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ABB in Underground Mining Technology Advances in Mine Winders

Technology Advances in Mine Winders

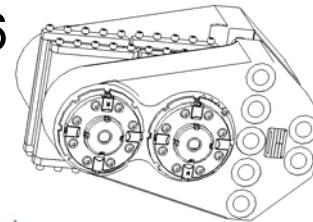
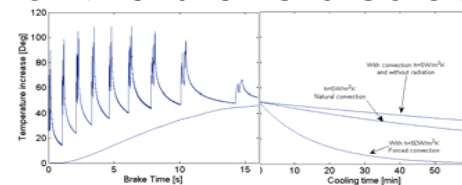
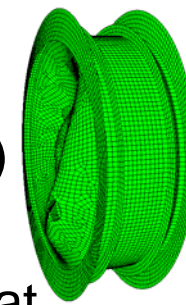
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Technology Advances on Mechanicals

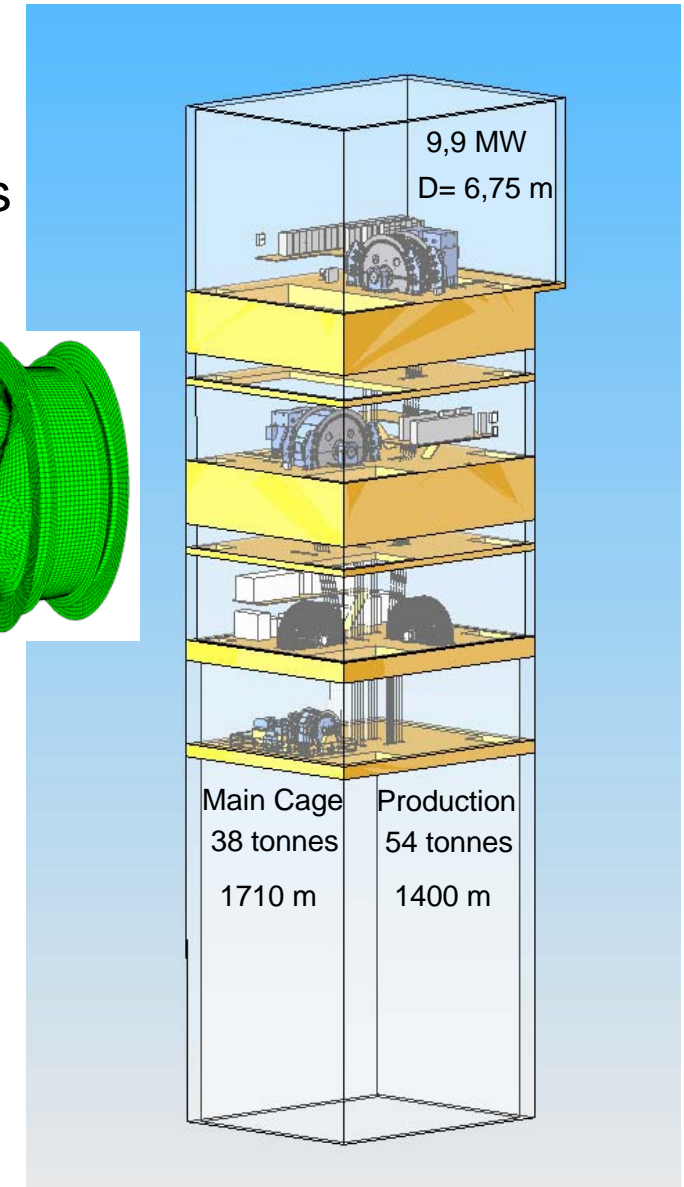
Larger Winders, Higher production – Deeper shafts

- Development project “Large Friction Hoist”
Develop models, methods and optimize the design
 - Payload => 60 tonnes, Suspended load => 500 tonnes
Pulley diameter => 7 m, Hoisting distance => 2000 m
 - Detailed fatigue analysis of the welded structural parts and the shaft
 - Investigations of the dynamics (natural frequencies) of the pulley and shaft
 - Detailed thermodynamic analysis of the brake disc at safety braking



