Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**
Resources Safety

Development of high headings underground audit – guide

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Introduction

This document was reformatted in November 2015. At this time no material changes were made to the content of the guide, which was originally published in February 2008 under the title *Guide to development of high headings underground HIF audit 2008*.
Note: The Safety Regulation System (SRS) has replaced the AXTAT system and all reporting is done online through SRS.

1 Design of excavation

Design of excavation

Point	Standard	Guideline
1.1	The purpose of the excavation has been established.	**Intent:** To ensure that the appropriate ground control design is utilised dependant upon whether the excavation will be used over the short or long term. **Personnel:** Underground manager, planning engineer etc. **Method:** Establish the intended nature of the heading, e.g. Stope, drive, Vent drive, decline etc., as this will influence issues such as support design and traffic levels. A temporary excavation would not attract the same design effort as a permanent one.
1.2	A geotechnical assessment has been completed.	**Intent:** To verify that this aspect of design has received an appropriate level of attention. **Personnel:** Underground manager, planning engineer etc. **Method:** Sight layout documents, support designs, written instructions either standing or specific. Refer to MSIR 10.28.
1.3	Ventilation requirements have been established.	**Intent:** To ensure that the ventilation needs, both during actual development and in whatever role the heading will be eventually used have been considered. **Personnel:** Underground manager, planning engineer, ventilation officer etc **Method:** Sight ventilation plans and ventilation log book. Interview official responsible for ventilation re: level of involvement.

1.4	Standards are set for the plan layouts. Intent	**Intent:** To verify that a formal planning process exists using standard parameters for the provision of safety nooks, vehicle clearances etc. **Personnel:** Underground manager, planning engineer etc. **Method:** Sight layouts, survey documents, development start notes, breakthrough advices etc. Refer to MSIR. 10.24, 10.28 and 10.39 (2) a & b.
1.5	A specific procedure is developed where an excavation will approach any likely dangerous accumulation of water, gas, mud etc. capable of inundating the workplace.	**Intent:** To verify that any excavation approaching a potentially hazardous area where possible dangerous accumulations are present is planned in a safe manner. **Personnel:** Underground manager, planning engineer survey department etc **Method:** Sight the procedure and any relevant plans or documents. Confirm that cover hole drilling is carried out in front of the advancing face to prevent an inundation. Refer to MSIR 10.18.
1.6	A specific procedure is developed when an excavation will approach any other opening or workplace.	**Intent:** To verify that any excavation approaching a potentially hazardous area where possible break through hazards are present is planned in a safe manner. **Personnel:** Underground manager, planning engineer survey department etc. **Method:** Sight the procedure and ensure that the issues with respect to ventilation short circuiting, roadway survey alignment and the opening in front of the advancing heading is checked for explosives and services are protected prior to breakthrough. Refer to MSIR 10.27.
1.7	Accountability during the established excavation planning procedure exists.	**Intent:** To ensure that accountability is accepted. **Personnel:** Underground manager, planning engineer etc. **Method:** Sight signatures of responsible persons on relevant documents, e.g. underground manager, senior mining engineer, surveyor & etc.

2 Drilling

Drilling operations

Point	Standard	Guideline
2.1	A standard drilling pattern for the heading exists.	**Intent:** To ensure that there is a standard pattern for the drilling of designated excavations. **Personnel:** Underground manager, planning engineer etc. **Method:** Sight drilling patterns.
2.2	A standard procedure for aligning the face (marking off) exists.	**Intent:** To ensure that the marking up of the line and grade of a developing heading follows the specifications of the surveyor. **Personnel:** Underground manager, planning engineer, surveyor and operators. **Method:** Sight procedure and confirm implementation by interview of operators. Tight control of this issue is essential if unplanned and potentially hazardous events such as, breakthroughs into old workings and open pit bottoms, mining too close to existing excavations or over mining, are to be avoided.
2.3	A standard procedure for drilling the face exists.	**Intent:** To ensure that there will be consistency in face drilling. **Personnel:** Underground manager, planning engineer and operators. **Method:** Sight procedure and interview the operators to establish compliance. This would specify how the jumbo is to be positioned, the brakes applied, jacks lowered and the manner and timing of changing from diesel power (transport mode) to operating (electro hydraulic) mode. The way in which electrical power is connected and which functions are permitted to be carried out under diesel power and/or electrical power should be specified. Matters such as positioning the cut and the order of drilling holes should be established.

