ranked. Instead, they serve as the foundation for the emergency response plan, guiding the selection and deployment of emergency equipment for not only a local emergency on the dam but for the full extent of the DBA.

Identification of mitigating controls based on catastrophic scenarios is an important step in emergency planning and is used to determine if the operation has the appropriate mitigating controls in place when an emergency occurs to implement the emergency plan.

Examples of Specific emergency mitigating controls include having a lifeboat and life ring available to save people who have fallen in the dam, ensuring that emergency response teams have the correct PPE available based upon the chemistry of the tailings or ensuring enough buses are

[3] Dams Safety NSW Emergency Plans, NSW Government, Australia, March 2024
[4] NSW Code of practice for emergency Planning in Mines, NSW Resources Regulator, Australia, May 2025

available to safely evacuate a town. The justification of emergency resources through the adequate identification of mitigating controls is an essential step in determining what equipment, procedures and people are required to be in place to manage response risks to as low as reasonably practicable in an emergency scenario. Your mine may have a large amount of emergency response equipment but a pertinent question to ask is “have you used a risk-based approach to determine what was required?”

Trigger Action Response Plans

Trigger Action Response Plans (TARPs) are used to provide guidance on relevant actions to be taken when parameters vary from normal. The ICMM Tailings Good Practice Guide defines a TARP as a ‘*series of thresholds corresponding to increasing concern or risk. For each threshold level, define the risk controls to be implemented. The risk management response is escalated as the concern (magnitude of variance of performance) increases. The number of levels of thresholds is dependent upon the performance indicator and the associated risk controls*”.[5]

Creating TARPs can be difficult. They should be easily accessible and understandable for those with roles under the EPRP and include adequate detail to regarding appropriate triggers, responses, and reporting.

TARPs should encompass the monitoring and inspection requirements for the dam while integrating the fundamental engineering design. This is important as change identified during routine inspections or monitoring parameters should have a predetermined set of actions and associated risk controls measures for each step of escalation. The TARPs should integrate into the sites OMS manual which should identify the baseline parameters.

Trigger Levels & Escalation

Typical TARP levels are proposed in the ICCM guideline for tailings management, which include:[6]

- Green – Acceptable Situation. Normal operating conditions. Performance is in line with performance criteria.
- Yellow – Minor-Risk Situation. The EOR (Engineer on Record) and RTFE (Responsible Tailings Facility Engineer) should be notified. There may be a pre-defined risk control to be implemented, or the pre-defined action may be to increase the frequency of surveillance and analysis. Additional surveillance activities may be undertaken. Surveillance results and corresponding actions are documented and reported.
- Orange – Moderate-Risk Situation. In addition to the EOR and RTFE, the Accountable Executive is notified. Depending on the credible failure mode and associated level of concern, regulators, local emergency responders and communities should be notified if further escalation could lead to an emergency. Pre-defined risk controls are implemented. Surveillance activities are intensified to monitor the performance indicator in question, related performance criteria, and the effectiveness of the risk control implemented. Expert advice may be sought as appropriate. Results of follow up surveillance activities are documented and reported. The accumulation or combination of moderate-risk situations could lead to a high-risk situation and threshold values may need to be assessed accordingly.
- Red – High-Risk Situation. Depending on the credible failure mode and how the thresholds are defined, reaching this level means there is an imminent loss of control or that a loss of control has occurred. Depending on the potential consequences, this may trigger very significant pre-defined risk controls (e.g. ceasing ore processing operations, emergency release of water through the spillway) or it may trigger the implementation of the EPRP. It is important to note that the accumulation or combination of moderate-risk situations could lead to a high-risk situation and threshold values may need to be assessed accordingly.

[5] ICMM Tailings Management Good Practice Guide, ICMM, February 2025
[6] ICMM Tailings Management Good Practice Guide, ICMM, February 2025

Roles and Responsibilities

It is important that roles and responsibilities for the TARP are defined within the EPRP. The roles and responsibilities should be defined for each person who is expected to respond to triggers within the TARP, which may include operators on the ground through to the most senior person in the organisation. For each role identified, individual positions in the TARP should be established with a clear set of responsibilities for each trigger point. Having TARPs start at the daily operational level is important as operators are generally the first people to identify physical changes in the operation of the dam.

The operation should ensure that an adequate number of people are defined within the TARP to prevent overloading of an individual role and that persons with each responsibility are competent to perform the role. The responsibilities should account for the span of control such that actions are allocated to allow for the quickest available response. Clear lines of reporting should be detailed in each TARP to provide unity of command and prompt an appropriate response. Responsibilities should:

- Be assigned to specific roles such that there is a single accountability for each task
- Be allocated such that tasks can be executed in a timely manner, with a manageable span of control

If external stakeholders are included within the TARP and have roles and responsibilities, operations must ensure they are familiar with them.

Triggers

TARP tables should be established for each trigger level and consider all stages of an escalating event and the appropriate responses for each stage.[7] TARPs should end in the final response, such as activation of the emergency plan, evacuation, withdrawal, or, in the case of a TSF, there should be clearly defined points within the TARP where all pumping is stopped into the dam. The triggers within the TARP or TARPs should identify the precursors to dam instability and the assigned response to investigate and mitigate the incident. It is important that each trigger for a dam is tangible. For example, a TARP may state “minor and moderate cracking” as a trigger. This is not a tangible, measurable trigger for the persons conducting inspections. The trigger should define a measurable threshold, for example, “Minor cracking up to 2mm or moderate cracking up to 5mm in width”. It is important that each trigger aligns with the engineering design of the dam, where applicable. For example, if beach width is a defined parameter within the engineering design of the dam, the TARP should clearly specify the triggers prior to exceeding the minimum beach width.

TARP triggers should have responsibilities assigned for each role, which are well-defined. For example, the development of a monitoring plan needs to be assigned to a specific role, such as the RP and EOR. If responses are not defined to individual roles, confusion can ensue, and sites may not execute the correct responses due to persons assuming another role will take care of the response. The TARP should be designed to initiate the formation of the site's Incident Management Team (IMT) before the dam failure occurs. This provides a prompt for key persons within the organisation at a site and corporate level to be made aware of a potential incident occurring, and the required resources and level of monitoring required to control the risk can be easily obtained for the persons trying to operate the dam.

Monitoring Sheets

Where possible, daily and weekly inspection checklists should link back to the TARPs. The inspection sheets should specify acceptable ranges for parameters such as beach width or freeboard, allowing operators to understand acceptable parameters, rather than simply being asked to fill out a blank table. This empowers operators to check TARPs when parameters are exceeded and provides a smooth notification process for mines when management is not present, such as on weekends or public holidays.

[7] NSW Technical Reference Guide: Withdrawal and emergency escape from underground coal mines, February 2023

Typical TARPs

Each site should have specific TARPs based on the credible failure modes. As a starting point, sites should consider having TARPs, which include:

- Piezometer readings
- Seepage
- Beach Width and Beach Height (Considering a TARP for normal conditions and one for Rainfall/Snow Melt)
- Dam Deformation (including cracking, satellite monitoring and triggers from geodetic monitoring)
- Pipeline failure
- Pump Failure/Decant Failure
- Earthquakes

Where parameters are triggered, sites should consider all the resources available onsite and offsite to investigate and maintain accurate information. As an example, all mines have a survey team; if cracking appears in a dam wall, it would be reasonable for the site surveyors to be able to survey the deformation, mark the cracks and continue to monitor. It is important that physical indicators are marked– for example, spray painting or pegging adjacent to the end of a crack in a dam wall plays an important role for persons carrying out an inspection on a dam wall without detailed instruments.

