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Innovative equipment to improve Safety and Productivity

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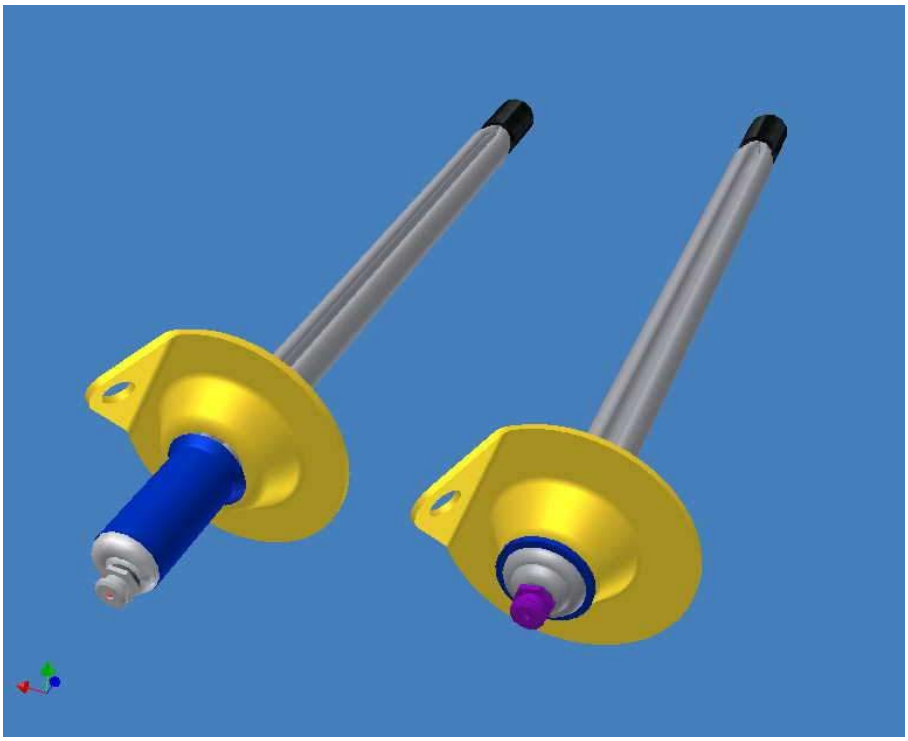
*Guideline for the compilation of a**

Risk Assessment

on the

Hydrabolt and ManziBolt

Rock Anchors



**This guideline has been prepared by New Concept Mining (Pty) Ltd to assist a user in the compilation of its own Risk assessment as required by the Mine Health and Safety Act.*

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Summary

1.1 Introduction

This guideline has been prepared by New Concept Mining (Pty) Ltd to assist any mine using the Hydrabolt and ManziBolt Rock anchors in compilation of its own risk assessment as required by section 11 of the Mine Health and Safety Act. The assessment has been undertaken by the supplier in terms of the requirement of section 21 of the Act.

This Risk assessment has been undertaken by staff of New Concept Mining who have been involved in the design, manufacturing and marketing of the unit to establish the risks associated with the use of the product.

This support unit is also designed to assist mines, where applicable, to comply with Chapter 14 of the Mine Health and Safety Act in terms of the new generation regulatory mechanisms Chapter 14.1 (7) refers to Competent person B who has the responsibility for the installation, removal and maintenance of support

1.2 Key Risk Issues

Arising from the assessment and analysis were the following main key risk issues:

- The underground environment and particularly the risk associated with falls of ground due to poor hanging wall conditions that may exist during the installation process.
- The inadequate installation of the anchor, which may lead to removal of the support by the blasting process with potential impacts of falls of ground. These installation conditions are characterized by insufficient preload pressure that will provide less than expected pull out forces.

1.3 Recommendations

The following recommendations have been made:

1. The user should develop, implement and maintain appropriate procedures and training programs for the correct and safe installation of the Hydrabolt anchors by its operating personnel.
2. The user's rock engineering department must be aware of and approve the use of the Hydrabolt or ManziBolt as compatible with existing support strategy.
3. Appropriate personal protective equipment (PPE) should be provided to all persons installing the unit (e.g. gloves, eye protection)
4. Appropriate pressurising equipment should be provided and authorized for use in the pre-stressing of the Hydrabolt or ManziBolt during the installation.