2.4	Drill Operators are trained in the standard procedure for drilling.	**Intent:** To verify that drill operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** Drill operators. **Method:** Examine a sample of training records. Confirm that each drill operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
2.5	The work quality of the drilling crew is regularly checked by management.	**Intent:** To ensure that the work of the drilling crews complies with the required standards. **Personnel:** U/G Manager, foreman and shift supervisors. **Method:** Inspect U/G manager, foreman and/or shift supervisors' notebooks or shift reports. Confirm by interview of line managers and supervisors.
2.6	The procedures are adhered to by the drilling crew.	**Intent:** To confirm whether or not practice is in line with procedure. **Personnel:** Drill operators. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Carry out physical task observation of drilling function. Check written records e.g. Supervisor and Operators Daily Logs.

3 Charging explosives

Charging explosives

Point	Standard	Guideline
3.1	A written procedure for charging up exists.	**Intent:** To ensure that charging up will be done in a consistent manner. **Personnel:** U/G manager, foreman and shift supervisors. **Method:** Sight the procedure document, or relevant training manual. The procedure should involve the method of handling the explosives and accessories from where they are issued to the crew, the method of transport and the method of actually charging up. Safety requirements affecting the task and equipment should be detailed.
3.2	The procedure makes provision for minimising blast damage to back and sidewalls.	**Intent:** To verify that the procedure recognises the importance of this issue and provides a response to it. **Personnel:** Managers and employees. **Method:** Examine procedure for evidence that it attempts to control sidewall and hanging wall damage. Most commonly this will involve a lighter charge in the outermost or 'contour' holes and possibly a greater number of holes than would otherwise be needed. Special 'trimming' explosives exist and can be used. These techniques are sometimes generically called 'smooth' blasting. Refer to MSIR 10.28(2)(b).
3.3	A standard to minimise overbreak exists.	**Intent:** To confirm management commitment to quality performance. **Personnel:** Managers and employees **Method:** Examine the procedure for evidence that overbreak and the control of it are concerns of management. Overbreak is normally expressed as a percentage of the designed cross-sectional area of the excavation e.g. if the design is for a 5m.x 5m. (25 sq. m.) tunnel and an actual survey measurement of it indicates it has been blasted to 5.5m.X6.5m. (35.75 sq. m), the overbreak is 43%. Good practice would normally suggest 10% as just acceptable. Poor control of overbreak leads to additional cost in terms of rock removal and support.

3.4	Operators are trained in the standard procedure for charging.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** Charge up operators. **Method:** Examine a sample of training records. Confirm that each charge up operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
3.5	The work quality of the charge up crew is checked by management.	**Intent:** To ensure that the work of the charging crews complies with the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors notebooks or shift reports. Confirm by interview of line managers and supervisors.
3.6	The procedure is adhered to by the charge up crew.	**Intent:** To confirm whether or not practice follows the written procedures. **Personnel:** Operators and supervisors. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken Carry out physical task observation to gauge compliance to procedure. Interview personnel.

4 Blasting practices

Blasting practices

Point	Standard	Guideline
4.1	A written standard procedure for blasting exists.	**Intent:** To verify that blasting procedures are consistent. **Personnel:** U/G manager and foreman. **Method:** Sight the procedure document, or relevant training manual. Safety requirements affecting the task and equipment should be detailed. Refer to MSIR 8.25 in regard to firing warnings and MSIR 8.27 in regard to firing times.
4.2	Operators are trained in the standard procedure for blasting.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** Supervisors, Shotfirers and sentries. **Method:** Examine a sample of training records. Confirm that each operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
4.3	Compliance with blasting procedures is regularly checked by management.	**Intent:** To ensure that blasting practice meets the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors notebooks or shift reports. Confirm by interview of line managers and supervisors.
4.4	Personnel involved adhere to the blasting procedure.	**Intent:** To confirm whether or not practice follows the written procedures. **Personnel:** Supervisors, Shotfirers and sentries. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Carry out physical task observation to gauge compliance to procedure. Interview personnel.

