



KF Gruppen AS



Norwegian Tunnel Technology, Practical life

18th of February- 2009, by Knut Fossum, Msc.



Summary

Norwegian Tunnel Technology is a practical way of constructing a tunnel, where a close co-operation is in place between the involved parties:

- The client as the owner and the initiator.
- The consultant as the advisor
- The Contractor as the operational construction company
- The importance of respecting HSE
- Practical built up of respect among parties
- Samples of Working instruction/ Job description



Agenda

- Introduction
- The Observation Method
- What is taking part in a tunnel
 - Drilling the drill pattern
 - Blasting
 - Ventilation
 - Mapping and Inspection
 - Rock support
 - Mucking out
- Communication
- Supporting work, Behind the Tunnel face
- Samples of Job- description



Historical back ground

- Traditions and political back ground
- Location of sites in Norway

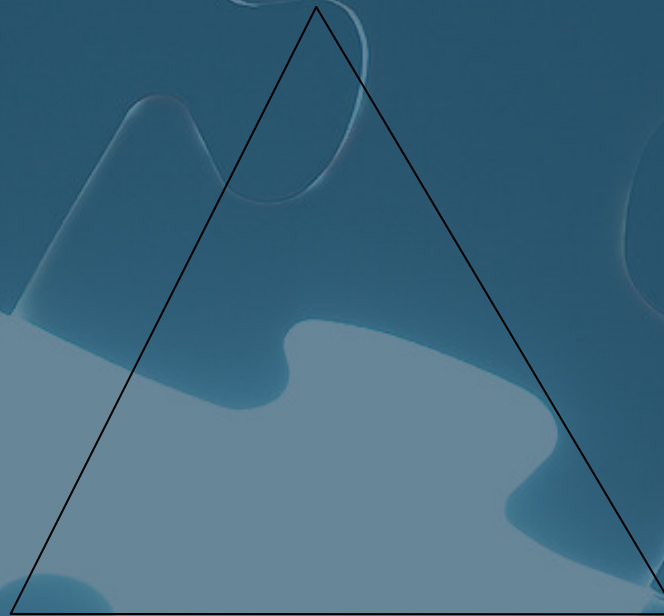


The Observation Methode

Client

Consultant

Contractor





The Start of A Project

- The owner of the ground, property of land
- Site investigation
- Common Goal divided into roles of the parties



HSE - WORKS

- **During construction time, the responsibility for workers on site is to the appointed contractor.**
- **After the handover, the responsibility is transferred to the Client.**



HSE - WORKS

- Safety and Environmental Issues into tunnel works
- Safe Job Analyses





Categories of Consequences in HSE

Consequence	People involved	Outside environment
1. Less Consequence	No people involved	Less impact
2. Little Consequences	Ignorable accidents	Local impact
3. Medium consequences	Serious accident for humans	Regional impact restitution at about 1 year
4. Huge consequences	Deadly for humans	Regional impact, restitution, up to 10 years
5. Very huge consequences	Deadly for several humans	Irreversible impact



HSE - EVALUATION

Risk Matrix

	Consequences				
Possibility	1. Less	2. Little	3. Medium	4. Huge	5. Very huge
5. Highly Possible	Low	Medium	High	High	High
4. Very Possible	Low	Medium	High	High	High
3. Possible	Low	Low	Medium	High	High
2. Moderate Possible	Low	Low	Medium	Medium	High
1. Less Possible	Low	Low	Low	Medium	Medium