- Brake units BSFG 408 => BSFG 816
Clamping force 160 kN

Bearings, $d > 800$ mm sleeve bearings
as an alternative to roller bearings

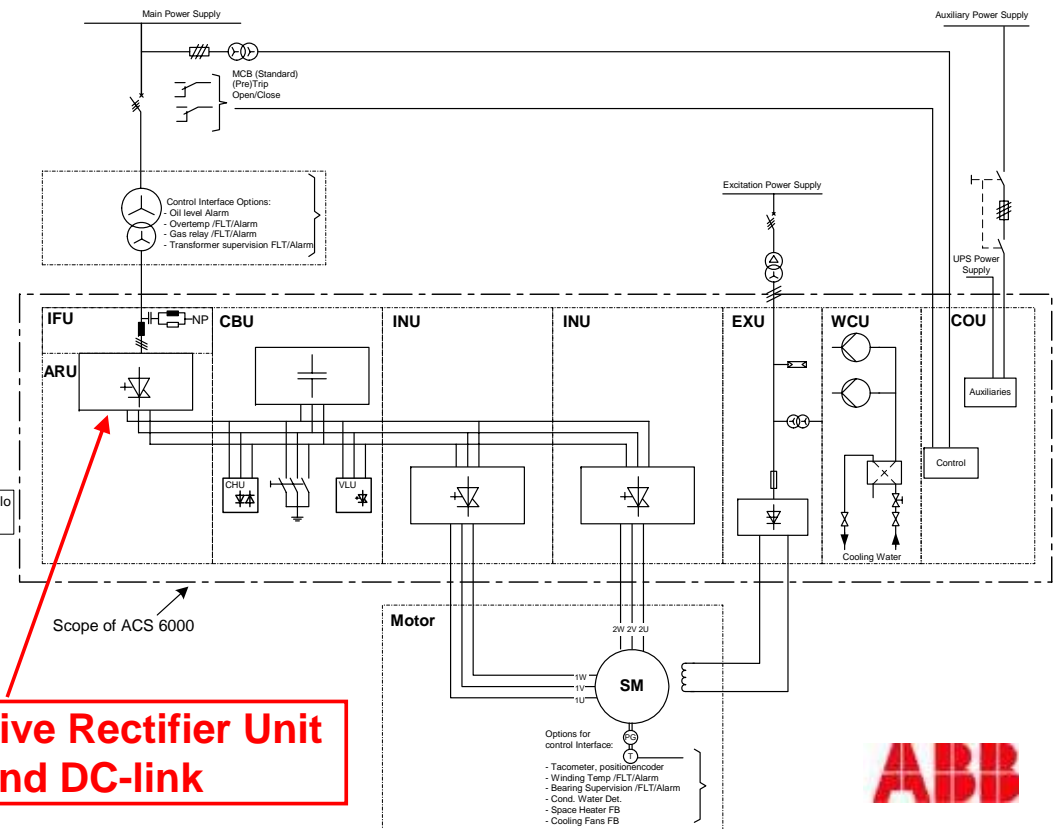
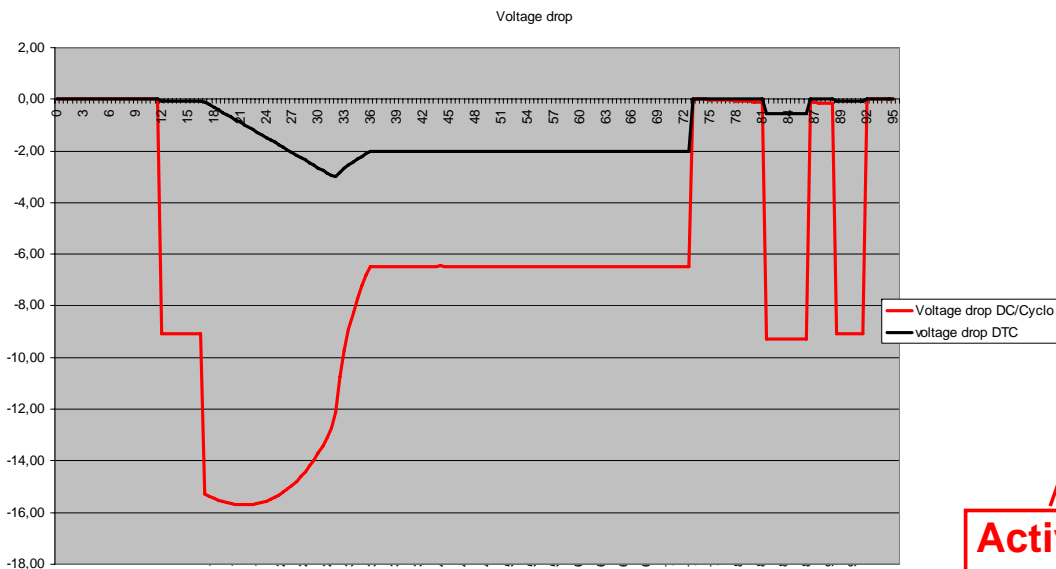
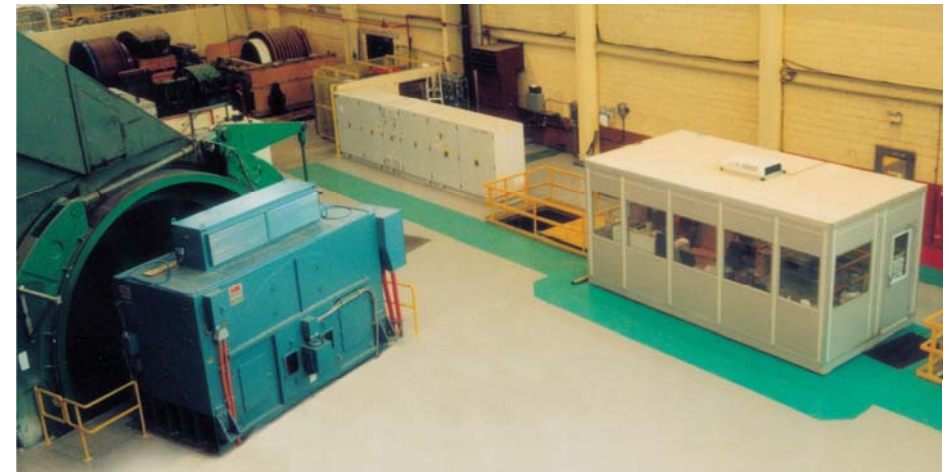


Technology Advances in Drives

DC-Drives => AC-Drives, MV-Drive ACS6000SD

Advantages at ACS6000SD (DTC) and Synchronous Motor drive:

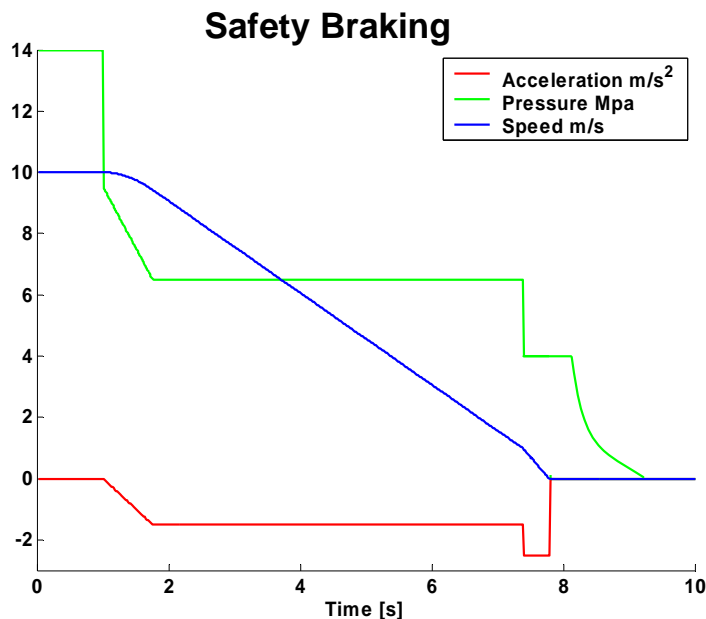
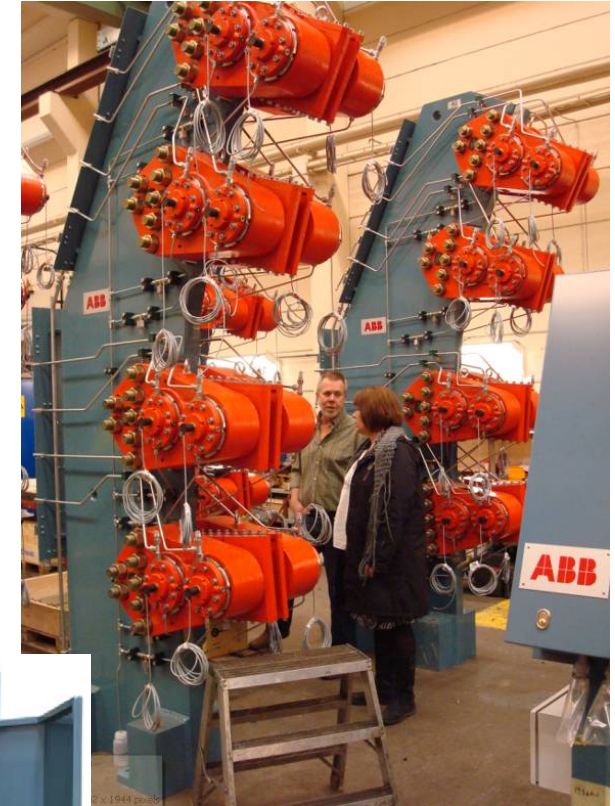
- Low harmonic generation on the net
- No reactive power consumption
=> Requires less transformer power
- Low voltage drop on the net (weak net)
=> Less influence on other objects
=> No flicker
- Large air gap in motor, 14 mm (overhang)



Technology Advances in Brake Control

Number of Brakes, 1 => 2 Brakes

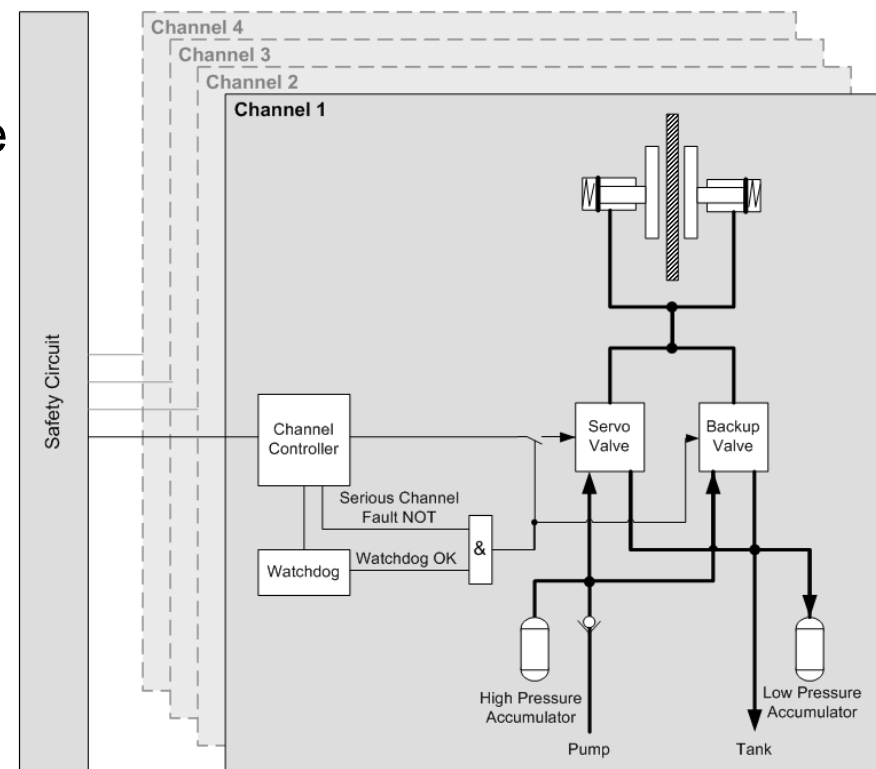
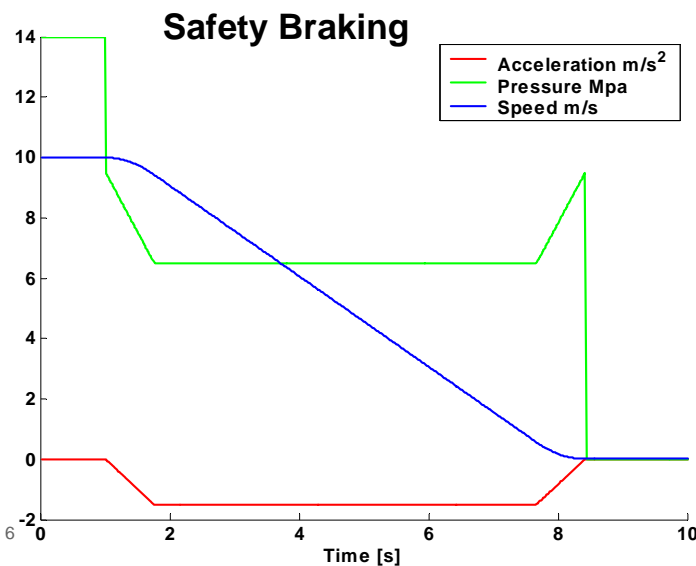
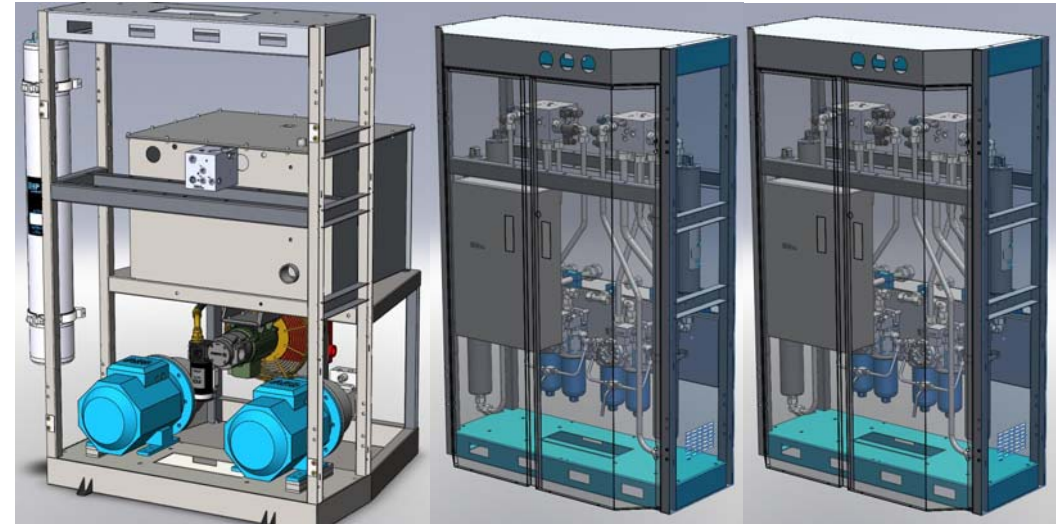
- Regulation requirements, brakes per winder/pulley/drum.
Two or more brake discs and hydraulic disc calipers.
 - One brake, no single component
 - Two brakes, particularly at carrying persons
- Safety braking control from “constant braking force” to “controlled retardation force” (constant braking as backup)



Technology Advances in Brake Control

Number of Brakes, 2 => 4 Brakes

- Safety philosophy, 4 independent channels so that 3 channels can retard within specified retardation (without rope slip)
- Closed-loop brake control system with double s-shaped deceleration at safety braking to minimize rope oscillations
- SABS 0294 and Code of Practice. Not result in slack rope or in rope forces in excess of 40% of the initial rope breaking strength, < 60% at single failure



Technology Advances in Winder Control Safety Related Parts of Control System

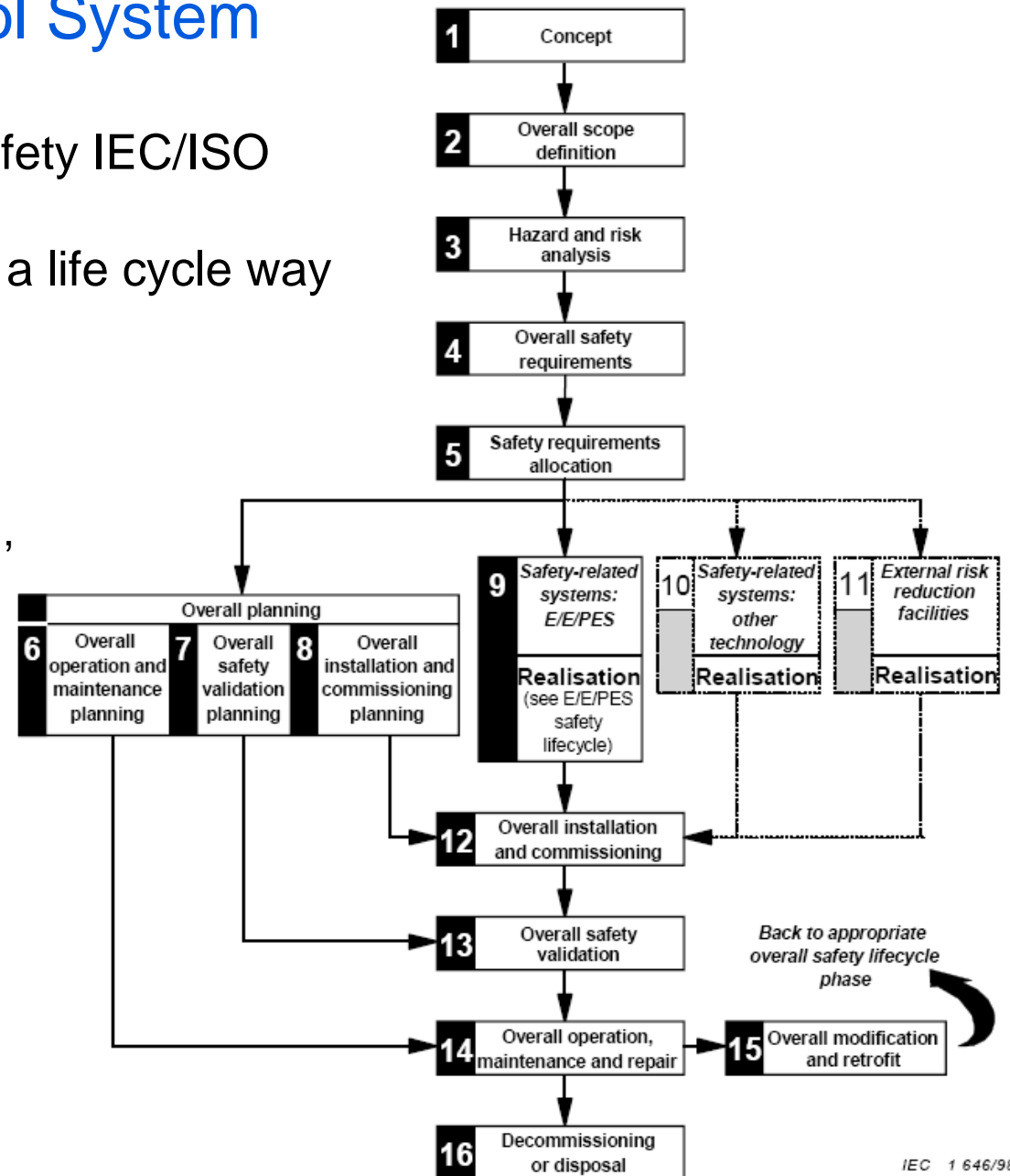
- Requirements / Local Standards, harmonize to Functional Safety IEC/ISO Standards
 - IEC AS 61508, Functional safety of electrical systems
 - Mostly used when developing electrical and/or electronic and/or programmable electronic components that are used to perform safety function
 - Using term Safety Integrity Level for the target failure measure, SIL 1 to 4
 - Risk focus on Safety of Men, Environment and Economical
 - IEC AS 62061, Safety of machinery – Functional safety
 - Used during machine control design of safety-related electrical control systems, built up by safety components
 - Also using SIL-levels, SIL 1 to 3
 - Risk focus on Safety of Men
 - ISO 13849, Safety of machinery – Safety related parts of control system
 - Used during machine control design of safety-related electrical, hydraulic, pneumatic and mechanical control systems, built up by safety components
 - Using term Performance Level for the target failure measure, PL a to e
 - Risk focus on Safety of Men

Table 4 — Relationship between performance level (PL) and safety integrity level (SIL)

PL	SIL (IEC 61508-1, for information) high/continuous mode of operation
a	No correspondence
b	1
c	1
d	2
e	3

Technology Advances in Winder Control Safety Related Parts of Control System

- Common for these three Functional Safety IEC/ISO Standards
 - They formalize a design process in a life cycle way
 - Functional safety plan; planned activities, identify persons, documentation requirements
 - Analysis phase; hazard identification, risk estimation, determination of “safety” level
 - Design phase; design, verification, validation and functional safety assessment
 - Operation phase; including modification and retrofit

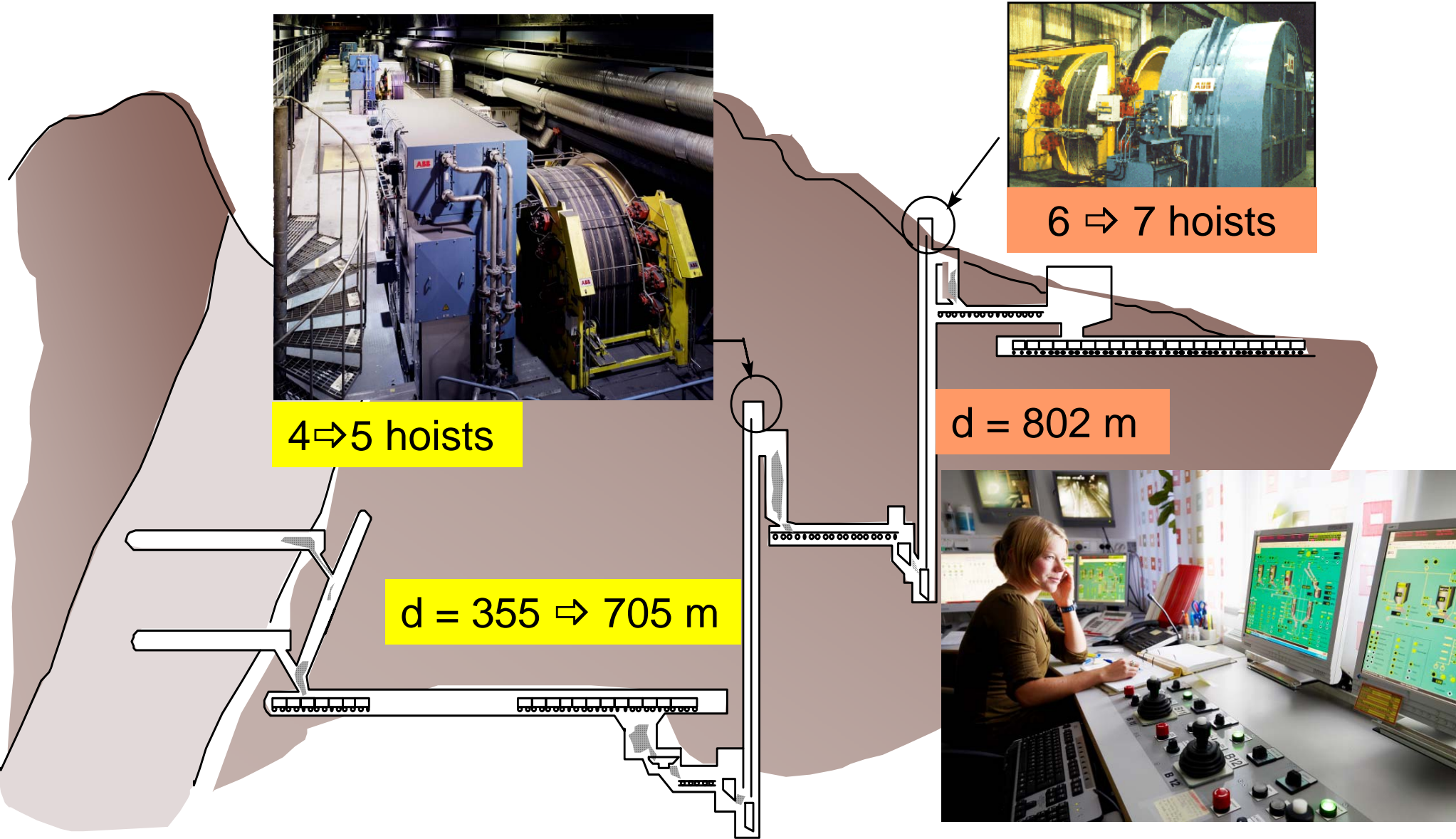


IEC 1646/98



Technology Advances in Winder Control

Centralized Winder Operator interaction - LKAB Kiruna Mine



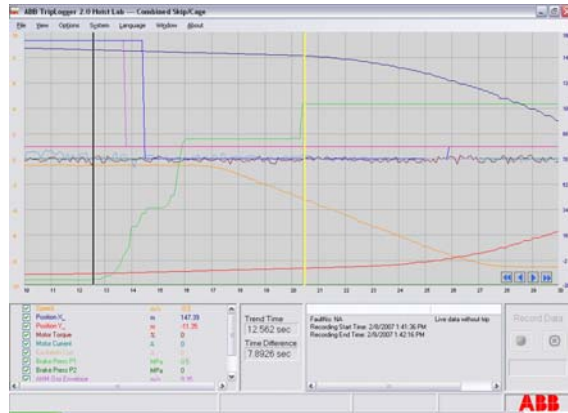
Total installed motor power for mine winders 58 MW



Technology Advances in Winder Control

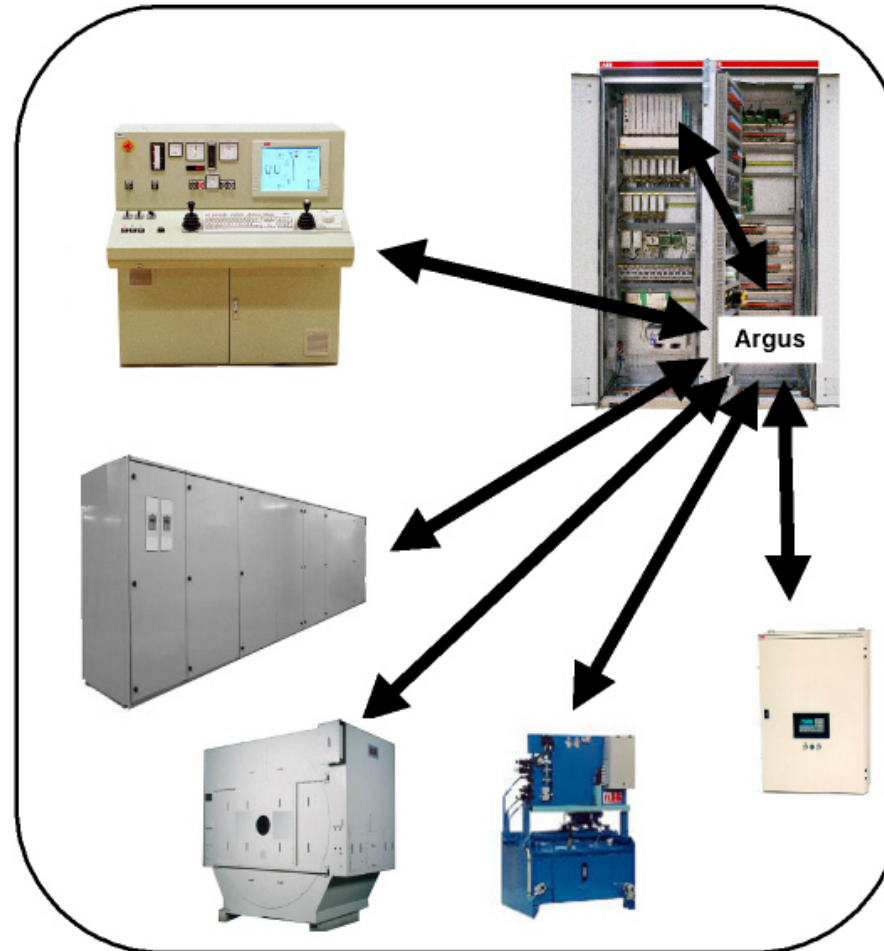
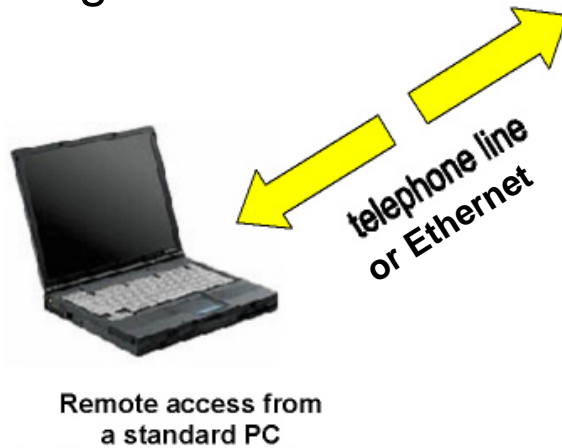
Diagnostic features

- Trip Logger, post-mortem recording of variables at winder trip



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- Remote Diagnostic



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