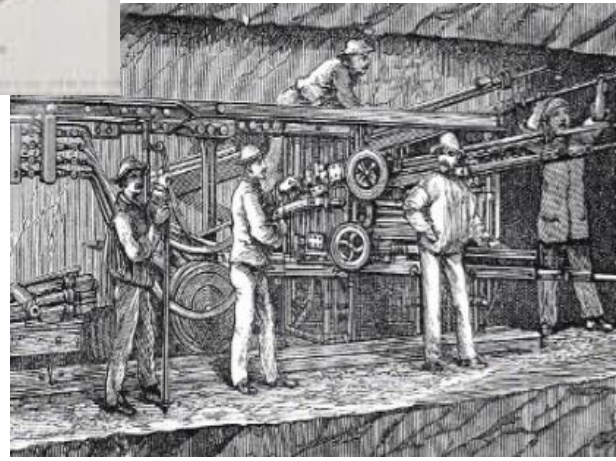
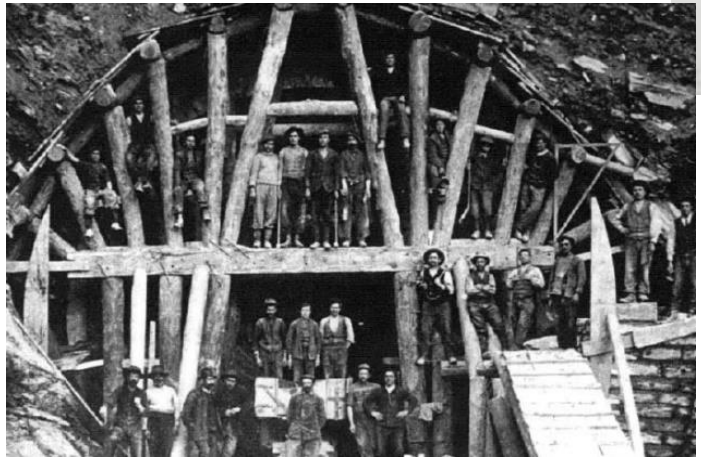
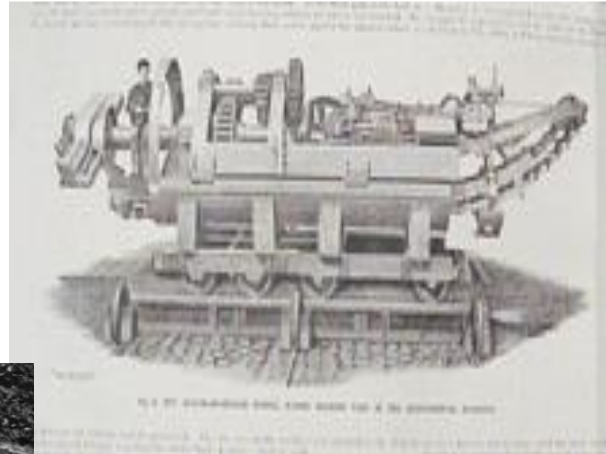
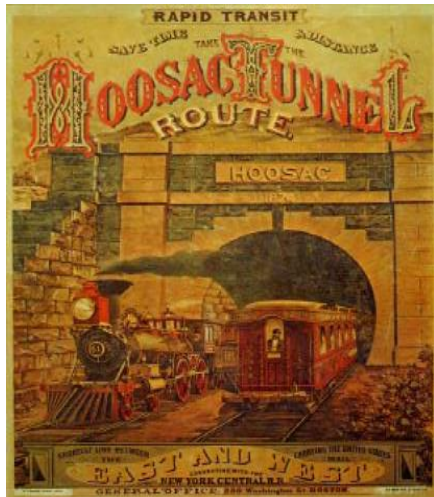


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Health & Safety in Underground Space
October 18th, 2019, Lisbon, Portugal

Health & Safety in underground works
Technical guide by the WG3 of CPT

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- > Construction Safety Regulations – do not consider Underground Works
- > Standards and guides...
- > Applicability for Decree-Law 162/90...
- > What to do?