SCALING

Manual Scaling, man
in a basket using
a rebar





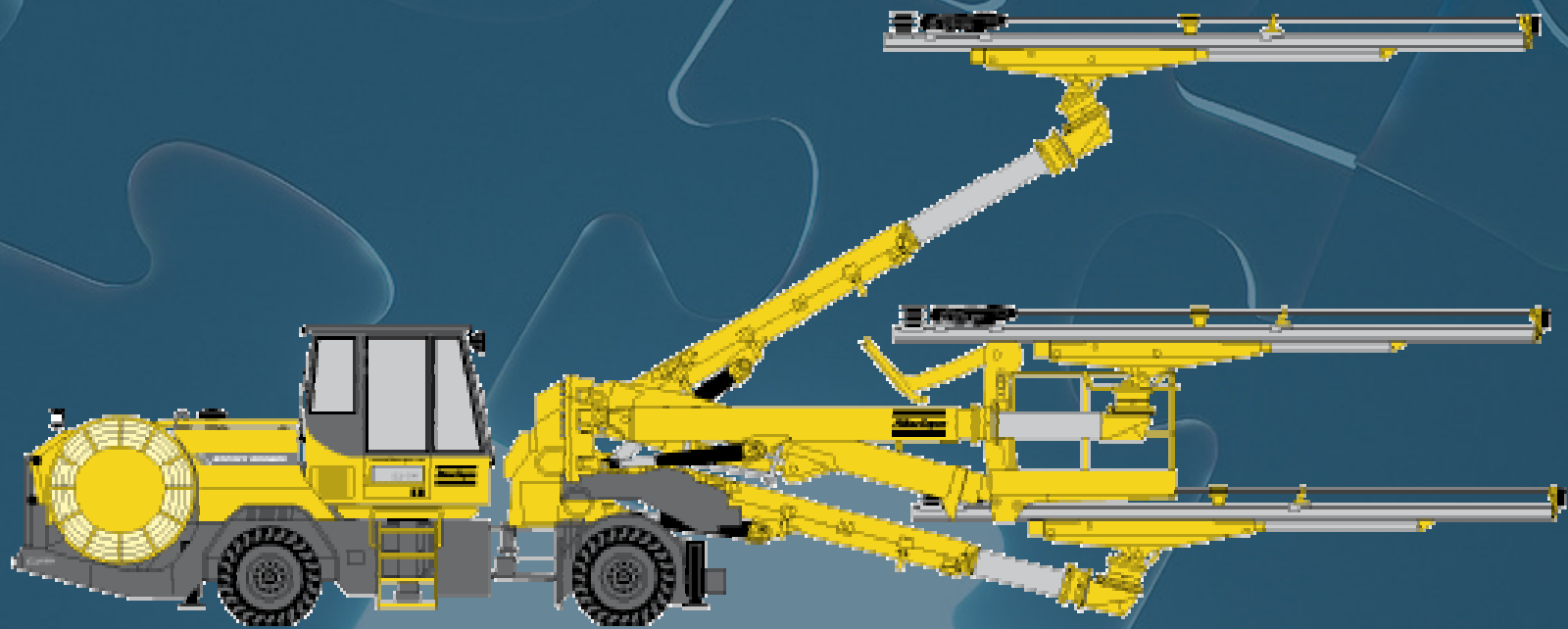
SCALING

**Mechanical scaling
using a special
equipped unit with a
hydraulic hammer of
a boom, tilted
upside down.**





DRILLING AT THE TUNNEL FACE



3- Boom drilling jumbo



DRILLING OF LARGER CROSS SECTIONS



- Excavation of larger caverns, top- heading
- And a Bench



ROCK SUPPORT

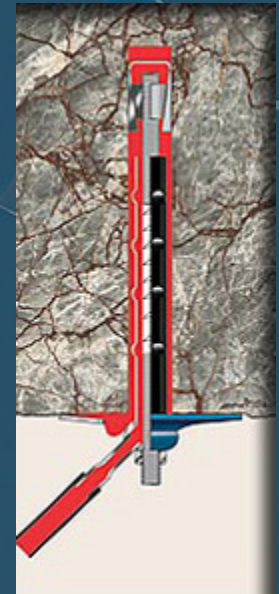
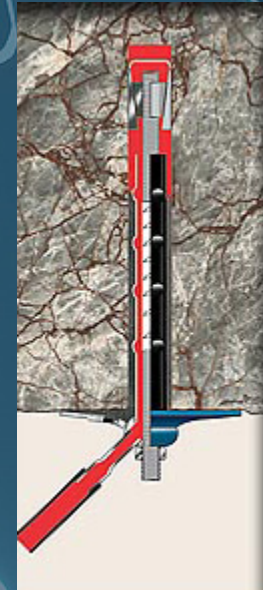