An example beach width TARP can be seen in Table 1. Within the TARP, it should be noted that all triggers are tangible, actions are assigned to a role, and the TARP has an endpoint in place for escalating triggers.

Table 1: Example Beach Width TARP

TARP LEVEL	Green	Yellow – Minor Risk Situation	Amber – Moderate Risk Situation	Red- High Risk Situation/ Dam has failed
Measurable parameter / Role	Beach width >100m and/or height of beach >1.5m from crest of dam	Beach Width 100-75m and/or height of beach <1.5m but >1.25m from crest of dam	Beach Width 75-50m and/or height of beach <1.25m but >1.0m from crest of dam	Beach Width <50m and/or height of beach <1.0m from crest of dam
TSF Technician	• Conduct normal inspections as per OMS	• Gather evidence such as photos, samples, data and monitor for secondary hazards and document situation • Notify Supervisor • Undertake further monitoring as per superintendents' instruction	• Notify Supervisor • Remove yourself and other people from danger if required • Gather evidence such as photos, samples, data, and monitor for secondary hazards and document situation if possible • Undertake further monitoring as per superintendent instruction (if safe to do so)	• Notify the emergency control room of issue, remove yourself from danger, aid other people if safe to do so or proceed to a muster point via the evacuation route. • Provide accurate details of actual emergency including location, nature and people affected • Notify TSF Supervisor & RTFE
TSF Supervisor	• Conduct normal inspections as per OMS	• Conduct Inspection with Technician - Document Issue including videos and photos • Notify Tailings Engineer (RTFE) • Review updated monitoring plan developed by RP & EOR and ensure it is understood by technicians and executed on shift level • Review and implement corrective action plan developed by RTFE and EOR • Ensure results of inspections and monitoring data are immediately made available to EOR and RTFE. • Verify standby pumps are available and increase pumping rate for dam if able	• Conduct Inspection with Technician - Document Issue including videos and photos • Notify RTFE • Arrange for the area to be made safe and demarcated (if applicable) • Activate additional pumping and confirm availability of spare pumping • Prevent personnel and vehicles working in the affected area until stability assessment completed • Implement traffic management plan and road diversions as per EPRP • Verify that muster point locations are in place • Review updated monitoring plan developed by RTFE & EOR and ensure it is understood by technicians and executed on shift level • Review and implement corrective action plan developed by RTFE and EOR. • Ensure results of inspections and monitoring data is immediately made available to EOR and RTFE.	• Notify concentrator to stop pumping into the dam • Advise all workers to move to nearest muster point • Implement site IMT and follow duty cards and Task Cards – Notify all IMT duty card holders and TSF Task Card Holders • Assist with site IMT
Tailings Engineer (RTFE)	• Conduct normal inspections as per OMS	• Investigate conditions and collect data to support assessment • Notify Engineer of Record and Dam Owner • Develop and implement corrective action plan in consultation with EOR • Review deposition plan with EOR and change as required. • Provide Action Plan to Dam Owner • Increase frequency of monitoring data collection and inspections as advised by EOR • **If conditions are deteriorating, instruct transition to Amber	• Notify EOR and Accountable Executive • Implement continuous monitoring (where safe to do so) • In discussion with the Accountable Executive, consider forming the sites IMT • Review with EOR if Tailings can still be pumped into the Dam. If not, advise Accountable Executive to shut down all activities pumping into the dam. • Ensure additional pumping capacity has been activated to remove water from the dam • Develop and implement corrective action plan in consultation with EOR and relevant subject matter experts for conditions at the dam. • Provide action plan to Accountable Executive	• Ensure no tailings are being pumped into the dam • Notify Accountable Executive and EOR • Implement site IMT, follow duty cards and action Task Cards – Notify all IMT duty card holders and TSF Task Card Holders

			• **If conditions are deteriorating to an unacceptable threshold, instruct on transition to red	
Engineer of Record (EOR)	• Conduct normal inspections as per OMS	• Undertake assessment and provide recommendations • Assist RTFE in developing a corrective action plan • Advise RTFE on updated frequency monitoring data collection and inspections • Update deposition plan to reflect changes	• Undertake assessment and provide recommendations • Advise RTFE on updated frequency monitoring data collection and inspections • Assist RTFE and relevant industry expert in developing a corrective action plan • Review, if necessary, the DBA to determine impact on workforce, communities and environment	• Assist with Site IMT as required.
Accountable Executive		• Track implementation of corrective action plan • Review investigation and assessment report	• Review Corrective action plan and ensure resources, supervision and management persons are made immediately available to implement the action plan and commence remedial works • Gain technical position from EOR and ITRB • Inform site IMT of Issue & consider forming IMT • Notify regulators, local emergency responders and community of issue • Remove community at risk in immediate inundation area (ie that cannot be evacuated in time if Incident Action Plan is implemented)	• Activate site IMT

EMERGENCY PLANNING

Emergency planning involves the pre-planning of all the elements that will be required to respond to an emergency, for both on-site and off-site (community) impacts. To adequately plan for the emergency, the various scenarios considered in the Emergency Preparedness section need to inform the emergency planning. For a tailings dam failure, the following elements should be considered based on the hierarchy of controls. Elimination of risks should always be prioritised; however, this should not prevent companies from planning responses to catastrophic events.

Places of Safety

Places of safety are designated points where people can assemble without being in any danger from the hazard that triggered the evacuation).[8] For Tailings Dams with potential offsite inundation areas, places of safety should have clear access routes to move people from the hazard and be outside potential inundation areas. Where this is not possible, for example, communities or access points are cut off due to inundation, operations must plan to move people prior to the inundation occurring (ideally in the escalation phase in the TARPs), which may involve moving people from temporary gathering points to a place of safety. All muster points and places of safety should be clearly signposted, including the paths that lead people to them. All operations that maintain off-site places of safety should develop a standard to ensure they are adequately maintained and have the correct facilities. When considering the location of places of safety, severe weather should be considered to allow ongoing access. For example, consideration of weathered roads inhibiting access or flooding inhibiting access. Operations should also consider alternative routes to the ones that are in the flood/inundation area, so community members can be taken to a temporary shelter after the emergency.

Site Muster Points

Site muster points should be in a position that is well known by workers and out of the potential path of inundation. For example, the installation of muster points adjacent to the TSF pump station on the downslope of the TSF may seem appropriate due to the availability of communication and shelter. This location is logical for other emergencies, but not for a dam break. Sites need to consider the Dam Break scenarios and ensure that the muster points are in a position that is not affected by a potential inundation. Training of workers should also occur to ensure they are aware of the requirement to move to the respective muster point based on the potential situation. For dams with multiple failure scenarios and breach locations, sites should consider establishing multiple muster points reflecting the possibility of one being inaccessible due to the dam failure.