2 Objectives

The purpose of this risk assessment is:

To identify the hazards, prioritise the associated risks and highlight the controls required to eliminate or minimise the risks related to the Hydrabolt and ManziBolt rock anchors and its operation, as well as any risk of failure, primarily from the point of view of the health and safety of the workforce, but also production delay and asset damage or a combination of the three.

This process ensures that all reasonable precautions are taken to either eliminate or minimise the risk of injury to the workforce during the installation or operating phases.

The outcome is a formal Risk assessment Report with prioritised actions where applicable.

3 Risk Analysis Method

The risk analysis follows a standard method of work process analysis. All risk assessments follow a general scheme, which can be described as follows:

1. Description of the system under analysis (including equipment, personnel, procedures, work environment, management and supervisory systems) etc.
2. Identification of loss scenarios (i.e. sequences of events leading up to potential or actual losses such as incidents or accidents) in the form of hazards, potential productivity interruptions, asset damage events, environmental contamination issues etc. and evaluation of the risks of each loss scenario by determination of the relative likelihood of each event, and the relative consequence of each event.
3. Evaluation of the currently planned controls, barriers and safeguards, including a post control risk rating.
4. Identification of additional controls, barriers and safeguards.

3.1 Defining the operational system

The report is scoped to review risks related to the work process during the storage, transport and installation of the Hydrabolt and ManziBolt. An operational flow chart highlighting these activities is derived within the risk assessment.

The performance of the unit was also examined by way of a Failure Mode and Effect Analysis (FMEA) on the component parts of the system. This appears in Appendix B.

3.2 Identification of the possible system hazards

This step postulates the maximum reasonable consequence of loss scenarios (i.e. of circumstances leading up to or resulting in hazards). The consequences were classified as losses to people (health & safety), production delays, equipment and environmental damage, or combinations of these losses.

In the current study, the focus is on the health & safety issues.

3.3 Determination of the level of risks

Risks associated with each step in the operational flow chart are considered. This is achieved by considering the event frequency (probability) and the event severity (consequence).

In South Africa, Sigma Risk utilises a standard ranking system that has been used on many previous analyses, and has been acknowledged by international authorities as an acceptable means of prioritising and ranking risk-based information during team exercises.

The definition of risk: - **Risk is defined as the product of probability and consequence.**

The ratings of probability and consequence used in this assessment are shown below.

3.3.1 Probability categories

Probability categories (A - E) were defined as follows.

Category	Probability
A	Common
B	Likely to happen
C	Could happen
D	Unlikely
E	Extremely unlikely (Practically impossible)

Table 1- Probability Categories

3.3.2 Consequence categories

Consequence categories (1 - 5) were defined for various loss categories as follows.

Category	Health & Safety consequence
1	Fatality / fatalities
2	Major Injury
3	Average Lost Time Injury
4	Minor Injury
5	Medical treatment only, or less

Table 2 - Consequence Categories

3.3.3 Risk categories

Risk categories are defined by combining the probability and consequence categories above according to a matrix of prioritised risk ranking as follows. For each hazard, an assessment of probability and consequence was carried out. The risk rating was then derived using the following risk matrix.

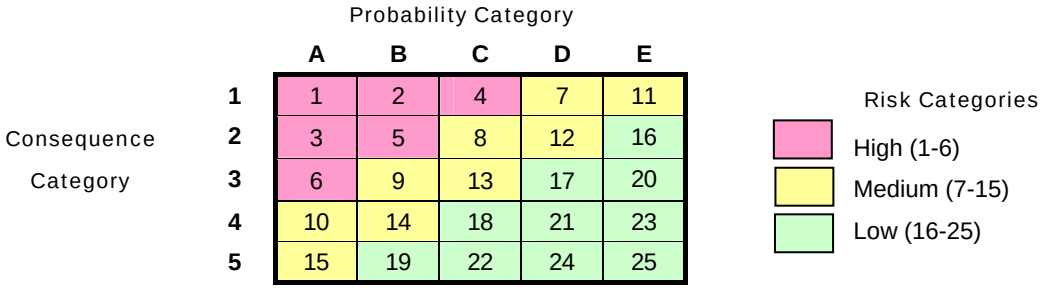

Figure 1 - Risk Matrix

A risk score of 1 denotes the highest (most significant) risk. A risk score of 25 denotes the lowest (least significant) risk.