- ROCK BOLTING,
- Using a special drilling jumbo for 90 degree on surface drilling



CT- BOLT

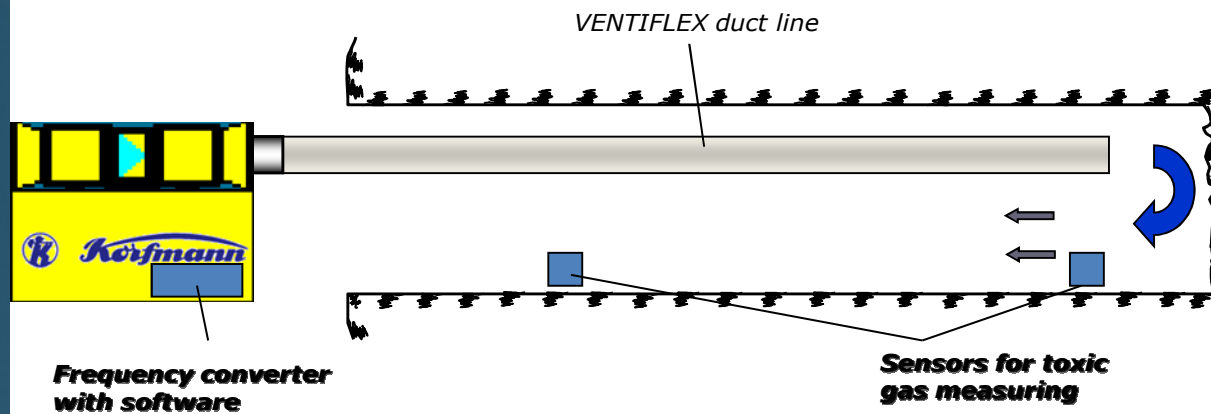
- Instalment,
- prestressing and
- grouting of the CT- Bolt





VENTILATION

Intelligent Tunnel Ventilation.



The fan speed is now controlled by measuring the toxic gas, and is supplying air as required.

A = area of profile section (profile area)



VENTILATION AS AN INTEGRATED PART

ADVANTAGES

- Energy savings for the ventilation systems
- Control of the environment in the tunnel
- Reduced down time for workers and equipment
- Improved economy for tunnel excavation

Ventilation is an integrated part of the production in a tunnel.

- Efficient production in the tunnel require reliable and good ventilation.
- Monitoring of the toxic gases and dust give us the data for the airflow.
- Energy consumption for ventilation systems are high, without a control system.
- An efficient control system can reduce the costs and maintain quality of the environment in the tunnel.



MUCKING OUT

A wheel loader which may empty the rock pile in an acceptable time, depending on the cross section.





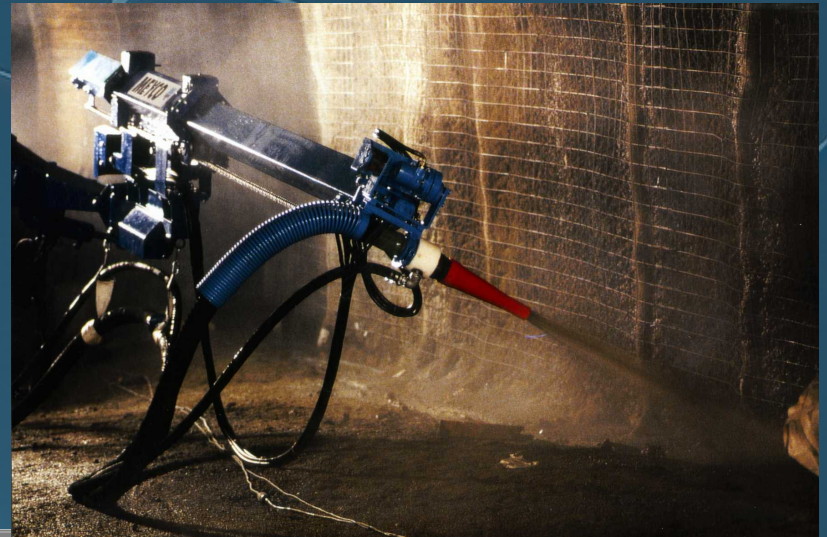
TRANSPORT

- A transport unit with acceptable
 - Capacity to empty the rock pile in time
 - To keep the wheel loader occupied, in size and numbers
 - To withstand heavy maintenance and roughness
 - Have enough speed and engine to carry the load