Community Muster Points

Community muster points should be established throughout potentially impacted communities adjacent to the inundation areas. These muster points should be strategically spaced so that the community members can reach them in a timely manner. When developing the muster point locations, sites should consider the worst-case inundation, the change in elevation (for example, if they are on top of a hill, the site might need multiple muster points), and the number of people planned to be evacuated to each muster point. This pre-planning also helps support the potential movement of people post- inundation. Local weather conditions also need to be considered. For areas with extreme heat and extreme cold, muster points may be required to be installed inside school buildings or halls to ensure people are not exposed to further risk.

Evacuation Routes

Evacuation routes should be clearly established for all muster points. Workers on-site should be trained in the various muster points and routes taken to reach them. As part of the community consultation process and drills community members should understand the route from their property and place of work to their designated muster point. The main roads that lead to these routes should be sign-posted.

[8] NSW Technical Reference Guide: Withdrawal and emergency escape from underground coal mines, February 2023

Relocating People from Gathering Points

Depending on the location of muster points and the facilities available, people may be required to be relocated at both a site level and community level due to the extent of inundation through the community. This requires the installation of gathering points for people in the community and the arrangement for moving these people during the escalation phase to an emergency in the TARP process. During the planning phase for these gathering points, the expected number of people for each location should be known, and the mode of transport, the company responsible, and the process for arranging the movement of people should be well established and rehearsed.

Early Warning Systems- Community and Worker Notification

Depending on the country and infrastructure available, a number of early warning systems are available. Whichever early warning system is deployed; it should be integrated into the site's initial response procedure or the initial operations Task Card, including the activation process, the person responsible, and the relevant contact details.

One example of a warning system is a siren within the community. Sirens can notify people of an incident occurring, however, affected persons should be trained to understand what the siren means to enact the evacuation. As dams increase in height and potential inundation areas increase, sites need to ensure the number of sirens within the community reflects the inundation area.

In some countries, emergency services have the ability to send out emergency broadcasts to landline phones and mobile phones in potential inundation areas. If this process is identified as the appropriate warning system for your site, it should be regularly tested and the process for activating these services and testing should be carried out routinely.

Radio Systems are now commonplace for workers and sites should have inbuilt evacuation processes using the site radios which are generally established from the site’s control room. This process should be embedded for any incident onsite, however will need to be verified for a dam failure.

In some countries, due to a lack of infrastructure and, in some instances, disregard for sirens, loudspeakers are also deployed. This process generally involves persons such as security guards driving around the local community with loudspeakers notifying persons of the imminent risk and the need to evacuate.

Communication Systems

Rapid, effective and robust communication systems, devices and procedures for initial notification of personnel and the community of a potential emergency, and for ongoing two-way communication during emergencies for key personnel should be considered in the development of the EPRP. The equipment required should always be available, regularly tested, sufficient in number to account for the worst-case scenario and maintained. Operations are to ensure this equipment is deployed throughout the workforce, community and given to local authorities/first responders. The infrastructure that supports the communication system should be located so that it does not become inoperable in the event of a TSF failure; this should form part of the review and emergency risk assessment process.

Removal of Power

As a tailings dam failure potentially involves water, mud and slurry inundating the site and impacted surrounding areas, the removal of power should form part of the initial response procedure, or the initial operations Task Card. Operators should have a defined process for contacting the power provider and nominating the feed that is required to be isolated based on the inundation area. This is a critical step in ensuring the safety of rescuers and the community in the event of a dam failure response. Operations may also consider the inundation velocity and depth when assessing this and determine if it is required. For example, if it is only expected, there would be 20mm of inundation in an area with power, the site may not require power to be removed, or alternatively, the service provider might have adequate protection settings such that power may not need to be isolated.

If power is removed to key infrastructure such as early warning systems or communication systems that are required by emergency services, the consideration should form part of the plan, including alternative communication equipment or alternative power sources. For example, consideration may be given to ensuring emergency communications systems have battery backup capability. The loss of power and flow on effects should be considered in the underpinning emergency risk assessment.

Competent People

When developing the Emergency Preparedness and Response Plan (EPRP) for each Tailings Storage Facility (TSF), it is essential to consider the capability, experience, and competency of personnel responsible for initiating and managing emergency responses. Training programs should reflect these requirements to ensure that sufficient and capable resources are available during an emergency.

The plans should be practical and easily executable by personnel present on site at the time of an incident. They should also ensure that the workload involved in implementation is reasonable and achievable within the required timeframe by those assigned the responsibilities.

Any individual who may receive an emergency call or be the first point of contact, such as control room operators, dispatchers, or senior managers, should follow a clearly documented procedure and fully understand their role in the initial response.

Operations should regularly assess the number of competent personnel required on site to activate the EPRP and ensure this staffing level is consistently maintained. During emergency drills, a review should be conducted to evaluate whether the workload placed on responsible individuals was manageable and the process effective. Emergency activation and response roles (particularly control room or dispatch operators) can quickly become overloaded. Consideration should be made for additional personnel being available to assist control or dispatch operators in answering phone calls, responding to alarms, and actioning responses.

Adequate Emergency Material

Any material required to deal with an emergency should be bought to site during the escalation phase of the TARP rather than when the emergency has occurred. Material that is difficult to source should be stockpiled onsite and regularly checked, for example sand and gravel for creating a reverse filter. Reliable and immediate access to excavation equipment should also be considered to manage the use of emergency materials.

Material consideration should include:

- Buttressing material (sites should determine if mine waste is suitable)
- Sand and Gravel (stockpiled to create a reverse filter if required)
- Dam wall material (suitable material to construct a dam wall or a diversion channel)
- Pipes (spare pipes to repair TSF lines)

The location of the dam and access routes should be considered for stockpile locations and the immediate availability of material. For example, if the dam is at the end of a long valley or mountainous region that uses the natural contours to increase capacity, the material will need to be stockpiled near the dam wall rather than relying on trucking this material through the potential inundation zone.

Another consideration is the lead time for the materials to contain a failure. If the lead time is too long, material should be kept on site near the location where the work may be required to occur but not in the line of fire of a potential TSF failure.

Adequate Emergency Equipment

Dam Emergency Response

Sites should consider different equipment requirements, such as:

- Pumps for dealing with excess water on the dam

- Equipment for the construction of diversion walls, buttressing and creating reverse filters
- Specialised equipment for developing access to an inundation area and the equipment to allow for the transport of people from muster points that have been cut off.
- Personal Protective Equipment (PPE) required for rescuers to enter the inundation zone (based on the chemistry of the dam)

Equipment such as dozers, excavators, dump trucks and buses should be considered in the emergency risk assessment. The site should consider the rate at which material would be potentially required to be placed and the mining fleet which would be made available to support it. The equipment onsite should be compared to the public sector capacity, for example, if you are relying on an external stakeholder to move people from muster points using buses, the site should review their capacity to undertake the work.

Additional pumping capacity and spare pumps should be considered in the escalation phase to increase freeboard in the dam; this is particularly important in areas that have snow melt, in which the pond level can increase dramatically with changes in weather. The site should also consider having emergency ponds to deal with excess water, pipeline failure or install additional capacity through options such as water treatment plant capacity as part of the operation.

If lead time for the equipment to contain a failure is too long, this equipment should be kept on site near the location where the work may be required to occur, but not in the line of fire of a potential TSF failure. Similar to materials, if the dam is in a valley or mountainous region, sites should consider moving a permanent mining fleet to be able to use the emergency material in the escalation phase of the TARP.