Each risk rating was then grouped into high, medium or low categories, according to the grouping above. High risks are those ranked 1 - 6 on the matrix, and medium risks are those which ranked 7 - 15. Low risk hazards may be analysed at a later date, but are considered to be of an acceptable level.

3.4 Definition and description of the system controls and barriers

This step identifies existing controls and barriers, and also considered planned and possible additional controls and barriers, which could be used to manage the operational risks. Controls and barriers include engineering devices, operational methods and practices, management actions and principles, and environmental and system amendments that the team agrees appropriate to consider.

Controls are assessed for all the hazards identified in the Work Process Analysis (WPA).

3.5 Assessment of the acceptability of the controls

The acceptability of the nominated controls in terms of design devices, management and operational practices and system amendments is reviewed to ensure that additional scope for risk reduction has not been overlooked within the time available. An assessment of the residual risk rating after the implementation of existing controls is made. Hazards still found to carry an unacceptably high risk rating are the subject of further assessment and additional measures are recommended where appropriate.

3.6 Documentation of the study process and results

The report is presented so that the user can review the planned and proposed controls and barriers and can devise an implementation plan to incorporate any additional approved controls established through the risk analysis.

4 Results

The risk analysis exercise generated a structured set of results presented in this section.

4.1 Format for results

The analysis is based on the flow chart of work activities and the component parts of the equipment.

Results are presented in the following sequence.

- System description
- Flow chart
- Component list
- Risk analysis tables

4.2 System description

The Hydrabolt and ManziBolt rock anchors are supplied to users of rock support anchors to improve

the anchoring of the rock surrounding an underground excavation at the time of installation. This is enabled through the application of hydraulic pressure to the unit, which is a sealed steel container shaped in the form of a collapsed tube. It is placed in a previously drilled support hole. The Hydrabolt is installed using water pressurised by means of a suitable pump. The pump is connected to the unit by a hose that clips on to the non-return valve on the end of the Hydrabolt or ManziBolt. The Hydrabolt is pressurised to a minimum of 25 MPa and the ManziBolt is pressurised to a minimum of 15MPa.

Two dimensions are available. 26mm and 29mm in diameter un-inflated to and inflated diameter of 37mm and 41mm respectively. The wall thickness is 1.9mm and 2.2mm respectively. These units have a mass of 2 kg per meter length. The above sizes have a tensile capacity of 10 tons.

A second option is available in the 26mm diameter (referred to as the Hydrabolt NT or ManziBolt NT range) with a wall thickness of 1,9mm and a tensile capacity of 8 tons.