SHOTCRETE



Shotcrete robots
Articulated and as a spray mobile
Practical for a site of certain
Size, avoiding transport on roads





DIFFERENT SHOTCRETE ROBOTS

- The basket solution where the operator is sitting closer to the surface and in a air- conditioned basket, fresh air ventilation/ air conditioned





DRILL PATTERN

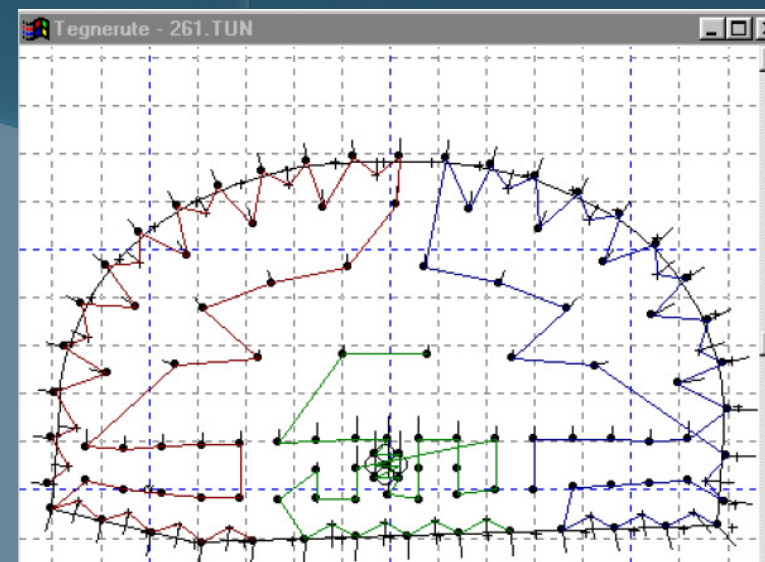
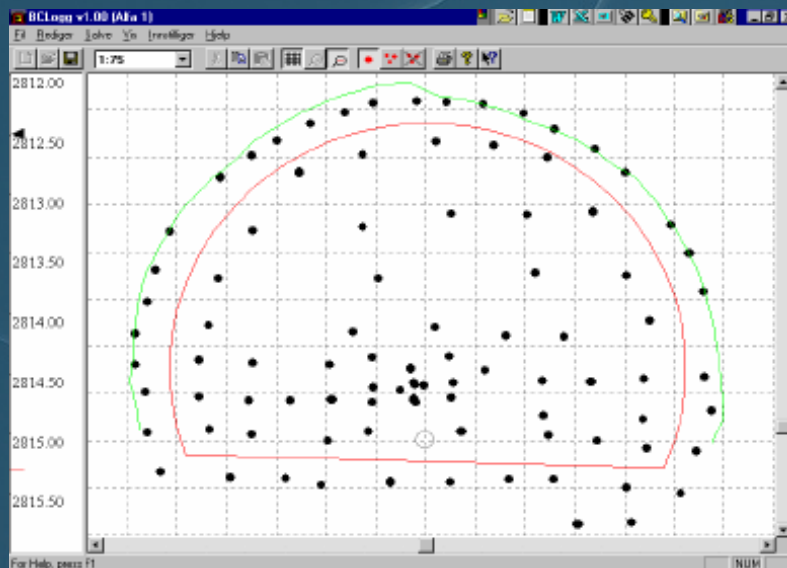
- The importance of adjusting the drill pattern to the actual situation and rock conditions