Personal Injury Response

EPRPs generally tend to focus on large-scale impacts of a dam failure. Incidents have occurred in industry where workers have been stranded on the tailings dam itself[9] or an emergency occurs on the dam, with people conducting inspections[10]. As part of the site's emergency risk assessment, these incidents should be considered and the relevant equipment obtained. The site should consider equipment such as:

- Lifejackets
- Boats
- Planks or sheets of plywood for accessing persons/equipment stuck
- Slings
- Lifebuoys
- Ropes
- PPE specific to the contents of the dam (based on the chemical composition)

This equipment should be stored close to the dam, and its location should be known by all workers. If this equipment is required to be locked away to prevent theft, then the way in which it is accessed (for example, the use of a combination lock) should be known by all persons who are required to use it.

Closure of Roads

As part of the emergency response, it is likely that roads leading into the inundation area will need to be closed. The locations of road closures should be considered in the planning phase and the persons responsible for closing the roads should form part of the Incident Action Plan or operational Task Card. Clear responsibility regarding road closure should be pre-established with local police or emergency services to identify if this responsibility lies with the police or if the responsibility is shared.

[9] Stranded worker rescued from active tailings dam, NSW Resources Regulator, August 2022
[10] Worker swims to shore after pontoon pump and boat sink, NSW Resources Regulator, September 2022

Whichever team are to close the roads, the responsible person and contact information should be clearly outlined within the plan.

Closure of Rail

Rail lines are typically used by concentrators, smelters and mines to move product. If these run through the inundation area, sites should consult with the rail operator on how trains are informed to be stopped. The information on how to close and stop the rail line should be included in the initial emergency response procedure or initial operations Task Card, with clear responsibility assigned to who is to contact the rail company and the clear points at which the train line is to be stopped, including the removal of power if applicable.

Closure of Airports

Sites may have airports or airstrips in the potential inundation area. Sites should review if this is the case for their operation and consult with the airport operator on how and when operations are to be stopped. This information should form part of the requirements of the of the initial emergency response procedure or initial operations Task Card with clear responsibility assigned for who is to contact the appropriate authority.

Underground Mines

Sites may have underground mine shafts, boreholes or mines located in the potential inundation area. Sites should review if this is the case for their operation, consult with the mine operator on how long a withdrawal takes from the mine, including the time taken to move people to a place of safety. If the timing of the withdrawal does not allow for the safe removal of people in an emergency, the removal of people should be integrated into the TARP escalation phase. Otherwise, the notification process should be included in the initial emergency response procedure or initial operations Task Card with clear responsibility assigned to who is to contact the mine operator.

Alternative access routes post-inundation

Consideration should be given to alternative access routes to communities or parts of communities that may be stranded during in the event of an emergency. In some cases, the local geography can assist with alternate access routes to the other side of the inundation, as there may be roads that go around the TSF. In cases where there is no alternative access road available, sites should prioritise access to towns to facilitate assistance to these people post-inundation. This is generally captured in the TSF Specific planning Task Card, which is executed once the emergency has stabilised.[11] The key areas which should be recovered can generally be clearly seen in the inundation mapping and the exact location, including resources should form part of the ongoing plan for the operation.

Maintenance of Emergency Equipment, Muster Points, Evacuation Routes and Emergency material

Sites should implement maintenance plans for the regular checking and maintenance of equipment, muster points, evacuation routes, and emergency material. They should consider using the site's maintenance management system, such as issuing regular work orders for these checks to ensure they are inspected and maintained.

External Response agencies

Sites should develop agreements with the local authorities and external agencies for the emergency response. Sites should provide them with the inundation mapping to help them understand their role within an emergency response. They should be involved in drills to refine the emergency response plan and should be included in the sites' underpinning emergency risk assessment.

[11] Task Cards are documents that are prefilled with information to be considered or actioned by an individual; providing important information prompts for tasks which may need to be actioned as soon as possible in the event of an emergency. Task Cards are discussed later in this paper.

Temporary Community Lodging

Following the initial emergency response, the community may need to be relocated to temporary shelters such as hotels, schools or gymnasiums. Sites should have a process is in place to enable temporary accommodation providers to provide essential services, including clean water, food, medical supplies, hygiene products, clothing, mattresses, blankets, bathroom facilities, community liaison teams, and psychological support. Additionally, operations should implement a system to share information about missing or located individuals and to communicate the support services available.

EMERGENCY RESPONSE

Response to an emergency encompasses all the parameters identified and considered within the emergency preparedness section. Systems should be clearly established for a response to an emergency. This should include:

- the command structure for an incident,
- how external authorities integrate into the response,
- an initial emergency procedure or Task Card which clearly details all the requirements to be initiated at the onset of an emergency, and
- how an ongoing Incident Action Plan should be developed through the command structure once an incident has occurred.

Command Structure

Several standards exist for emergency and incident management, which detail suitable command structures. These standards include ISO22320 Emergency Management – Guidelines for Incident Management and the Australian AIIMS framework (Australasian Interservice Incident Management System). Similar systems exist in other jurisdictions including USA-based NIIMS (National Incident Management System), NZ- based CIMS (Coordinated Incident Management System), and Canada -based ICS (Incident Command System).

To reduce confusion and duplication, it is important that the site command structure is applied for all crises and emergencies. Using a consistent command structure from the incident scene through to corporate level will assist in ensuring that the command system is adaptable, scalable, and uses uniform terminology to ensure effective communication. Alignment with local emergency management structures is also advantageous, ensuring that if local emergency management services are required to assist, they are likely to quickly recognise and understand the mining company's command structures. Such recognition and alignment can assist with the integration of site and external emergency service teams.

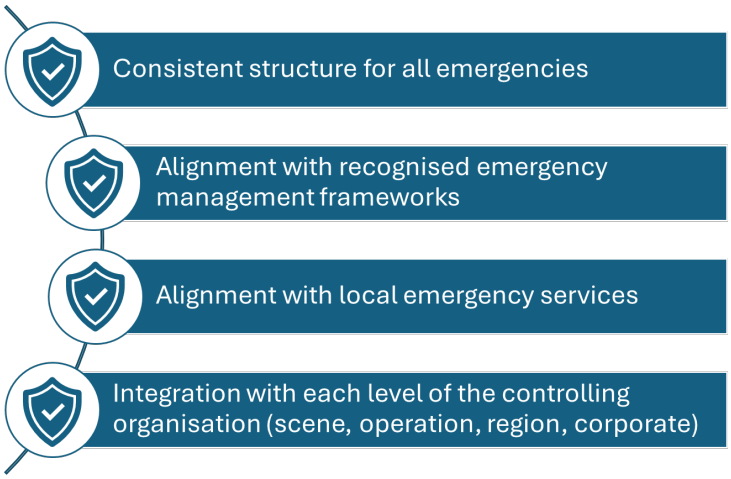

Figure 2: Key Considerations for Command Structures

Command structures also need to consider each level of the controlling organisation. For example, for a large multinational mining company, the command structure may include controlling structures at the following levels:

- Incident scene
- Site-based Incident Management Team
- Country-based Crisis Management support
- Organisation-based Crisis Management Team

Finalising an incident management team structure for your mine site can be difficult due to the number of considerations to be taken into account. The “keep it simple” philosophy should be adopted to minimise span of control, only adding additional roles when necessary. Figure 3 is an example of a simplified incident management structure.