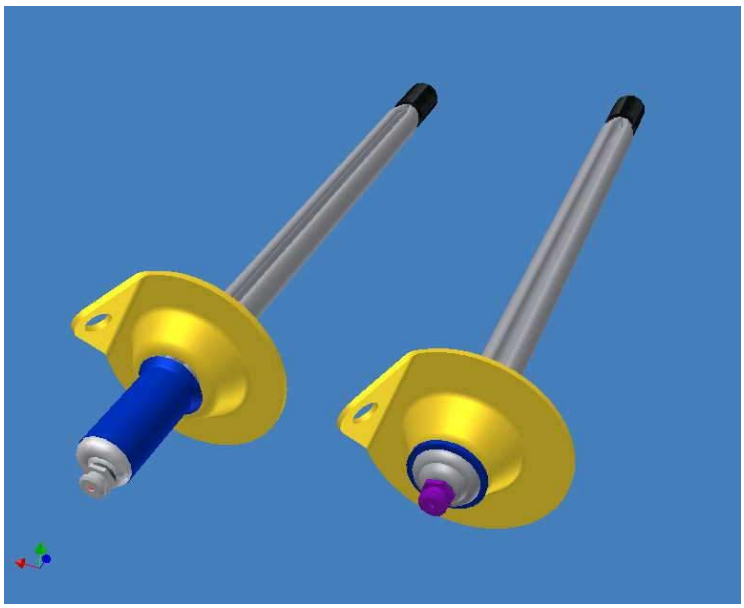

Figure 2: Appearance of Hydrabolt and ManziBolt rock anchors

The assessment considers the associated risks involved with the transport, storage and installation of the Hydrabolt and ManziBolt as shown in the flowchart in 4.3, Figure 3.

4.3 The flowchart of work activities

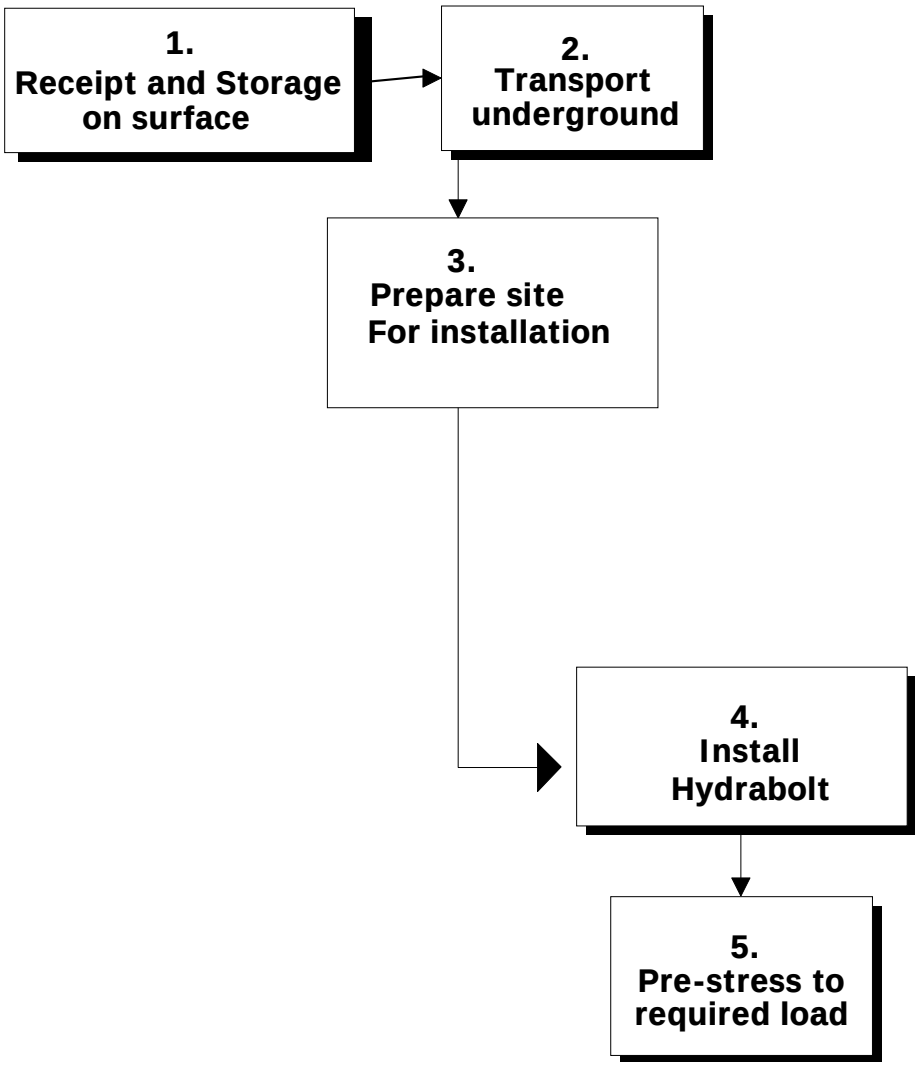

Figure 3 - Activities falling within the scope of this assessment

4.4 Component List

1. Steel body
2. Pressurising valve
3. Steel washer (optional according to Mine Standard)

A failure mode and effects analysis was carried out on the various components as identified and results are tabulated in the table in Appendix B.

4.5 Hazards

Based on the table of results of the assessment the following principal hazards have been identified in the handling, storage and installation of the Hydrabolt and ManziBolt. These constitute the higher risk areas as rated using the risk matrix in 3.3.3 above.

4.5.1 Use in the underground environment

Hydrabolts and ManziBolts are used extensively in the underground environment as rock anchors. This is often a systematic application, which requires regular, frequent and repetitious installation requiring continuous exposure to the hazards of the hanging wall and sidewall in a variety of conditions. As the principal hazard is a fall of ground, a potentially life threatening occurrence, this represents the highest risk to users of the Hydrabolt and ManziBolt and must be taken into account when determining the level of controls required to mitigate this risk.

Before use in long term or permanent installations the effect of corrosion in specific areas should be determined.

4.5.2 Installation issues

A number of hazards are highlighted in the installation process. These focus on the potential for incorrect installation of the Hydrabolt and ManziBolt that will normally result in inadequate load setting and potential falls of ground. Installing the Hydrabolt and ManziBolt with insufficient pre-load pressure, or not installing the correct length of Hydrabolt and ManziBolt in a support hole of sufficient length can cause this.

Hydrabolts and ManziBolts should be installed at an angle as close to 90 degree's as possible to the strata, angles lower than this may result in inadequate support and potential falls of ground.

Hydrabolts and ManziBolts should be pumped immediately after installation so as to provide immediate support for the operator to work under whilst drilling the hole for the next installation.

5 Hydrabolt and ManziBolt Installation Procedures

5.1 Installation using NCM Safety Pistol and High Pressure Air Pump (Blue and Orange)

1. Examine and make safe the area where the installation will take place.
2. Install temporary support as per mine standard.
3. Prepare the hanging wall to drill the support holes.
4. Mark off and drill the required holes in the hanging-wall according to your mine standard. As close to 90 degrees as possible to the strata.
5. Check the Hydrabolt or ManziBolt for any damage to the tube and the valve.
6. Assemble the washer onto the Hydrabolt or ManziBolt if your mine standard requires use of a washer.
7. If using a washer, insert the Hydrabolt or ManziBolt into the hole until the washer is tight against the hanging wall. If the washer is not required, insert the Hydrabolt or ManziBolt into the hole until the collar of the Hydrabolt or ManziBolt is tight against the hanging wall. Hold the Hydrabolt or ManziBolt in place if necessary with hand.
8. Remove the plastic cap from the valve.
9. Check that the valve is clean and free of dirt, clean with water if required.
10. Fit the nozzle onto the valve.
11. Compress the handle on the safety pistol and start pumping water into the Hydrabolt or ManziBolt.
12. As soon as the Hydrabolt or ManziBolt starts expanding move away and pressurise the Hydrabolt from a safe position.
13. Continue pumping until the safety pistol squirts water out the relief valve (25MPa for Hydrabolt, 15MPa for ManziBolt).
14. Release the handle on the Safety Pistol to relieve the pressure in the hose and then remove the nozzle from the Hydrabolt or ManziBolt and check that the load indicator is visible.
    If the load indicator is not visible, re-pump the Hydrabolt or ManziBolt and check the pump pressure if required.
15. Prepare for the next installation.

Hydrabolts and ManziBolts should be pumped immediately after installation so as to provide immediate support for the operator to work under whilst drilling the hole for the next installation.

5.2 Installation of ManziBolts using NCM Hydropower Safety Pistol (not applicable to Hydrabolts)

1. Examine and make safe the area where the installation will take place.
2. Install temporary support as per mine standard.
3. Prepare the hanging wall to drill the support holes.
4. Mark off and drill the required holes in the hanging-wall according to your mine standard. As close to 90 degrees as possible to the strata.
5. Check the ManziBolt for any damage to the tube and the valve.
6. Assemble the washer onto the ManziBolt if your mine standard requires use of a washer.
7. If using a washer, insert the ManziBolt into the hole until the washer is tight against the hanging wall. If the washer is not required, insert the Manzibolt into the hole until the collar of the ManziBolt is tight against the hanging wall. Hold the ManziBolt in place if necessary with hand.
8. Remove the plastic cap from the valve.
9. Check that the valve is clean and free of dirt, clean with water if required.
10. Fit the nozzle onto the valve.
11. Compress the handle on the safety pistol and start pumping water into the ManziBolt.
12. As soon as the ManziBolt starts expanding move away and pressurise the ManziBolt from a safe position.
13. Continue pumping until the safety pistol squirts water out the relief valve (15MPa for ManziBolt).
14. Release the handle on the Safety Pistol to relieve the pressure in the hose and then remove the nozzle from the ManziBolt and check that the load indicator is visible.
    If the load indicator is not visible, re-pump the ManziBolt and check the pump pressure if required.
15. Prepare for the next installation.

ManziBolts should be pumped immediately after installation so as to provide immediate support for the operator to work under whilst drilling the hole for the next installation.

5.3 Installation using a Third Party pump.

1. Examine and make safe the area where the installation will take place
2. Install temporary support as per mine standard.
3. Prepare the hanging wall to drill the support holes.
4. Mark off and drill the required holes in the hanging-wall according to your mine standard. As close to 90 degrees as possible to the strata.
5. Check the Hydrabolt or ManziBolt for any damage to the tube and the valve.
6. Assemble the washer onto the Hydrabolt or ManziBolt if your mine standard requires use of a washer.
7. If using a washer, insert the Hydrabolt or ManziBolt into the hole until the washer is tight against the hanging wall. If the washer is not required, insert the Hydrabolt or ManziBolt into the hole until the collar of the Hydrabolt or ManziBolt is tight against the hanging wall. Hold the Hydrabolt or ManziBolt in place if necessary with hand.
8. Remove the plastic cap from the valve.
9. Check that the valve is clean and free of dirt, clean with water if required.
10. Fit the nozzle onto the valve.
11. Pump water into the Hydrabolt or ManziBolt until it starts expanding and then move away to a safe position and pump until the 3rd party pump indicates it has reached the correct pressure (25 MPa minimum for Hydrabolt, 15 MPa minimum for ManziBolt).
    If the load indicator is not visible re-pump the Hydrabolt or ManziBolt and check the pump pressure if required.
12. Prepare for the next installation.

When using a third party pump the following should be taken note of:

- Ensure that the third party pump is compatible with the Nozzle.
- Ensure the third party pump can pump the required pressure.
- Although other pumps can be used it is recommended that New Concept Mining equipment and accessories are used as they were designed in conjunction with each other.

Hydrabolts should be pumped immediately after installation so as to provide immediate support for the operator to work under whilst drilling the hole for the next installation.

5.4 Safety Tips and Hints

1. Always work from a supported and safe position
2. Always use NCM approved equipment to install Hydrabolts and ManziBolts.
3. Always make sure you are wearing gloves and safety goggles when installing Hydrabolts or ManziBolts.
4. Do not use a Hydrabolt or ManziBolt if it has been damaged.
5. Check the delivery pressure on the pump daily.
6. Always repair any leaks on the nozzle, air pump, hoses and safety pistol before installing Hydrabolts or ManziBolts.
7. Improper installation can result in poorly supported rock, which can cause severe injury or death.
8. The High Pressure Air Pump and Hydropower equipment is supplied with a Combi-Nozzle so that Hydrabolts, ManziBolts, X-Pandabolts and Jackpots can be installed with the High Pressure Airpump
9. Never use a Low Pressure Jackpot Pump (Yellow) to install Hydrabolts or ManziBolts.
10. Always check that the load indicator is visible after installation, this indicates that the Hydrabolt or ManziBolt has been pumped to the correct pressure.
11. Always make sure that the holes have been drilled at an angle of between 90 and 7 degree's to the strata.

5.5 Controls

5.5.1 Design and manufacturing process

In the manufacture of the Hydrabolt and ManziBolt certain controls have been identified as having a positive effect on the control of the potential hazards. These include the correct Quality Assurance procedures for steel procurement, quality control checks in the manufacturing process, quality acceptance testing on all materials and components, low pressure testing of completed Hydrabolts and ManziBolts and high pressure testing of completed units.

5.5.2 Procedures

The use of the Hydrabolt and ManziBolt is directed through training programs offered by the supplier and assistance with the setting up of standard procedures for the transport and installation of the units in the workplace.

The user will normally be responsible for setting up its own procedures in the use of the unit in accordance with both the current safety procedures for the installation of support and the rock engineering requirements regarding the deployment of the support units.

5.5.3 Training

Assistance with the training of mine trainers by the supplier is offered to ensure that the units

are properly installed by the safest possible means. The supplier also offers on-site demonstration to assist in the accumulation of the proper skills by mine staff. It is recommended by the supplier that all operatives required to install the support unit are appropriately trained and assessed.

5.5.4 PPE

In the area of PPE, it is important that proper protective equipment is issued to those either transporting or installing the Hydrabolt and ManziBolt. This should include safety boots, gloves, eye protection.

Appendix A - Table of Risk Assessment Results

	AREA / ACTIVITY /	HAZARD	CONSEQUENCE / EFFECT	PRE-CONTROLS RISK INDEX			EXISTING SAFEGUARDS / CONTROLS	POST-CONTROLS RISK INDEX			RECOMMENDED CONTROLS
				P	C	R		P	C	R	
1	**Receipt and storage on surface**	a. Stored in adverse conditions	▪ Steel corrodes and unit becomes unusable	D	4	21	▪ Recommended stock turnover on FIFO basis ▪ Appropriate storage conditions recommended by supplier	E	5	25	
2	**Transport underground**	a. Hydrabolts or ManziBolts damaged in transit	• Damage to unit. Unit unusable	C	5	22	• Proper care during transport	E	5	25	
3	**Transport into stope**	a. Worker drops unit whilst carrying it	▪ Damage to unit	C	5	22		C	5	22	▪ Use mono rope where possible, ▪ Procedure should include a requirement to carry, not throw the unit
		b. Loosely stacked units slide down dip into worker	▪ Minor Injury, damage to unit	C	5	22		C	5	22	▪ Stack correctly in stope storage areas ▪ Training and Supervision
		c. Unit falls off mono rope	▪ Damage to unit	D	3	17	▪ Fastening unit securely	E	5	25	▪ Mine standards for steep areas apply.
		d. Slip and fall whilst carrying Hydrabolt or ManziBolt	▪ Minor Injury	C	4	18		C	4	18	▪ Good housekeeping. ▪ Gate stulls in steep areas. ▪ Mine procedure to prevent rolling rocks etc.
4	**Preparation of site for installation**	a. Hammering on Hydrabolt or ManziBolt	▪ Damage to unit	D	3	9	• Use supplied Dolly	D	3	17	▪ Mine Standard procedures for making safe
		b. Holes drilled too short	▪ Inadequate installation	C	5	22	▪ Suitable training ▪ Supplier recommended procedure	D	5	24	• Mine Standard for hole lengths
		c. Holes drilled at an angle lower than 70 degrees	▪ FOG	B	1	2	▪ Suitable training ▪ Supplier recommended procedure	D	1	7	▪ Mine Standards • Rock Mechanic recommendations
		d. Incorrect length Hydrabolt or ManziBolt used for conditions	▪ FOG	B	1	2	▪ Suitable training ▪ Supplier recommended procedure	D	1	7	▪ Mine Standards ▪ Rock Mechanic recommendations
		e. Holes drilled into prominent geological feature	▪ FOG	C	1	4	▪ Adhere to mine standard	D	1	7	▪ Adhere to mine standard
5	**Installing the Hydrabolt / ManziBolt**	a. Hydrabolt or ManziBolt protruding from the hole	▪ In adequate support	B	1	2	▪ Suitable training ▪ Correct hole length drilled	D	1	7	▪ Install to full length

	AREA / ACTIVITY /	HAZARD	CONSEQUENCE / EFFECT	PRE-CONTROLS RISK INDEX P	C	R	EXISTING SAFEGUARDS / CONTROLS	POST-CONTROLS RISK INDEX P	C	R	RECOMMENDED CONTROLS
		b. Rocks fall during installation or handling	▪ Injury	D	3	17	• Suitable training • Supplier recommended procedure	D	3	17	▪ No workers to work below installation ▪ Remote stressing of the Hydrabolt or ManziBolt
		c. Under size drill hole	▪ Sub standard Hydrabolt or ManziBolt installation	C	5	22	▪ Suitable training ▪ Supplier recommended procedure	D	5	24	▪ Mine standards and controls.
		d. Oversize drill hole	▪ Sub-standard support ▪ FOG	C	1	4	▪ Mine training	D	1	7	• Mine standard procedure
6	**Inflation to correct pressure**	a. Nozzle does not fit onto non-return valve	▪ Hydrabolt or ManziBolt won't inflate ▪ Injury from falling Hydrabolt or ManziBolt	D	3	17	▪ Suitable training ▪ Supplier recommended procedure	D	5	24	• Mine standard procedure
		b. Nozzle seal leaks during pressurisation	▪ Hydrabolt or ManziBolt not installed to correct pressure ▪ Operator forced to hold nozzle in position ▪ Potential injury from water spray or falling rock	B	1	2	▪ Suitable training – install from remote position ▪ Mine training – pressurise from remote position ▪ Safety posters regarding repair of nozzle seals	D	1	7	• Ensure all leaks on installation equipment are repaired immediately • Mine standards to include remote installation
	Note: Always release the Safety Pistol handle before removing the nozzle from the PSU, this relieves the pressure in the pipe and prevents injury	c. Hydrabolt or ManziBolt falls out during pre-loading	▪ Injury from falling Hydrabolt	D	3	17	▪ Suitable training ▪ Supplier recommended procedure ▪ Remote pre-stressing advised	D	5	24	• Mine standard procedure
		d. Hydrabolt or ManziBolt is not pre-loaded to the correct pressure Load Indicator not visible.	▪ Sub-standard support ▪ FOG	C	1	4	▪ Suitable training ▪ Supplier recommended procedure	D	1	7	• Training
		e. Bursting of Hydrabolt or ManziBolt	▪ High-pressure water in eyes.	D	2	12	▪ Correct QA procedures by Supplier	E	2	16	▪ PPE (Eye protection) supplied by mine
		f. Struck by hose	▪ Injury from loose hose	C	4	8	▪ Recommend regular inspections of equipment	D	4	21	▪ Attach hoses securely ▪ Training
		g. Valve fails after pre-stressing	▪ Loss of load	D	5	24	▪ QA by supplier ▪ Unit pressure tested prior to departure	E	1	11	
		h. Valve damaged by flying rock.	▪ Loss of load	D	5	24	▪ Internal valve unaffected by fly rock.	E	5	25	

Appendix B - Failure Mode and Effect Analysis

	COMPONENT	FAILURE MODE	CONSEQUENCE / EFFECT	SAFEGUARDS / CONTROLS	RECOMMENDED CONTROLS
1	**Hydrabolt and ManziBolt body**	Failure of weld between valve and body Longitudinal failure	Hydrabolt or ManziBolt cannot be properly pre-stressed	▪ Check material batch chemical analysis certificates ▪ Quality Acceptance testing on all material and components ▪ Low pressure testing of all completed units ▪ High Pressure destruction testing	▪
2	**Valve**	Failure of valve on Hydrabolt or ManziBolt	Required bond length increases by an approximate factor of 3. Bolt continues to supply support and tensile capacity is unchanged.	▪ Procedures for pre use inspection of valve ▪ Low pressure testing	▪
3	**Face Plate / Washer**	Bent or severed No face plate	Loss of collar support Support element of bolt is not lost	▪ Heavy steel gauge used ▪ Correct packaging	▪