Assumptions

- The drill pattern is programmed into the computer from where the holes automatically is placed during the drilling operation via the booms.
- Reporting system after is of importance, loaded into the computer





GROUTING

- Modern grouting today requires a full multi grouting units where several holes may be grouted at the same time.
- Mixing and floating volume is measured



SUPPLEMENTARY WORK BEHIND THE TUNNEL FACE

- Working platforms for
 - Ventilation ducts
 - Cable for electricity
 - Grouting of bolts behind the tunnel face
 - Additional rock support
 - Installation of others





ELECTRICAL INSTALLITION

- All equipment in a tunnel will be more or less electrical driven, 1000 Volt
- Transformers to be installed
- Cable wheel to follow the equipment near the face
- High Voltage supply to the transformer





SAMPLES OF JOB DESCRIPTION

- Job description is to describe the present position of the man
- Where to work in the organisation
- The task they are dedicated for.
- Their authority areas.
- Who to report to.



Tunnel Manager

WORKING INSTRUCT

POSITION : Tunnel Manager

NAME :

WHERE TO WORK :

- *Be the assistant to The Construction Manger, and replace him in his absent.
- *Be a part of the Management Team at site.
- *Assist in Contractual matters, and participate in all meetings together with The Construction Manager.
- *Organise and run the supporting functions on behalf of The Construction Manager.
- *Participate in detail planning for the different position.

TASKS :

- *Do recruitment of staff from KF Gruppen AS in accordance with the agreement with the Client.
- *Keep track of the Selmer staff contractual and functional matters in Singapore.
- *Be updated of the contractual situation with the client, as well as propose co-operation improvements for the contractor and client.
- *Prepare a program for the technology transfer efforts from KF Gruppen AS to the clients appointed representatives. Special related to the function between the local as the expatriates.
- *Do detail plans for the different positions together with the different superintendents.
- *Prepare a shift plan for the project and implement it to the foremen.
- *Develop a program for the tunnel engineer from the client to follow The Tunnel Construction Manager.
- *Prepare and assist in detail cost planning and detail time scheduling.

REPORTS TO : Construction Manager OR: Project Manager

DATE :
.....
Sign. Tunnel. Const. Manager Sign. Reporting Manager



Assisting Tunnel Manager

WORKING INSTRUCT

POSITION : Assistant Construction Manager

NAME :

WHERE TO WORK :

- *Be the assistant to The Construction Manager, and replace him in his absent.
- *Be a part of the Management Team at site.
- *Assist in Contractual matters, and participate in all meetings together with The Construction Manager.
- *Organise and run the supporting functions on behalf of The Construction Manager.
- *Participate in detail planning for the different position.

TASKS :

- *Do recruitment of staff from Selmer in accordance with the agreement with SCC and Leo.
- *Keep track of the Selmer staff contractual and functional matters in Singapore.
- *Be updated of the contractual situation with the client, Leo, as well as propose co-operation improvements for the JO SCC/Selmer.
- *Prepare a program for the technology transfer efforts from Selmer to SCC and present it for Leo together with SCC. Special related to the function between the local as the expatriates.
- *Do detail plans for the different positions together with the different superintendents.
- *Prepare a shift plan for the project and implement it to the foremen.
- *Develop a program for the tunnel engineer from SCC to follow The Assistant Construction Manager.
- *Prepare and assist in detail cost planning and detail time scheduling.

REPORTS TO : Construction Manager OR: Project Manager

DATE :