4.5	A written standard procedure for re-entry after blasting exists.	**Intent:** To verify that a safe procedure is developed for the removal of blasting fumes prior to re-entry. **Personnel:** U/G manager, supervisors and operators. **Method:** Sight procedure. Whilst most mining operations do make provision for this type of procedure, it is normally related to re-entry within short time periods, typically 24 hours. There have, however, been a number of instances involving people suffering injury, usually fuming, from having entered places where blasting had occurred a long time previously and where the person involved had no knowledge of the likely conditions prevailing, due to the lapse of time. An acceptable re-entry procedure would embody steps to avoid this situation. Refer to MSIR 9.22.
4.6	Re-entry personnel are trained in the standard procedure.	**Intent:** To verify that personnel are trained and assessed competent to perform the task in line with the procedure. **Personnel:** U/G operators. **Method:** Examine a sample of training records. Confirm that each person involved in re-entry has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
4.7	Compliance with re entry procedures is regularly checked by management.	**Intent:** To ensure that re-entry practices meet the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors Notebooks or shift reports. Confirm by interview of line managers and supervisors.
4.8	The re-entry procedure is adhered to by underground personnel.	**Intent:** To confirm whether or not practice follows the written procedures. **Personnel:** Operators. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Physically observe and/or interview as appropriate.

5 Making safe

Making headings safe

Point	Standard	Guideline
5.1	A written standard procedure for making the heading safe exists.	**Intent:** To verify that this aspect of the development process has been accorded the appropriate priority by management. Such procedures will include provision for re-establishing the ventilation, watering down and scaling the excavation. **Personnel:** U/G manager, supervisors etc. **Method:** Refer to MSIR 10.13 and 10.28. Sight procedure.
5.2	The equipment and/or vehicles required by the procedure are available.	**Intent:** To ensure that the work can be carried out in accordance with the procedure. **Personnel:** Operators and supervisors. **Method:** Physically check for, and confirm by interview with the operators involved, that the equipment, vehicles and materials specified in the procedure are available when required. It is not sufficient for the procedure to state that, for instance, an IT vehicle should be used for barring down, when this particular machine is often not available for this purpose due to other duties, thereby forcing the operators to improvise.
5.3	Illumination of sufficient quality is provided for inspection of high work places.	**Intent:** To ensure that the equipment required to actually carry out the work safely is available. **Personnel:** Supervisors and employees. **Method:** Ascertain what type of lighting is provided to employees inspecting high headings.

5.4	Personnel involved in making the heading safe are trained in the standard procedure.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** U/G operators. **Method:** Examine a sample of training records. Confirm that each operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
5.5	Compliance with making safe procedures is regularly checked by management.	**Intent:** To ensure that the work complies with the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors Notebooks or shift reports. Confirm by interview of line managers and supervisors.
5.6	The procedure for making safe in high headings is adhered to by the personnel involved.	**Intent:** To confirm whether or not practice follows the written procedure. **Personnel:** Operators and supervisors. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Carry out physical task observations. Interview personnel.

6 Loading out operations

Loading out operations

Point	Standard	Guideline
6.1	There is a written standard procedure for face cleaning (mucking out).	**Intent:** To ensure that this aspect of the development process has been accorded the appropriate priority by management. **Personnel:** U/G manager, supervisors etc. **Method:** Sight procedure.
6.2	Personnel are trained in the standard procedure for loading operations.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** Loader operators. **Method:** Examine a sample of training records. Confirm that each loader operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.
6.3	Compliance with load out procedures is regularly checked by management.	**Intent:** To ensure that the work complies with the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors Notebooks or shift reports. Confirm by interview of line managers and supervisors.
6.4	The procedure is adhered to by the operators involved.	**Intent:** To confirm whether or not practice follows the written procedure. **Personnel:** Operators and supervisors. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Carry out physical task observations. Interview personnel.

7 Ground assessment and support design

Ground assessment and support design

Point	Standard	Guideline
7.1	A geological assessment has been made at the planning stage of the excavation.	**Intent:** To verify whether the geology of the rock mass in which the excavation is to be made has been considered in the planning of the excavation. **Personnel:** Geologist, planning engineer and U/G manager. **Method:** Examine current and future planning for its geological input. Refer to MSIR 10.28(2).
7.2	Rock mass classification (RMC) has been carried out and results are available.	**Intent:** To determine if systematic rock classification has been carried out. The two most commonly used rock mass classification systems are The Geomechanics Classification (BIENIAWSKI - 1973) and the 'Q' System (BARTON, LIEN and LUNDE - 1974) which are readily available from a number of sources. Application of these systems is not particularly difficult but does require some work. In consequence there is a tendency amongst some rock mechanics practitioners to 'guess' at a classification value rather than go through the procedure. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check documentation. Refer to MSIR 10.28.
7.3	Dimensions and geometry of the planned excavation have been considered in relation to the RMC and geology.	**Intent:** To verify that excavation dimensions and geometry are determined with due consideration of the geological environment. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check documentation specifying the excavation dimensions and geometry. Refer to MSIR 10.28(2).

7.4	The range of dimensions of potentially unstable rock blocks is determined.	**Intent:** To verify that the potentially unstable blocks have been identified. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check written evaluations of potentially unstable blocks within the rock mass. Computer programs such as 'Unwedge' may be used to model geological discontinuities and the excavation. It should be noted that the orientation of an excavation is often critical in the formation of unstable wedges and should therefore be evaluated in the support design process. Refer to MSIR 10.28.
7.5	The type of support appropriate to the identified conditions is established.	**Intent:** To verify that support recommendations reflect the analysis above. Variations along the length of an excavation may require changes in support strategy. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check recommendations. Where the standard does not include meshing in the backs justification is recorded as outlined in the MOSHAB Code of Practice 'Surface Support for U/G Mines'. Refer to MSIR 10.28.
7.6	Length and orientation of support elements are specified.	**Intent:** To verify that these critical specifications are defined and are not left uncontrolled. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check documentation. Refer to MSIR 10.28.
7.7	Maximum and minimum spacing of support elements are identified.	**Intent:** To verify that basic support pattern standards are defined. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check support designs/recommendations. Refer to MSIR 10.28

7.8	Ground support and/or surface protection is designed to contain side wall failure.	**Intent:** To protect underground operators from side wall failure, liable to be more likely in high headings. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Check support designs/recommendations.
7.9	The hazard of potential deterioration of support elements has been identified.	**Intent:** To ensure that this hazard has been assessed and responded to. The groundwater in many mining areas of W.A. is extremely saline and can cause accelerated corrosion in iron based material. Non grouted steel support members and welded mesh are particularly vulnerable. Galvanising the mesh is an effective protection but the success achieved using galvanised friction anchors is highly questionable as it has been shown that that the zinc coating becomes scored and flakes off when the bolt is inserted in the hole. A feature of chloride attack on steel is that it propagates from point of entry until all of the iron based material is converted. In consequence, claims that this issue is dealt with by the use of galvanised ‘split sets’ must be treated with caution and physical evidence that no corrosion is occurring must be sought. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Interview personnel with geotechnical responsibility and check relevant documentation.

7.10	The method and frequency of support testing is determined at the design stage, including testing of shotcrete where used.	**Intent:** To ensure that the need to test support is recognised and a method of implementation is available. This can be of different forms. An external contractor or possibly a roofbolt supplier might be utilised. Alternatively testing equipment and expertise may be available at the actual mine. It is important also, where shotcrete is used, to establish that some means of controlling the quality of the concrete and the thickness applied, is in place. Shotcrete is perceived in W.A. to be a 'new' technique which does not fall within the ambit of formal 'support' and thus does not require to be tested. This view is quite erroneous, rigorous testing is essential in any shotcrete program. **Personnel:** Geotechnical personnel, planning engineer and U/G manager. **Method:** Ascertain whether or not a means for support testing has been specified and is available on the mine. Testing specifications are usually recommended by the manufacturers and may be in the order of 0.5 to 1% of the bolts installed in a particular geological domain.

8 Ground support installation

Ground support installation

Point	Standard	Guideline
8.1	There is a written standard procedure for installing support in high headings at the mine.	**Intent:** To ensure that this aspect of the development process has been accorded the appropriate priority by management. **Personnel:** U/G manager, supervisors etc. **Method:** Sight procedures for spot bolting, meshing and/or shotcreting as applicable.
8.2	The equipment and/or vehicles required by the procedure are available.	**Intent:** To ensure that the work can be carried out in accordance with the required procedure. **Personnel:** Operators and supervisors. **Method:** Physically check for, and confirm by interview with the operators involved, that the equipment, vehicles and materials specified in the procedure are available when required. It is not sufficient for the procedure to state that, for instance, a short boom jumbo should be used for bolt installation, when in fact this particular machine is often not available for this purpose due to other duties, thereby forcing the operators to improvise.
8.3	Operators are trained in the standard procedure for installing ground support.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** U/G operators. **Method:** Examine a sample of training records. Confirm that each operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.

8.4	Compliance with the ground support installation procedures is regularly checked by management.	**Intent:** To ensure that the work complies with the required standards. **Personnel:** U/G manager, supervisors and/or foreman. **Method:** Inspect U/G manager, foreman and/or shift supervisors Notebooks or shift reports. Confirm by interview of line managers and supervisors.
8.5	The procedure for installing support in high headings is adhered to by the operators involved.	**Intent:** To confirm whether or not practice follows the written procedure. **Personnel:** Operators and supervisors. **Method:** View a sample of site task observations to confirm that compliance checks are being undertaken. Carry out physical task observations. Interview personnel.
8.6	Testing of support is carried out on a systematic basis as required by the design and a record is kept.	**Intent:** To ensure that the support system is working as designed. **Personnel:** Geotechnical personnel, planning engineer and U/G manager **Method:** Check records against design frequency and recognition of the significance of results obtained.

9 High headings lifetime management

High headings lifetime management

Point	Standard	Guideline
9.1	A procedure exists for the post development inspection of high headings, both active and inactive.	**Intent:** To verify that a mechanism is in place to examine systematically the ongoing safety of excavations. **Personnel:** U/G manager. **Method:** Refer to MSIR 10.13. Sight the procedure.
9.2	The equipment and/or vehicles required by the procedure are available.	**Intent:** To ensure that the work can be carried out in accordance with the required procedure. **Personnel:** Operators and supervisors. **Method:** Physically check for, and confirm by interview with the operators involved, that the equipment, vehicles and materials specified in the procedure are available when required.
9.3	Operators are trained in the standard procedure for the post development inspection of high headings.	**Intent:** To verify that operators are trained and assessed competent to perform the task in line with the procedure. **Personnel:** U/G operators. **Method:** Examine a sample of training records. Confirm that each operator has completed a written questionnaire and a physical assessment on the job. Refer to MSIR 4.13.

9.4	A maximum time period between inspections is defined.	**Intent:** To ensure that the procedure recognises that mine excavations can deteriorate with time and provides a response. **Personnel:** U/G manager. **Method:** Check the procedure for this provision. The frequency of formal inspections is site specific. Each mine and section of development will have varying geological, support and usage parameters which determine the risk being managed. Areas that are frequently used as travelling ways will require an increased frequency of inspection compared with those rarely entered. It should be noted that entering areas rarely visited would require additional precautions. As a rule of thumb emergency escape routes and main access ways should be inspected at least monthly and all other travel ways at least quarterly. This would be over and above the shift by shift supervisor inspection of the individual working places.
9.5	A means of recording the inspection results is provided.	**Intent:** To ensure that inspection results are recorded. **Personnel:** U/G manager and supervisors. **Method:** Sight records. Ensure that site specific records of inspection are documented for each area (separate pages are set aside for each high heading requiring post development inspection).
9.6	Inspection records are countersigned and dated by the Underground Manager or appropriate nominee.	**Intent:** To ensure management is aware of the inspection findings. **Personnel:** U/G manager. **Method:** Sight records.
9.7	A scaling programme is established based on the inspection findings in areas where mesh, shotcrete or other lining protection is not installed.	**Intent:** To verify that all unlined sections of high headings and large excavations where personnel work or travel are maintained in a safe condition. **Personnel:** U/G manager, shift supervisor. **Method:** Refer to MSIR 10.13. Sight scaling programme records.

9.8	A maintenance repair programme is established where the inspection findings identify deterioration in the installed roadway excavation lining.	**Intent:** To verify that all lined sections of high headings and large excavations where personnel work or travel are maintained in a safe condition. **Personnel:** U/G manager, shift supervisor. **Method:** Refer to MSIR 10.13. Sight maintenance repair programme records.