Portuguese Tunnelling Committee

WG Health and Safety

University of Minho

PhD Thesis

R&D Project “SegOS”

WG Meetings

- Infraestruturas de Portugal – Eng. João Baptista
- Mota-Engil – Eng. Mário Campos
- EDP – Eng. Jaime Queiroz
- ORICA – Dr. Pedro Bernardo
- EPOS – Dr. António Garcia
- TPF – Eng^a. Vitória Rodrigues



Starting point

Studies already carried out by ITA WG5

Decree-Law 162/90

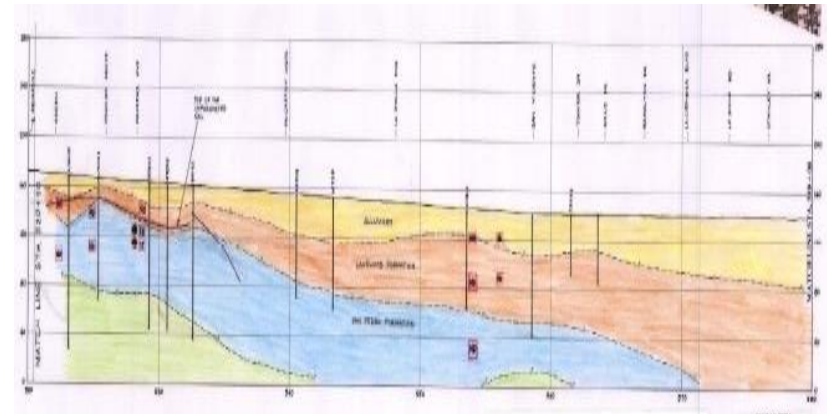
BS6164 – Health and Safety in Tunnelling

NR22 – Health and Safety in Mining

Duties

- Project Owner
- Designer
- Contractor
- Health and Safety Coordinators

- Health and Safety begins in design phase
- Teamwork and effort
- Impact of design options in construction
- Design reviews

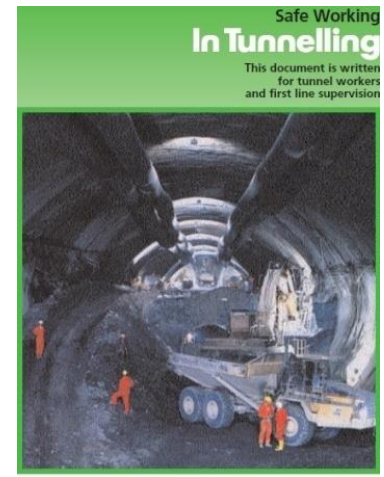


Skills

- Minimum standards
- Requirements from Project Owner

Training

- Minimum content of the 4-hour initial training
 - duties, infrastructures, movement of equipment and pedestrians, use and maintenance of protective equipment, emergency and rescue procedures
- Minimum content of specific training
- Specific training for first aid and fire fighting
- Training for visitors



Well being

- Physical and mental health
- Role of managers in recognizing symptoms
- Requirements for working places: water supply, WC
- PPE
 - Self-rescuer



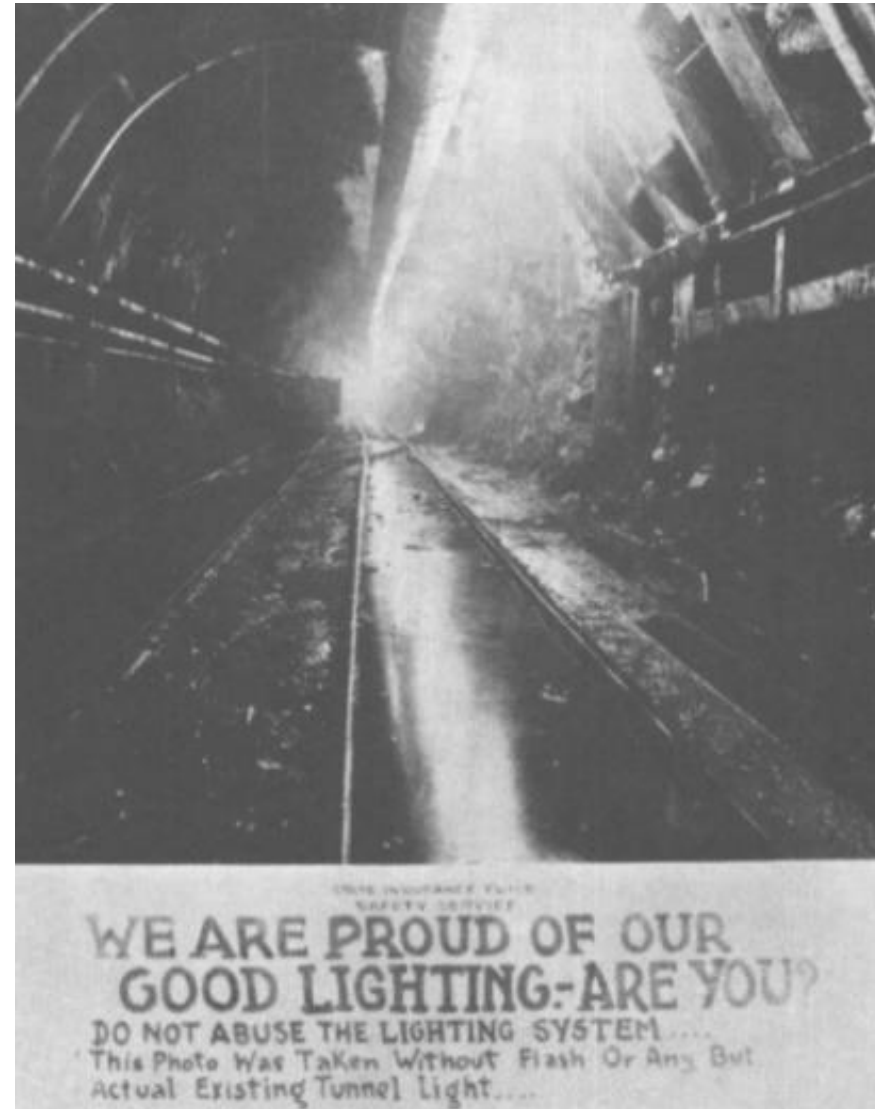
Accesses and infrastructures

- Access control
- Organization and neatness
- Separation workers / equipments
- Criteria for infrastructures
- Requirements for infrastructure maintenance



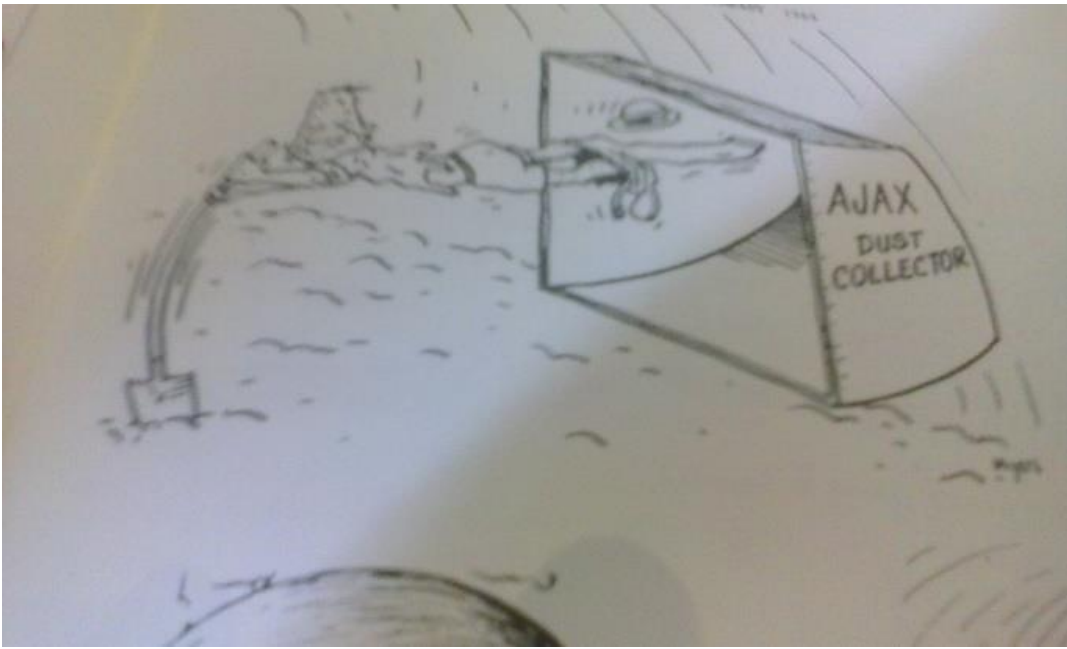
Lighting

- Requirements
- Critical workplaces
- Emergency lighting





Ventilation

- Requirements
- Extraction / insufflation
- Minimum air flows and velocity
- Emergency ventilation



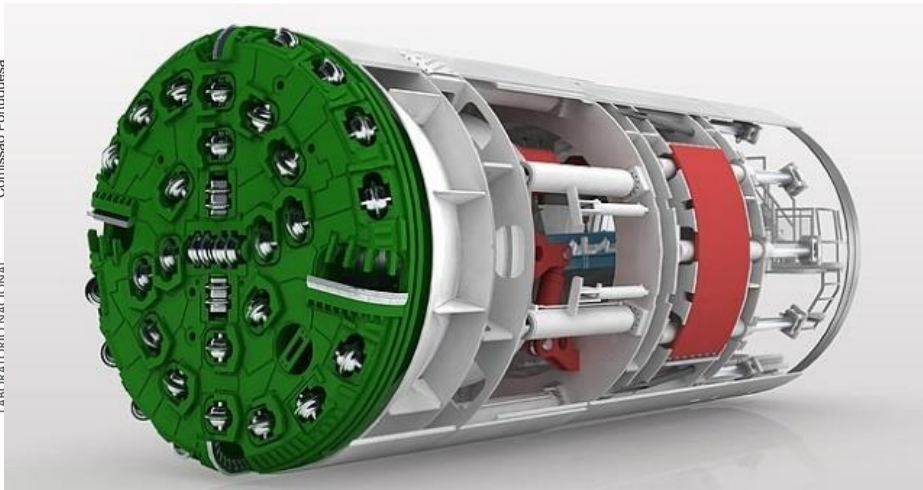
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Working equipment

- Minimum requirements
- Badge if ok
- Vertical, wheel, rail, conveyors
- Procedures to start works
- Interface with workers



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Electrical risks

- Criteria for location
- Physical protection/covers
- Authorization for works
- Emergency infrastructure
- Criteria for maintenance



Gases from rock mass and fuel vapours

- Ignition sources
- Concentration limits
- Specific protections
- Batteries
- Types of engine
- Criteria for refuelling



- Purification systems
- Monitoring
- Maintenance

EU Directive 2017/164 – NO, NO₂, CO



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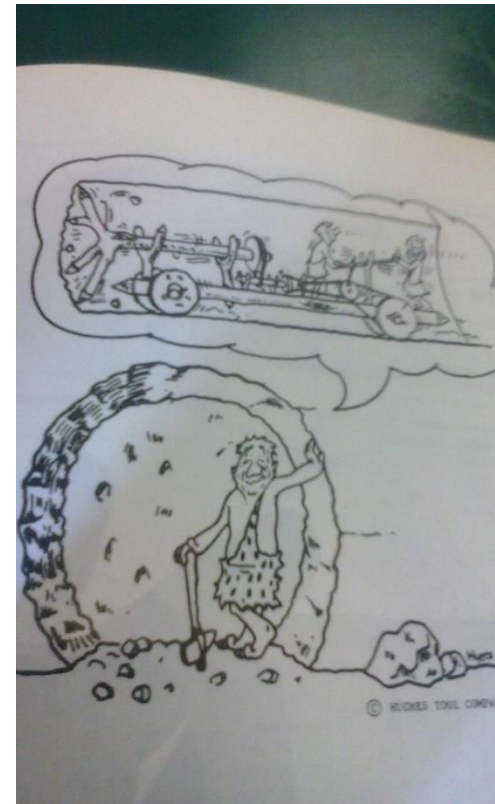


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Explosives

- Licensing of operators
- Fire plans
- Attend to OH when choosing explosives
 - Technical note for ANFO and electric detonators
- Places for storage
- Transport for excavation front
- Signalling
- Procedures for detonation
- Missed shots



Fire

- Specific works
- Critical zones
- Ignition sources
- Flammable products
- Detection and suppression equipment
- Rescue teams