.....
Sign. Ass. Construction Manager Sign. Reporting Manager



CIEF ENGINEERING GEOLOGIST

WORKING INSTRUCT	
POSITION	: Chief Engineering Geologist
NAME	:
WHERE TO WORK : *Organise and manage/ supervise in all matter related to: *Geological mapping *Keep an over view of the total geological situation *Be present in the tunnel *Participate in meetings with the employer. *Be updated on all type of rock support. *Participate in problem solving, disagreements related to geological conditions. *Do a classification of rock conditions at any sections in the tunnels, in accordance wit the rock classification program.	
TASKS : *Establish and run a full over view of the geological condition in and around all the underground openings and excavations *Be responsible for all testing of rock support method and follow the quality assurance here. *Keep a log and file of what is tested, where and at which consumption. *Make sure that the contractor with proper expertise is present after any blast in the tunnel. *Keep a day to day contact with the counter partner at the employers side. *Make sure a technical transfer program is implemented so that all contractors employee understand and are serious in regards of rock support and excavation methods. *Make sure together with the different Site Managers at each working Adit,s that sufficient stock for rock support alternatives are available. *Make sure that NO method for rock support is in conflict with HSE- routines at site. *Assist then Project Manager in his evaluations and requirement versus the Employer and te contractors own team.	
REPORTS TO	: Project Manager OR: Ass. Project Manager
DATE	:
 Sign. Chief Engineering Geologist Sign. Reporting Manager



Engineering Geologist

WORKING INSTRUCT	
POSITION	: Engineering Geologist
NAME	:
WHERE TO WORK : *Organise and manage/ supervise in all matter related to: *Geological mapping on the site, it be the tunnel or an open pit. *Keep an over view of the geological situation on hat specific site under his area. *Be present in the tunnel *Participate in meetings with the employer. *Be updated on all type of rock support. *Participate in problem solving, disagreements related to geological conditions. *Do a classification of rock conditions at the sections in the tunnels or areas, in accordance with the rock classification program.	
TASKS : *Establish and run a full over view of the geological condition at his/ she's area. *Make sure the rock support is carried out according to specifications, and follow the quality assurance here. *Keep a log and file of what is tested on site and consumption. *Make sure that the contractor with proper expertise is present after any blast in the tunnel. *Keep a day to day contact with the counter partner at the employers side. *Participate in technological transfer programs. *Make sure that NO method for rock support is in conflict with HSE- routines at site. *Assist the Site Manager on his working area in his evaluations and requirement versus the Employer and the contractors own team.	
REPORTS TO	: Chief Engineering Geologist OR/AND: Site Manager
DATE	:
..... Sign. Engineering Geologist Sign. Chief Eng. Geologist



Workshop Superintendent

WORKING INSTRUCT	
POSITION	: Workshop Superintendent
NAME	:
WHERE TO WORK : *Organise and manage/ supervise in the running of the workshop and the storage of material, among also the electric maintenance and supply of electric power. *Follow up all type of machinery on site.	
TASKS : *Establish and run the workshop and storage facilities (as to men, equipment etc.) in the project in looking after and carry out all necessary maintenance and repair work on the sites mechanical and electrical driven equipment. *Take part in all type of commissioning of any equipment arriving on site, or examine what is sent off from the site. Go through that they are in accordance with what is ordered. *Follow up with the suppliers in regards of what is delivered and what required of services to the site. (Among here the training of how to operate the equipment and how to maintain it in accordance with regulations and requirements. Also in regards of spare parts and other service requirements.) *Follow up technical routines, certificates for how to use of all kind of mechanical and electrical equipment in regards of regulations from authorities in additional to the sites own routines to fulfil the requirements for Health - Safety and Environment regulations. *Take part in budgeting and investment for the requirement of running the workshop as well as purchasing of new equipment. *Follow up internally accounting of the expenses for running the sites total stock of equipment. *Assist other Superintendents and the Project Management on site in their use of the equipment and the operators. *	
REPORTS TO	: OR:
DATE	:
..... Sign. Workshop Superintendent Sign. Reporting Manager