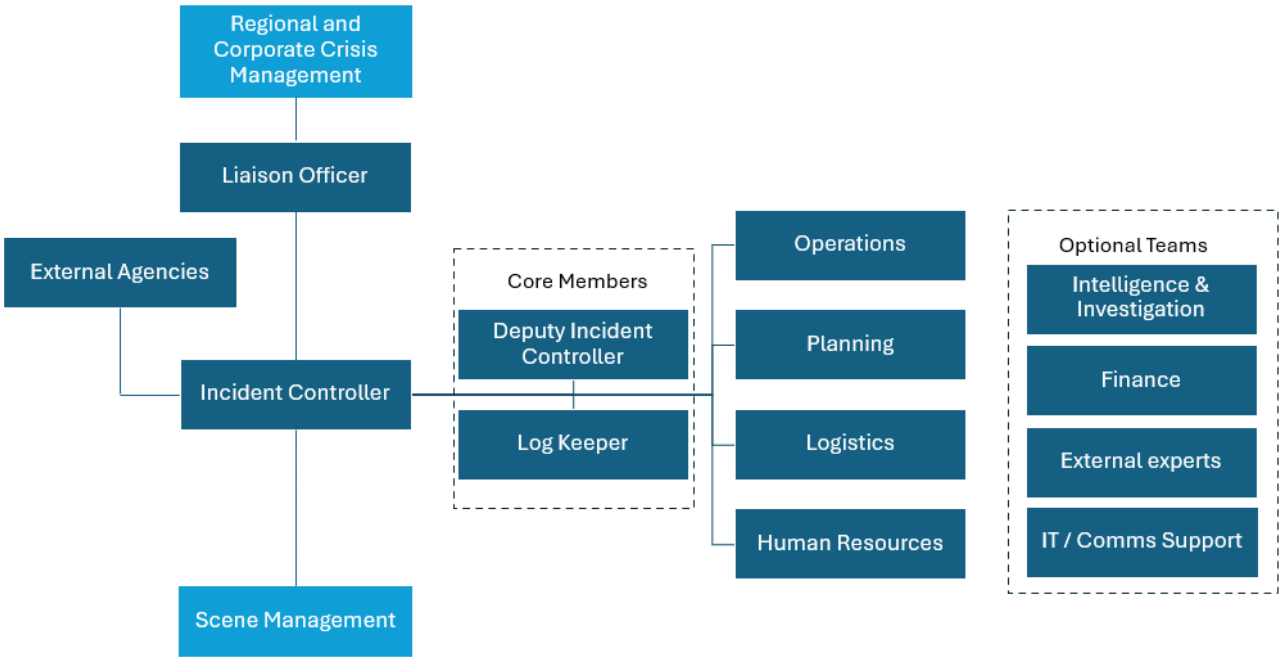

Figure 3: Example of an incident management structure for a mine site

Sites need to determine the appropriate place for the IMT to form, the resources required and ensure the planned meeting location is not in the inundation zone or affected by the inundation, for example, it will still have power after the TSF failure.

Functions of Incident Management

The incident management command structure should have assigned leaders from within the organisation allocated to each role. As part of the site’s Emergency Management Plan, the site should define the responsibilities for each of these roles. To enable clear identification of each person with a key role in the incident management team, sites typically use tabards to identify each role. An example summary for the responsibility of each role and tabard can be seen below in Figure 4. Each person with a key role in the incident management team should be adequately trained to ensure they understand the site’s emergency management system, their role, functions and responsibilities. Typically, each key role in the incident management team also has an associated Duty Card, which summarises the role's responsibilities and provides prompts for actions that need to be considered for the role.

Figure 4: IMT Tabards and Functions

Task Cards

An effective way to provide guidance on the immediate actions to be taken in the event of a TSF emergency is the use of an initial response procedure or a TSF Initial Operations Task Cards. “Task Cards” are documents that are prefilled with information to be considered or actioned by an individual; providing important information prompts for tasks that may need to be actioned as soon as possible in the event of an emergency. Where Task Cards are used, they should have a clear link to the site's IMT structure, as exemplified below in Figure 5

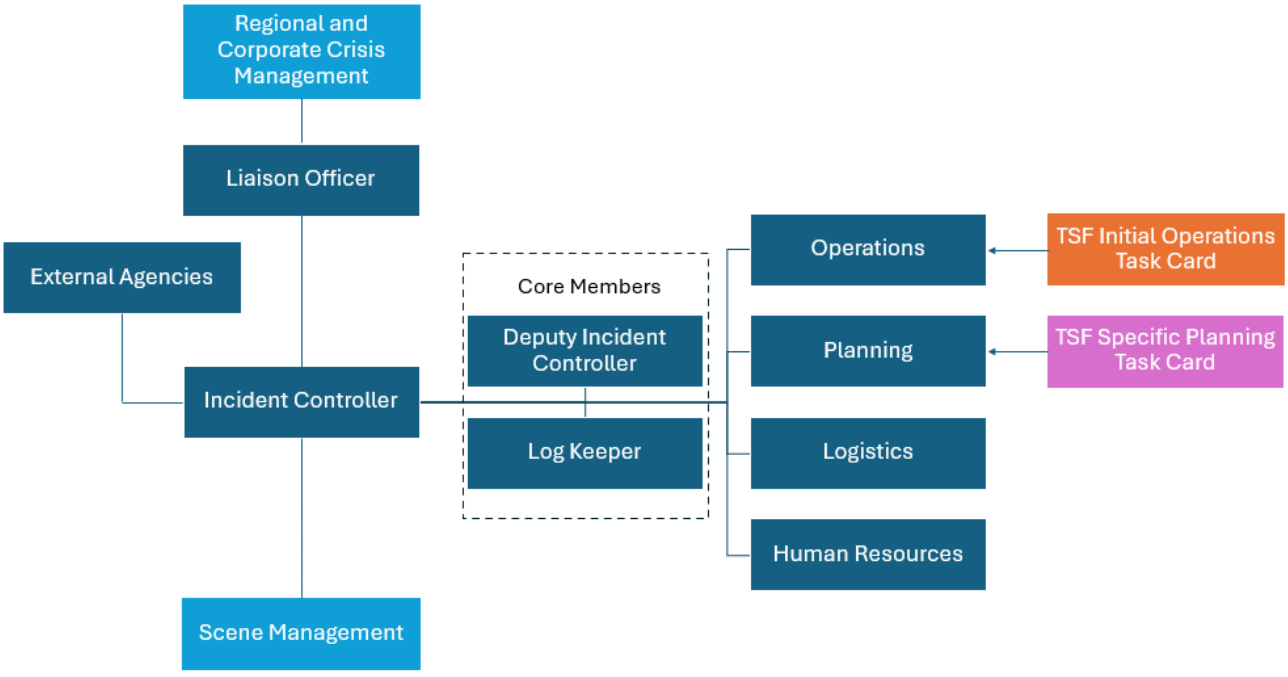

Figure 5: Task Cards linked to the site IMT structure

The TSF initial operational Task Cards or the initial response procedure should contain specific tasks that can be executed (rather than things to consider). These tasks should be SMART tasks (specific, measurable, achievable, relevant, timely). For example: remove power to the area by contacting X power company on contact number XX and specifying that feed X must have power removed due to inundation. This aims to ensure specific actions are undertaken which can assist in preserving life, site resources and also removes any ambiguity from the plan. Such Task Cards or procedures should include a tick sheet to ensure each action is completed sequentially, ensuring all the considerations developed in the Emergency Preparedness section are undertaken. An important benefit of a Task Card is that it can be issued to any role on site with a basic level of understanding of the site's risks and management structure.

Initial Response Procedures & Initial Operations Task Cards can be initially implemented by onsite operations teams and then can be handed over to the site IMT when it has formed. In practice, roles such as Control Room operator or operations supervisor are typically tasked with undertaking initial response actions in the event of an emergency. An example of an operational Task Card can be seen in Figure 6.

Consideration should be given by sites as to whether content experts for the tailings dam, such as the EOR, RTFE and various operational persons, are embedded into the site's overall incident management structure. It is important to have a clear system for integrating people with intricate knowledge of the dam into the ongoing response when an emergency level is initiated. One option is to integrate key TSF supervisory and technical roles into the site's overall emergency management structure through the provision of a separate planning Task Card. This TSF-specific planning Task Card aims to provide prompts on developing dam-specific response plans, considering the engineering aspects of the dam. This allows the core IMT group to focus on the immediate incident and assistance measures, whilst the TSF-specific planning Task Card is focused on the overall stability of what is potentially left of the dam and possible containment or stabilisation. An example of a planning Task Card can be seen in Figure 7.

A site with an adequate TARP system in place should have the IMT formed prior to dam failure. If TARP triggers are escalating to the point where the dam needs to be the key focus of the site and the corporate management team, the formation of the IMT can assist in the mitigation or elimination of a potential dam emergency through the provision of adequate resources, supervision and personnel.

TSF Initial Operations Task Card
The TSF Initial Operations Task Card reports directly to the IMT Operations duty card holder for Emergencies involving Tailing Storage Facilities. They are responsible for implementing the immediate action plan through the various resources on site. These could consist of members from the site Emergency Services, Operational personnel from the affected area, and additional support from outside the affected area.
IMMEDIATE ACTIONS
☐ Commence an Individual Action Log ☐ Notify IMT team members of incident ☐ Activate sirens in community by contacting XX, which will automatically activate system ☐ Broadcast the emergency over the radio the emergency and notify persons to move to muster points ☐ Arrange with Security for car to be dispatched with loudspeaker notifying persons of potential failure to the relevant area (where safe to do so) ☐ Notify the Local emergency responders on XX and regulator including police on XX XX ☐ Activate emergency pumping from dam (if safe to do so) ☐ Arrange for all plants to stop pumping into the TSF. Contact concentrator on XX to notify them of the requirement to stop the plant ☐ Arrange for road closures to be put in place as per plan by contacting the local police on XX x ☐ Contact energy network provider to remove power to feed 1 in the inundation area on contact number 123 123 ☐ Notify Train company to stop all trains from X to X and remove power to trainline on contact number 1234 1233 ☐ Notify local airport to stop all inbound traffic and prepare for inundation on contact number 1234 1234 ☐ Mobilise persons to site muster points and conduct a roll call Muster Point 1 Person Sent: …… Radio Channel: …….. Muster Point 2 Person Sent: …… Radio Channel: ……. ☐ Notify bus company on X to send X number of buses to Community muster point 1 and X number of buses to community muster point 2 (if in inundation area) ☐ Arrange transport of people from muster points and for roll call logs to be collected when persons transported outside of inundation area ☐ Arrange for notification of road closures to site Personnel (email, text message or SOS Briefs) due to potential dam failure/failure ☐ Provide brief to IMT on status of Task Card
ONGOING ACTIONS
Make recommendations to the Incident Controller from within their specific field of expertise to assist with the management or control of the incident Assist with the management of all Response Operations personnel involved in the incident. Attend IMT briefings and keep the Team informed on the progress of the incident. Support the ERT (on-scene Emergency Response Team) Ensure that all actions, decisions, instructions and events are accurately recorded and documented.
POST-INCIDENT
Assist with the collection and filing of all documentation from all ERT's and Operational groups. Attend the ERT and other on-scene responders debrief(s) Attend any IMT debrief

Figure 6: Example Initial Operations Task Card

TSF Specific Planning Task Card
Reporting to IMT recovery for emergencies relating to Tailings Storage facilities. They are responsible for ensuring that all possible dam-specific contingencies are considered during the emergency response and recovery phases. This could include providing technical/engineering advice necessary to safeguard life and limb, protect the environment and lead to the restoration of operational normality once the emergency comes under control.
IMMEDIATE ACTIONS
☐ Respond to IMT activation. Proceed to the IMT Room ☐ Attend the IMT initial briefing ☐ Start and maintain an individual log of all actions, decisions and instructions ☐ Notify RTFE, EOR, TSF Supervisor and relevant industry experts and together develop an action plan considering: Buttressing Creating a reverse Filter Building a diversion Bund Additional Pumping Other forms of containment ☐ Notify Incident Controller and Planning Officer of Incident Action Plan and resources required ☐ Consider reviewing the DBA, ensuring it takes into account the current failure mode ☐ Consider placing a spotter in a safe position to continually monitor the situation and advise of any changes or escalations ☐ Consider alternative access roads to towns in inundation area and notify IMT of locations and equipment required to open access routes.
ONGOING ACTIONS
Regularly update Incident Briefing Document for distribution to IMT, (if an IMT incident) and other internal stakeholders Attend IMT Recovery briefings and provide input on: Present status of recovery effort Utilise TSF data available to provide analysis, including possible worst-case/best-case consequences, and outline the planning options Communicate show-stopping issues and the need for additional support Develop plans for recovery operations to implement tomorrow, the next day, next week etc Implement existing Business Continuity Plans if applicable
POST- INCIDENT
Ensure all group actions, decisions, instructions and events have been accurately recorded and documented in the IMT Log. Upon Team Leader's declaration that the emergency is over, be prepared to continue managing the recovery effort with a scaled-down Area Leadership Team or project group Participate in the IMT debrief with all Planning Group members and provide feedback, Contribute to the incident report.

Figure 7: Example TSF Specific Planning Task Card

Ongoing Response – Incident Action Planning

Once the initial response has been initiated, including completion of the initial response procedures or Task Cards, control of the incident is likely to become the responsibility of the incident management team, who should develop ongoing Incident Action Plans to control the incident.

The primary purpose of the Incident Action Plan is to document the strategies to control the incident and to set clear goals and expectations, ensuring a common operating picture is established for the IMT and extended team involved in the response. The function of an Incident Action Plan is to:[12]

- Specify the overall incident objectives, strategies and the incident controller's intent
- Identify key threats and risk exposures (including impact on the community and the environment)
- Establish continuity of command and control
- Ensure effective use of resources
- Identify anticipated resources needed

The Incident Action Plan (IAP) can be established on written boards in the IMT room or maintained online. Once approved by the Incident Controller, the IAP can be distributed internally (including up to corporate), to responders, support organisations and any other relevant stakeholders. Sharing of the IAP allows for a common operating picture to be maintained whilst providing critical information and direction for all persons involved in the incident. It is important to have a scribe within the IMT function, which allows these plans to be moved efficiently from a mental/verbal picture into a documented plan, allowing multiple objectives and strategies to be tracked and remain current. Assessing and managing risk is a critical part of incident management, and the IAP should reflect the assessment of risk relating to the objectives, strategies and tactics chosen to resolve the incident. When setting objectives, the team should use the SMART principles, which can be seen in Figure 8 below:

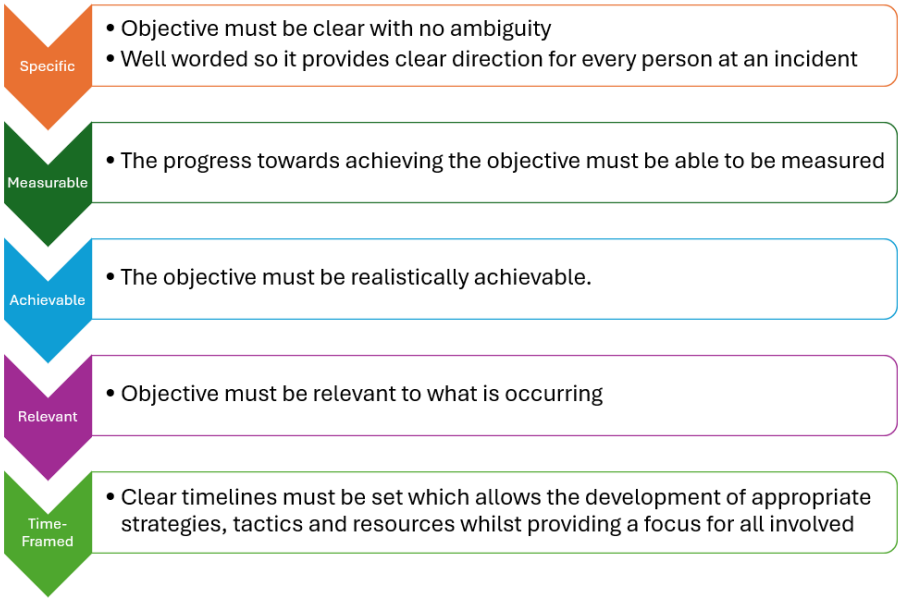

Figure 8: SMART Principles (AIIMS)

For a complex incident, a documented Incident Action Plan should include:

- current situation - a situation statement and predictions of the incident's likely development, including key risk exposures
- objective to be achieved

[12] Australian Inter Service Incident Management System – A management system for any emergency, AFAC, 2017

- strategy to achieve the defined incident objective
- secondary strategy information, if the primary strategy is achieved early
- management arrangements
- identification of allocated resources
- identification of applicable locations and affected areas using maps or site plans
- consideration of health and safety issues or inclusion of a Medical Plan
- communications plan including information on all agencies involved and appropriate contact details
- timings of meetings and changeovers
- accommodation and welfare arrangements
- information regarding necessary logistical arrangements
- traffic management information, if needed, showing traffic flow around the incident
- information plan for dissemination of information to all stakeholders

An example of an Incident Action Plan template can be seen below in Figure 9, these are typically placed on the walls of the IMT room in A0 size and filled out by the scribe.

Incident Action Plan (Example)

Reference					
Approved by (name):		on the (date):		at (time):	

Situation	
Current situation update. *Include all areas if more than one location or incident. Include projected situation (where applicable).*	

Mission (*Emergency Objective*)	
Emergency objective *What is the Emergency Objective – Specific, Measurable, Achievable, Relevant, Time-framed.* *If required, a secondary objective may be applicable if the primary objective is completed.*	Primary
	Secondary

Execution *(Overall strategy or approach as to how the mission is to be achieved)*		
General Outline *Strategies and tactics (current, proposed, alternatives)*		
Tasks Summary *(Include specific detail in Task and Actions form)*	Task	Assigned to
Coordinating Instructions *Timings, routes, assembly areas, staging areas. Traffic Management Arrangements for site*		

Logistics ***Support Aspects*** *Unit names, locations, contact names, phone numbers, timings, duties and tasks, routes, suppliers, status, etc.*	
Allocation of resources *Who, what and where resources are currently allocated*	
Supply *Who, what, where, when of resources not readily available*	

Incident Action Plan (Example)

Communications *Communication required internal and external including to corporate*	
Staging Area *Setting up, communications, staffing*	

Control, Coordination and Communications

Incident Management Team			
Role	Name	Contact	Comments
Incident Commander			
Deputy Incident Commander			
Liaison			
Log Keeper			
Operations			
Planning			
Logistics			
Human Resources			

Weather

Weather *Current and forecast, including any warnings.*	

Other

Details of any other information relevant to the emergency response.	

Safety

Relevant actions and warnings *To enhance the safety and welfare of all personnel. Add additional information as required to address the emergency.*	
Critical elements *May include risk, legal, or other specific requirements.*	

Time of Next Meeting	

Figure 9: Incident Action Plan Example

Overall Response

An example of the overall response process for a response to an imminent/actual TSF emergency is summarised in the flow chart shown in Figure 10.

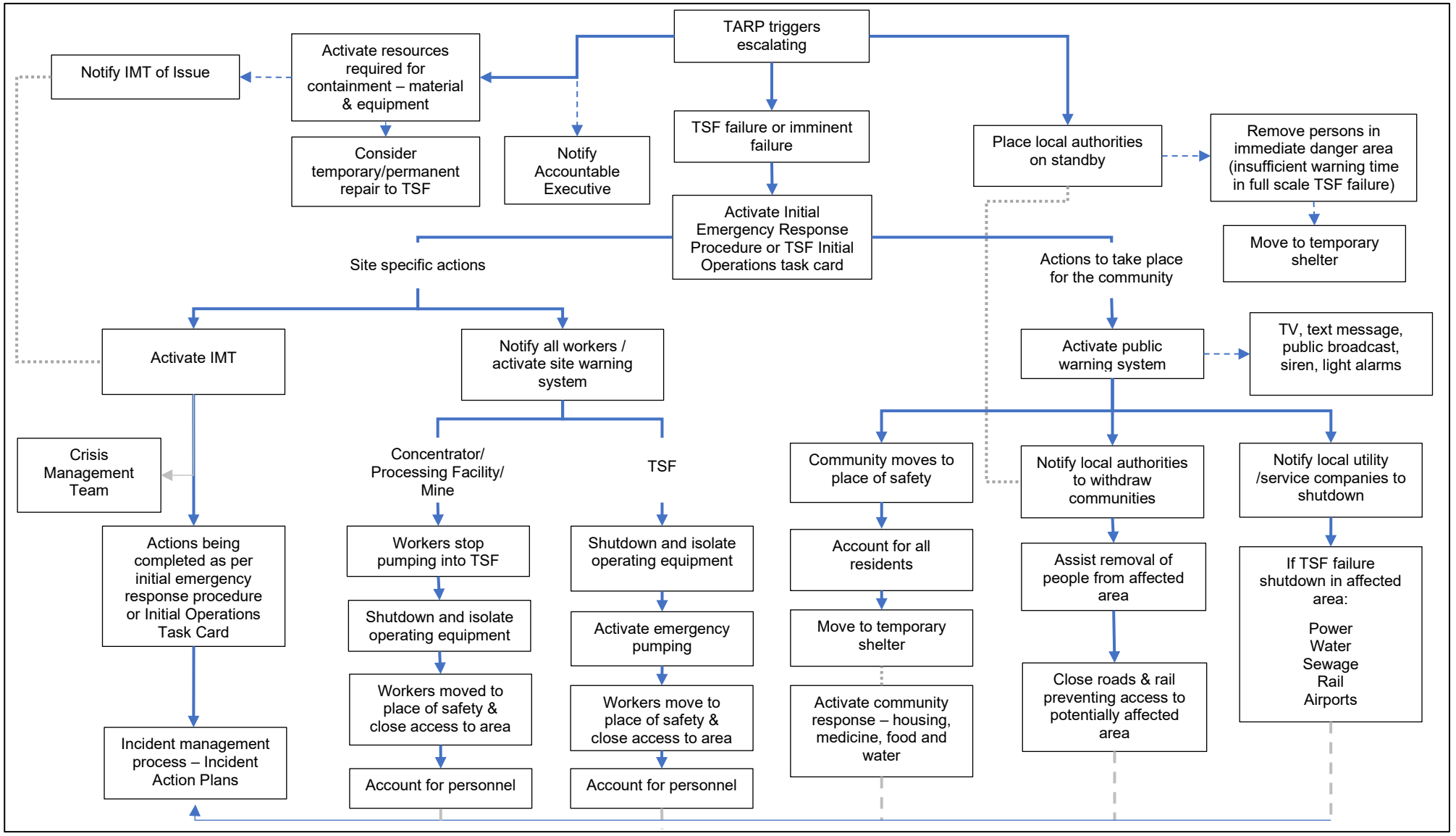

Figure 10: Example Incident Flowchart

CONSULTATION

Consultation is a vital part of each stage of the development of the TSF EPRP. Meaningful engagement needs to occur at relevant stages with employees, contractors, public sector agencies, and any potentially affected communities.[13]

Consultation should occur with workers and contractors regarding the health and safety matters related to the TSF EPRP, which potentially affect them. These workers and contractors should be provided with relevant information, be allowed to express their views, and these views should be taken into account by management before making decisions.[14]

In line with GISTM requirements, sites should engage with public sector agencies, first responders, local authorities and institutions and take reasonable steps to assess the capability of emergency response services to address the hazards identified in the TSF EPRP, identify gaps in capability and use this information to support the development of a collaborative plan to improve preparedness.

TRAINING, EMERGENCY EXERCISES AND REVIEW

Training

As part of the overall risk management process, each operation should identify the training needs of all persons in the organisation related to the emergency plan. Operations should consider training for all persons involved in the dam's day-to-day operations, those who carry out inspections, and those who have a responsibility under the TARP or in the emergency response. Persons who are identified in the site's command system (such as IMT members) should also be trained to enable them to understand the site's emergency response system and their responsibilities.

The site should ensure an adequate frequency of retraining is adopted and that the site induction process covers emergency response training prior to affected persons being appointed to perform a role.

Emergency Exercises

The operation should conduct regular exercises to test the TSF EPRP. Exercises should include the escalation factors within the TARP prior to the emergency occurring (i.e. test the TARPs), followed by initiation of the simulated emergency exercise, including the activation of the site's overarching emergency plan. The testing should also test the ability of external agencies to respond. Equally, if potential communities are identified as needing to respond as part of the EPRP, then exercises should test the community's state of readiness.[15]

Exercises can range from desktop scenarios to full simulations. It is recommended that sites engage external agencies on the initial testing of the plan and subsequently conduct simulations at least every 3 years, in line with GISTM requirements. It is important to engage the external entities, such as power providers and rail line operators, to confirm the site's initial response procedure aligns with external stakeholder requirements. Drills shall be designed to safely test resources, capabilities, processes and competencies. Results of drills should be compiled into a report and reviewed by the operation and external stakeholders to enable continuous improvement in the process.

Review and Update of the EPRP

Industry guidance material recommends the EPRP be reviewed and updated at:[16,17]

[13] Global Industry Standard on Tailings Management, GISTM, August 2020, Requirement 13.1
[14] Model Work Health and Safety Act, Safe Work Australia, Part 5, November 2023.
[15] Global Industry Standard on Tailings Management, GISTM, August 2020, Requirement 13.3
[16] Global Industry Standard on Tailings Management, GISTM, August 2020, Requirement 13.3
[17] ICMM Tailings Management Good Practice Guide, ICMM, February 2025

- All phases of the tailings facility lifecycle at a frequency established in the plan, or more frequently if triggered by a material change either to the tailings facility or to the social, environmental and local economic context.
- After updates to the risk assessment, if those updates lead to changes in the understanding of credible failure modes or potential consequences of a failure.
- In response to material changes to the tailings facility.
- When the lifecycle transitions to a different phase (e.g. transition from Operations to Closure phase).
- To reflect relevant changes in:
    - Personnel or organisational structures related to emergency response and referred to in the EPRP.
    - Sources or contact information related to off-site support, such as suppliers of material or equipment that would be used for emergency response.
    - Practices or technology related to emergency response (e.g. warning systems).
    - Legal requirements.
    - Other changes on or off-site relevant to emergency response, such as changes to road access, communication or other infrastructure.

CONCLUSIONS

A comprehensive process is required to enable TSF operators to have an effective EPRP that integrates into the mine's overall emergency plan. It is important that sites develop TARPs based on engineering design that are supported by a dam failure/emergency risk assessment. The site's emergency risk assessment should also review the mitigating control measures the site has based on the assumption that the failure has occurred, to determine if the site has adequate systems in place, considering the worst-case dam break assessment and response equipment available. Sites should establish clear protocols on how initial response plans and TSF- specific expertise integrate into the overall site incident command structure.

Whilst all due care has been taken by Mines Rescue in documenting these considerations for TSF EPRPs and TARPs, sites must undertake their own risk-based approach to determine possible failure modes and assign adequate preventative and mitigative controls. This paper may not cover all relevant legal and guidance information, has not been catered for your site, and therefore cannot be solely relied upon.

REFERENCES

Australasian Fire and Emergency Services Authority Council (AFAC), Australian Inter Service Incident Management System (AIIMS) – A Management System for any emergency, 2017

International Council on Mining and Metals (ICMM), Tailings Management Good Practice Guide

International Standard, ISO22325: Security and Resilience – Emergency Management – Guidelines for Capability Assessment, 1st Edition, 2016

Global Industry Standard on Tailings Management (GISTM), August 2020.

Model Work Health and Safety Act, Safe Work Australia, November 2023

NSW Government, Dam Safety Emergency Plans, March 2024

NSW Government, NSW Code of Practice for Emergency Planning in Mines, May 2025

NSW Government, Technical reference guide: Withdrawal and emergency escape from Underground Coal Mines, February 2023

NSW Government, August 2020, Stranded worker rescued from active tailings dam

NSW Government, September 2022, Worker swims to shore after pontoon pump and boat sink