Drowning

- Location of shafts
- Aquifers
- Periodic inspection of rock mass
- Pumping system
- Flood warnings

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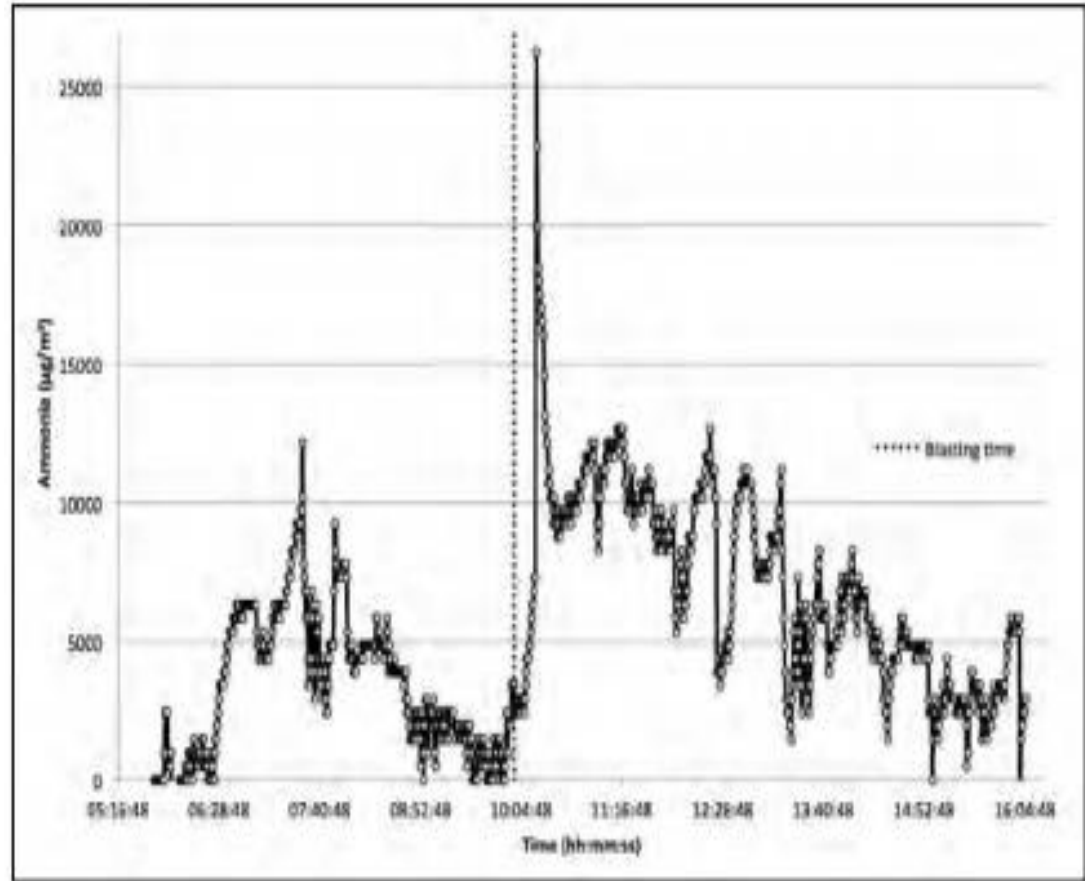
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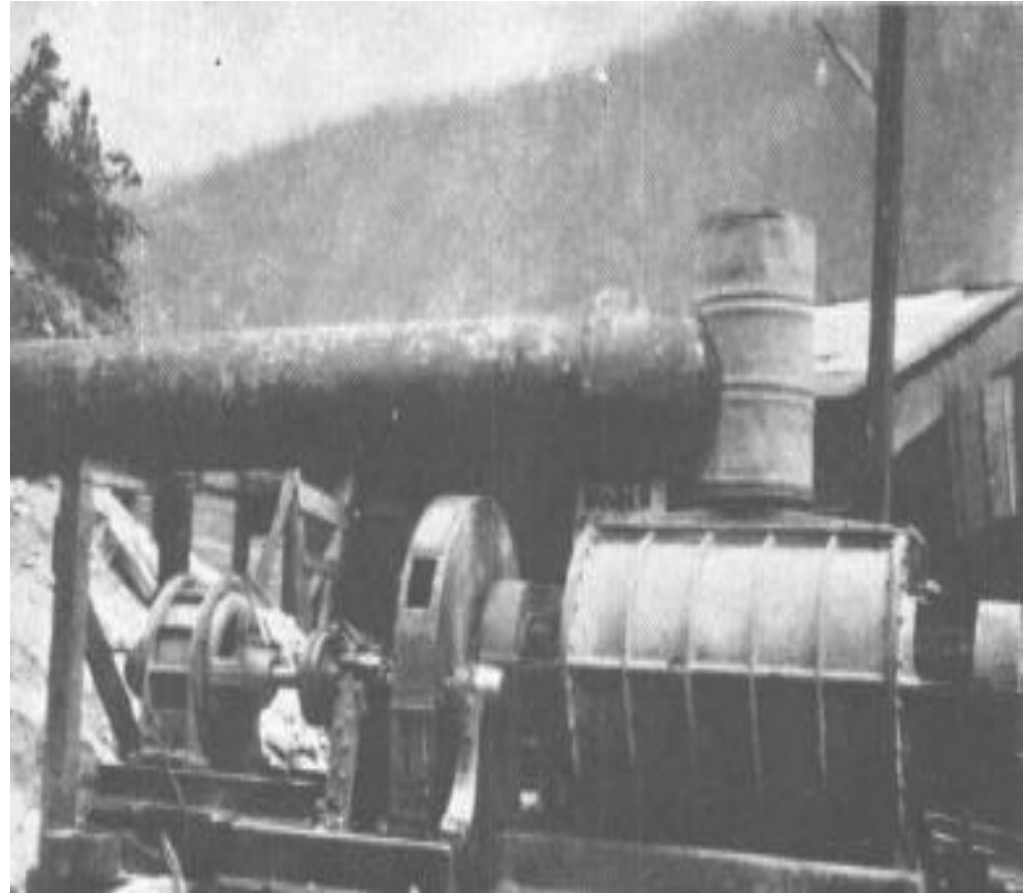
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Gases from explosives

- OH and the choice of explosives
- Criteria to re-enter excavation front after blast
- Physical barriers



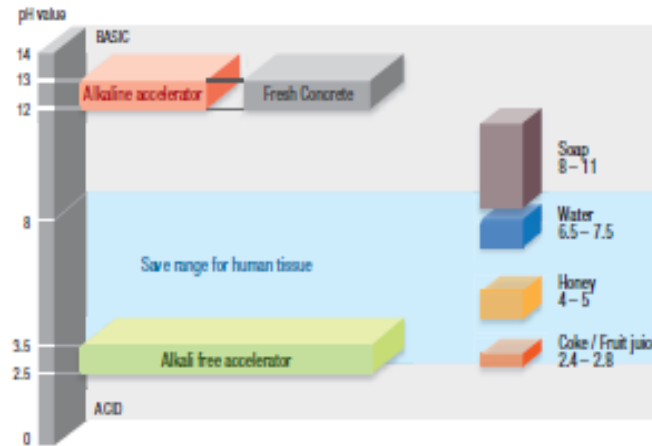
- What to monitor?
 - Gases from the rock mass, explosives, engines and welding, and dust
- Acceptable levels
- Monitoring periodicity
- Monitoring system
- Records

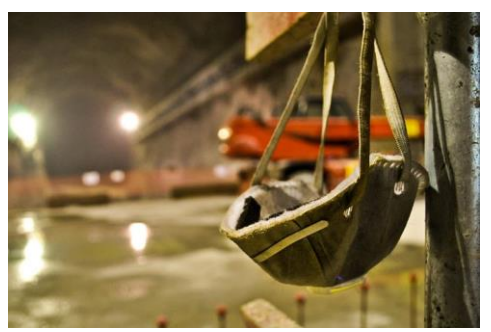




Chemicals

- Physical barriers against spilling
- Concrete accelerators
- Asbestos and lead





Dust from rock mass and sprayed concrete

- Dust collection at source
- Humidification
- Monitoring
- Wet sprayed concrete





Collapse

- Procedures for inspection
- Load-bearing capacity of pavements
- Signalling of pathways
- Slope delimitation
- Stability of temporary structures



Burst structures and equipment

- Types of and criteria for containers, piping and accessories
- Piping purge
- Signalling



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Fall of rocks from excavation front, vaults or rods

- Structural safety / Occupational safety
- Conditions of the rock mass
- Geological risk assessment
- Water inflow
- Assembly of stabilization devices



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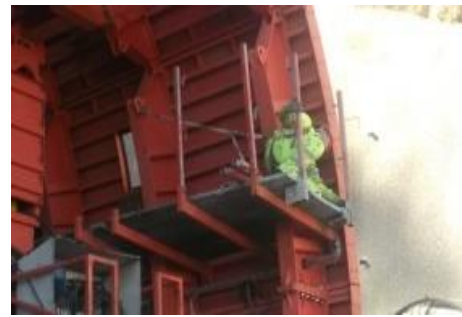
Fall of fresh concrete

- Mechanical spray of concrete
- Inspections after blasting
- Signalling of critical places



Falling at same level

- Organization



Fall from heights

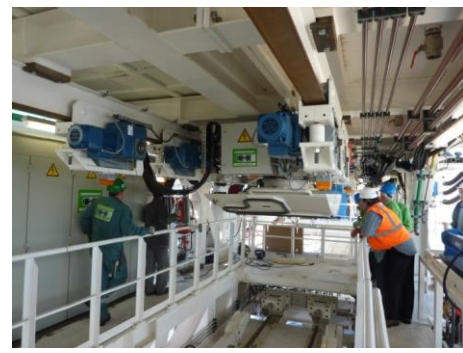
- Collective and Personal PE



- Types of pavement



- Ladders



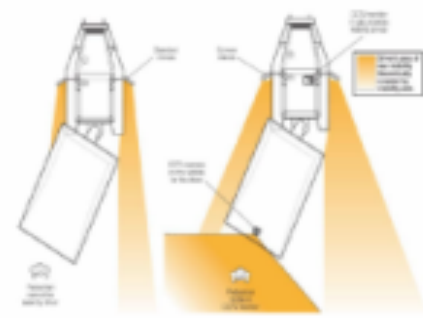
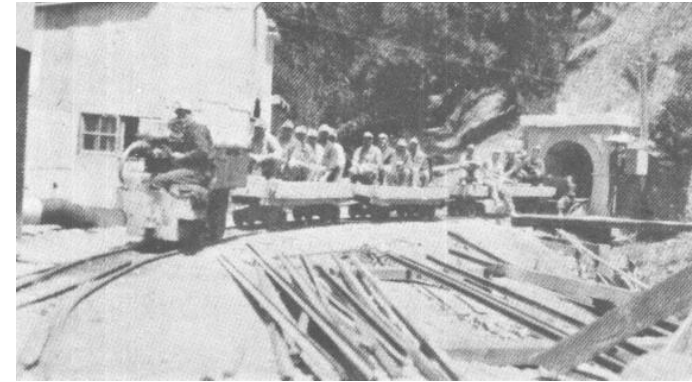
Musculoskeletal injuries, crushing, burning, cutting

- Types of movements
- Rotativity of works
- Set conditions for handling loads
- Handling plans
- Lifting points
- Lifting accessories
- Lifting in shafts



Roll-over

- Defined and separate routes
- Safety devices
- Compatibility of pedestrians/machinery
- Criteria



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Contact with biological agents

- Legionella
- Personal hygiene
- Hot water systems
- PPE





Safe, but also healthy
Health considerations should not be a poor relation to worker safety on site.



Noise

- Reduction in emission points
- Damping systems
- PPE



Vibrations

- Reduction in emission points
- Equipment checks
- State of floors
- Equipment seats
- PPE



Extreme temperatures (hot/cold)

- Air quality
- Working clothes
- Specific protections in equipment

Radiation

- Identification and signalling of hazard area
- Laser equipment



Pressure

- Tests and essays to pressurized systems
- Hyperbaric chambers
- Records



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Emergency planning

- Minimum content
- External bodies
- Escape routes
- First aid facilities
- Shelter chambers
- Emergency equipment





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Thank you for your attention

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