Chief Quantity Surveyor

WORKING INSTRUCT	
POSITION	: Chief Quantity Surveyor
NAME	:
WHERE TO WORK : *Organise and manage/ supervise in all matter related to: *Planning and report of what has been carried out. *Supervise and operate as a Chief Quantity Surveyor in close co-operation with the Project Manager. *Implement reporting routines. *Update an any time the Time Schedule and planning of work. *Be present at any internal meeting at the central Main Office for the project.	
TASKS : *Establish and run a full over view of the contractual routines and requirements for invoicing and documentation for the invoicing. *Make sure the reports and documentation at any time are in accordance with requirements and contractual conditions. *Keep and implement a filing system for documentation of what has been carried out and how this is reported. *For elements not covered by the contract, raise the claims in due time in accordance with requirements in the contract. *Make sure that the contractor with proper expertise is present after disagreements related to the contractual work on site. *Keep a day to day contact with the counter partner at the employer's side. *Participate in technological transfer programs, to implement routines on each working sector,/ adits, so that proper reporting systems are implemented. *Make sure that all reports are approved for all elements in te working process. *Assist the Project Manager on his working area in his evaluations and requirement versus the Employer and the contractors own team.	
REPORTS TO	: The Project Manager OR/AND: Ass. Project Manager
DATE	:
 Sign. Chief Quantity Surveyor Sign. Project Manager



Foremen

WORKING INSTRUCTIONS	
POSITION:	FOREMEN
NAME:	
MAIN RESPONSIBILITIES - TASKS - MANDATES	
<p>The Tunnel foremen shall:</p> <p>Arrive at least 15 min. before the others at work, about 6.45 AM.</p> <ul style="list-style-type: none">Start the day with reading the foreman report from the day before, evening/ night shift. <p>Take note of any new messages.</p> <p>Call in all team leaders for their daily information. Distribute tasks and start the work for the day.</p> <ul style="list-style-type: none">Inspect all reported areas as well as the areas where the team leaders are sat to start to work to make sure the start of work goes smoothly.. <p>Inspect and approve all scaling.</p> <p>Inspect all working places to make sure safety is taken care of.</p> <p>Discuss and make sure that all parties have the right drawings, drill patterns and excavation is carried out in accordance with these.</p> <ul style="list-style-type: none">Discuss and report to the engineering geologist all rock support matters, shotcrete, rock bolts, scaling etc.Report and discuss the status of the equipment and the maintenance procedure with the Work Shop Superintendent. <p>Make sure the wheel loader, mucking up team are updated on when and where to start work.</p> <p>Start planning for the rest of this day, preparations for the oncoming shift and the coming day.</p> <p>Calculation of explosives:</p> <ul style="list-style-type: none">Make sure that explosives are ordered in time, and stay in contact with Orica. <p>Make sure that The licensed shotfire is available.</p> <p>Make sure that the Safety Officer has been given notice.</p> <ul style="list-style-type: none">make sure that all precautions are taken before any charging take place etc. <p>Shotcrete application:</p> <ul style="list-style-type: none">Make sure that planned shotcreting areas are properly profiled.Inform the shotcrete team in time.Calculated the volume of shotcrete by thickness etc. <p>Important. Carry out the shotcrete at the right place.</p> <p>Supplies in the tunnel:</p> <p>Make sure there are sufficient with ventilation/ air at the working sites.</p> <p>Enough power supply, electricity.</p> <p>water supply is brought forward</p> <p>The road is ready and maintained</p> <p>Check daily the roads for a proper transport availability.</p> <p>Drain to be checked.</p> <p>Pump sump to be cleared.</p> <p>Pumps to be installed.</p> <p>Light to be sufficient along the road.</p> <p>Make sure that there are enough at the stock for:</p> <ul style="list-style-type: none">Drilling bits <p>Drilling rods</p> <p>Shank adapters</p> <p>Hoses for possible hydraulic break down.</p> <p>Mortar for rock anchors, bolts.</p> <p>Make sure that all reports are forwarded back to the workshop in regards of breakdowns in the tunnel, for equipment etc.</p> <p>The foreman shall at any time be available to the tunnel crew.</p> <p>The foreman must be available for communication with the clients representatives on site, in the tunnel. But never loose the sight of production.</p> <p>At the end of the shift prepare a report for the coming on foreman, for him to know what is going on.</p> <p>Give a mutual information to the on coming foreman. ½ hour before the end of the shift.</p>	
REPORTS TO: Tunnel Engineer and Tunnel Manager.	DEPUTY: None
Signed by:	Approved by:
Date:	Date: