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## Harmonization of technical requirements in the scope of machines for underground mines

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### Abstract:

In the European Union different methods of harmonizing technical requirements are accepted. The main legal instrument includes, among others, directives and European standards which are a key component of the European Single Market. European Standardization plays an important role in the development and consolidation of the European Single Market. The fact that each European Standard is recognized across the whole of Europe, and automatically becomes the national standard in 34 European countries, makes it much easier for businesses to sell their goods or services to customers throughout the European Single Market. This article presents general principles of implementing uniform technical requirements contained in the harmonized standards following the example of mining machines, in particular powered roof supports. The article concerns the standard EN 1804-Parts:1; 2; 3, i.e. Machines for underground mines - Safety requirements for hydraulic powered roof supports:

- Part 1: Support units and general requirements,
- Part 2: Power set legs and rams,
- Part 3: Hydraulic and electrohydraulic control systems.

The authors described the work results of the Technical Committee CEN/TC 196 "Mining machinery and equipment - Safety", over the years 2017-2020, oriented onto establishing three new edition of standards. These new edition of standards have been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directives.

Keywords: European Standard, mining machines, hydraulic powered roof supports



## 1. Introduction

In the process of opening markets to international trade within the EEA - European Economic Area, an elimination of technical barriers is based, among others on two basic documents:

- The Single European Act,
- The White Paper from 1985, in which the European Commission formulated projects of about 280 directives foreseeing an elimination of fiscal, technical and physical barriers in dealings among the EU countries.

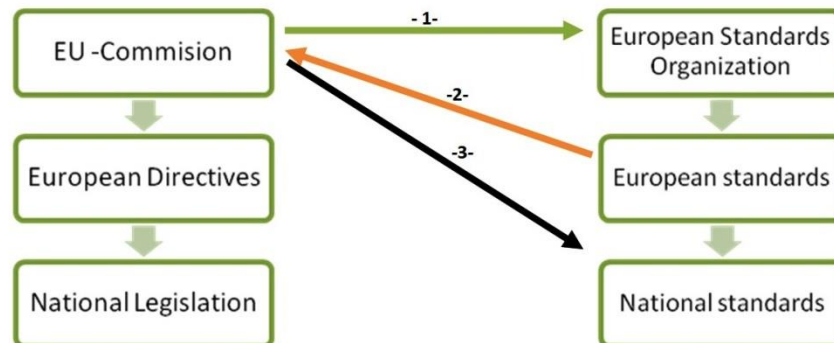
An essential element of the free flow of goods is the creation of the Community harmonization legislation, i.e. regulations (EC), decisions (EC), directives (so-called "hard" law) supported by voluntary standards, in principle, including in particular harmonized with the given technical harmonization directive (so called of new and global approach) as well as with the procedures of conformity assessment whose goal is to test the conformity with declared requirements.

The "New Approach" to product safety has been applied in Europe. EU directives and regulations set out essential requirements, which in turn are supported by harmonized European standards. The arrangements for some aspects of the system were modified recently [1].

At present the main legal instrument of harmonizing requirements includes directives. A directive is a legislative act that sets out a goal that all EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals.

Due to the fact that directives contain only essential safety requirements for technical products, detailed requirements are related most often to European standards, harmonized with the directives, elaborated on the basis of a mandate from the Commission given to the CEN and CENELEC and then introduced to national standards in an unchanged form.

Harmonized standards are elaborated by the European standardization organizations (CEN, CENELEC, ETSI) on the basis of a mandate given by the European Commission and they are accepted by these European standardization organizations according to their internal procedures. The European Commission, after having accepted them, makes their numbers and additional information concerning the date of edition, possibilities of taking advantage of the supposition privilege, are published in the Official Journal of the European Union (Fig.1).



1-Mandate; 2- Verification process; 3- Publication in the Official Journal of the EU Harmonized Standard

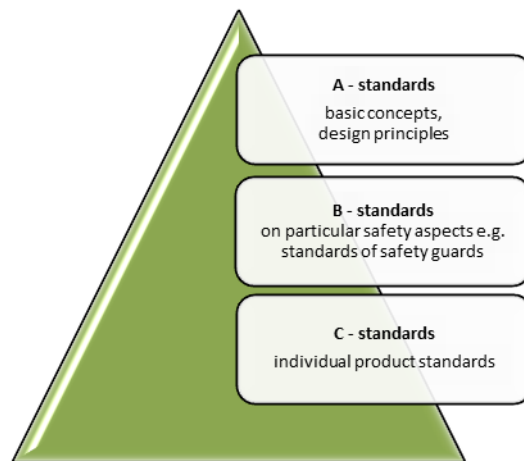
**Fig. 1.** Elaboration process of harmonized standards

If the EN standard, elaborated on the European level, becomes the national standard, due to its introduction to the set of national standards by at least one member country, this standard becomes the "harmonized standard". It should be highlighted that about 20% of all the European standards are elaborated following up such an order from the European Commission.

Despite a close connection of harmonized European standards with directives, these standards still maintain the status of a voluntary application document.

The harmonized European standards specify in total or partly essential safety requirements included in a given directive, and the statements contained in the harmonized standards determine an acceptable level of technical safety.

Machine safety standards are divided into type A, B and C standards. The A-type standard is framework and very general. This standard sets out basic strategies and conditions that users must observe in order to reduce risk to an acceptable level. Type B standards describe principles of a safety aspect or requirements. Type C standards govern a specific product (Fig. 2).



**Fig. 2.** Structure of harmonized standards

European Committee for Standardization CEN is one of three European Standardization Organizations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level. CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 34 European countries [2].

National standardization bodies, which accept and publish national standards manage the standardization process on the national level. The national standardization bodies also introduce all the European standards as identical national standards and they simultaneously withdraw any national standards which are not in accordance with the new ones.

The objective of this article is to present the results of the TC 196 - Mining machinery and equipment- Safety, in particular the TC196/WG3 – Machines for underground mines – Roof support course of activities.

## 2. Materials and Methods

### 2.1. Business environment of the CEN/TC 196 - international trade and standardization aspects

The activities of the CEN/TC196 concentrate on ensuring that the health and safety of workers are maintained and on ensuring that the applied safety standards, previously in place at the national level, remains. It should be borne in mind that European standards satisfy the Essential Safety Requirements of EN Machinery Directive (2006/42/EC). It is recognized throughout the world that European manufacturers have traditionally produced machinery to high safety standards. It needs to be highlighted that there is a definite move towards an acceptance of European standards and testing facilities globally giving the European manufacturers increased competitive edge. The priorities of CEN/TC 196 include safety requirements for mining machines and equipment and a significant improvement of safety in mine sites.

There are real or potential technical barriers to trade related to the scope of the CEN activity. Political, economic, technical, regulatory, legal, societal and/or international dynamics describe the business environmental of the industry sector, products, materials, disciplines or practices related to

the scope of the CEN /TC 196 activity, and they may significantly influence the relevant standards development processes and the content of the resulting standards. Market access outside the European Community is frequently restricted by technical barriers to trade, based on national regulations for health, safety and environment issues. A free market access can be achieved by applying justified European Standards transferred to the ISO level and vice versa. Those standards have to be supported by the national legislation in the particular countries for being effective. The international model of UN Economic Commission for Europe (UN ECE) is an excellent example for creating those technical legislation procedures at the national level [3].

The technical details within this this international model are specified by international standards which enable a harmonization of the market access.

With regard to current international trade and standardization aspect, many countries of the world, particularly: China, Russia, Australia, South Africa and the GSO (Gulf Cooperation Council Standardization Organization) adopt and accept the standards generated in Europe.

Certain other countries, such as India are ready to follow.

All the CEN national members are entitled to nominate delegates to the CEN Technical Committees and experts to the Working Groups, ensuring a balance of all interested groups.

The main objectives of the CEN/TC 196 include a transition from a legal framework based on an approval of machinery safety through national requirements and standards to one of essential requirements supported by technical standards, an elimination of trade barriers across the European market and a provision a of common set of European Standards for use internationally thereby promoting a global market.

The work programme of the CEN/TC196 is divided into seven subject areas with three active working groups established [2,3]:

WG 1 Mobile machines at the face (active)

WG 2 Mobile machines for underground mines (active)

WG 3 Machines for underground mines - Roof support (active)

WG 4 Mining ventilation machinery (no activities)

WG 5 Armoured face conveyors (no activities)

WG 6 Continuous handling equipment and systems (no activities)

WG 7 Noise requirements (no activities).

In the following chapters detailed information is given on standardization activities in the field of hydraulic powered roof supports and on the work results of the CEN/TC196-WG3 Members.

## 2.2 The European system of standardization activities in the field of hydraulic powered roof supports

The standardization activities of CEN are steered by the CEN Technical Board (BT), who has full responsibility for the execution of CEN's work programme. Standards are prepared by Technical Committees (TCs). Each TC has its own field of operation (scope) within which a work programme of identified standards is developed and executed. TCs work on the basis of national participation by the CEN Members, where delegates represent their respective national point of view. This principle allows the TCs to take balanced decisions that reflect a wide consensus [2].

Hydraulic powered roof supports are qualified as the equipment of increased risk of hazards, which requires a specific procedure before their introduction into operation, what is included in the 2006/42/EC Directive (Machinery) [4].

This Directive contains only essential safety requirements for supports, but detailed requirements are referred to groups of the European standards, harmonized with the directive, elaborated on the basis of the Commission's mandate by the CEN and the CENELEC.

As regards the mining machinery and equipment the CEN/TC 196 deals with an elaboration of standards. It concentrates its activities on standardization relating to safety aspects of specialized mining machinery and equipment for opencast mining and machinery and equipment for underground mine development. It also deals with standardization concerning additional safety requirements for other machinery primarily designed for use outside mines but also intended for use in underground mines.

The CEN/TC 196 consists of three Subcommittees and seven Working Groups, and effects of their work include publishing of ten different standards [2]. All the tasks, undertaken by the Committee, are realized according to the guidelines included in the Internal Regulations [5,6].

In the 2017 CEN/TC 196/WG 3 Machines for underground mines – Roof support started its activities in scope of amendments to three standards belonging to Type C safety standards.

They were as follows:

- EN 1804-1 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 1: Support units and general requirements,
- EN 1804-2 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 2: Power set legs and rams,
- EN 1804-3 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 3: Hydraulic control systems.

As it has already been mentioned all the above given standards belong to Type C, which covers a specific type of machines and all the included requirements are specific to that type of machines, where the Working Group for the Type C safety standard has members vertically involved with that type of machines.

It is worth mentioning that the first edition of the above mentioned standards from the EN 1804-1;2;3 series appeared in 2001 and in 2006, and during the following years they were subject to several reviews and minor corrections resulting from a necessity of their adoption to the changed machinery directive (2006/42/EC). However, these reviews have never been ended with real amending of documents with a simultaneous review and modifications of the requirements included in them.

During twenty years three documents mentioned above, constituted the basis for designing new solutions, conducting stand tests of supports and conducting conformity assessments of these machines and equipment.

The leading countries which conducted tests with use of these standards have been: Germany, Poland and the Czech Republic. A scope of using these standards and results of tests, conducted on their basis, are mentioned among others in [7,8,9,10,11,12].

The methods and results of tests of powered roof support units and of their components, realized in Poland mainly at the KOMAG Institute of Mining Technology as well as a comprehensive analysis of testing capabilities of laboratories, realizing tests of powered roof support units and their components, are presented in the publication [13]. Results of tests of powered roof support in China are presented in [14].

### 3. Results

#### 3.1. Realization of activities by the Members of CEN/TC 196-WG 3

The following companies delegated their representatives to participate in the activities of CEN/TC 196-WG3:

- Marco Systemanalyse und Entwicklung GmbH, Germany,
- JOY GLOBAL (UK), Great Britain,
- TECHNICKE LABORATORE OPAVA, Czech Republic,
- Caterpillar Global Mining Europe, Germany,
- DIN - Deutsches Institut für Normung, Germany,
- ZMJ Germany GmbH, Germany,
- KOMAG Institute of Mining Technology, Poland,
- TIEFENBACH Control Systems GmbH, Germany.

The activities were conducted by the representatives of the countries, mentioned above during the following meetings among others [3]:

- 17<sup>th</sup> June 2016 – Plenary Meeting of CEN/TC 196 - an announcement of starting activities on introducing changes to the EN 1804-1;2;3 Standards (Stockholm, Sweden)

- 28<sup>th</sup>-30<sup>th</sup> March 2017 – a preparatory meeting in Frankfurt - a presentation of WG3 members and invited experts (Frankfurt, Germany),
- 28<sup>th</sup>-29<sup>th</sup> March 2017- Plenary Meeting of CEN/TC 196 - a presentation of scheduled work programme (Madrid, Spain).
- 22<sup>th</sup>-23<sup>th</sup> March 2018 - WG3 Meeting to discuss critical remarks submitted by the Members (Frankfurt, Germany)
- 12<sup>th</sup>-14<sup>th</sup> July 2018 - Plenary meeting of CEN/TC 196 - a presentation of scheduled work plan and organizational changes (Warsaw, Poland),
- 24<sup>th</sup>-25<sup>th</sup> July 2018 - WG3 Meeting - a discussion on modifications to be introduced in the EN 1804-1; 2; 3 - a clarification of opinion differences (Frankfurt, Germany),
- 21<sup>th</sup>- 24<sup>th</sup> May 2019 - WG3 Meeting of CEN /TC 196 EN 1804-1; 2; 3 "Safety requirements for hydraulic powered roof supports" - a discussion of received comments of the HAS Consultant and a discussion of received comments on pr EN 1804-1, pr EN 1804-2, pr EN 1804-3.
- 21<sup>st</sup>- 22<sup>nd</sup> October 2019 - WG3 Meeting dedicated to the issue of eliminating the yield test – visit to KOMAG Laboratory (Gliwice, Poland).
- 12<sup>th</sup> November 2020 - WG3 Web Meeting - final discussion on opinion differences leading to conclusions.

### 3.2. Course of scheduled work programme

#### Draft Proposal pr EN 1804-1 Standard

The discussions were dominated by the producers of powered roof supports who were oriented onto a reduction or even an elimination of certain stand tests due to economic reasons. KOMAG representatives highlighted the fact that such an approach would have a negative impact on operational safety of powered roof supports. Tests of convergence caused a lot of controversies. In the case of a very important requirement, concerning the support unit yield capability, a method of testing the yield capability by the roof pressure was deleted. In such an approach a withdrawal of testing the support unit yield capability eliminates a standard requirement i.e. the support yield by an active roof. The deleted test may have a negative impact on the operational safety of powered roof supports. Alternative procedures of verifying the yield capability do not reflect the support yield from the roof. The first suggested procedure assumed an application of the least 300 kN external force to the support unit.

As at present the state-of-the-art roof support units have an operational load-bearing capacity above 6000 kN (20 times greater), the force of 300 kN does not simulate yield of the support unit effected by the roof and it does not make it possible to verify the strength of the support unit kinematic system. The liquid from the legs should be released at the pressure corresponding to the operational load – bearing capacity of the support units. The second alternative procedure is technically contradictory. It is not possible to generate the force yielding the support unit by releasing the liquid from the under the piston area of the legs. In the opinion of the KOMAG experts an implementation of alternative procedures will make a full strength verification of a powered roof support unit impossible.

In addition, a number of other structured comments were made, such as:

- The enumeration of hazards should refer to the EN ISO 12100:2000 standards, because some requirements should be completed and added.
- Normative references were updated in the result of discussions.
- Requirements of replacing a dynamic task with the FEM (Finite Elements Methods) calculations for legs (props) of 400 mm in diameter and more were introduced. The FEM verification method should be validated for at least 3 legs (props) of different diameters. It was suggested that other methods of dynamic loading, causing an effect, specified in the requirements, should be acceptable as well.

#### Draft Proposal pr EN 1804-2 Standard

- It was suggested to introduce separate definitions of legs and canopy supporting rams as the canopy supporting ram does not ensure load bearing capacity of the support unit.
- In the former text of standard the definition of yield pressure of actuators was not precise and it did not apply to the actuators operating without the pressure limiting valves. Thus all the requirements, concerning yield pressure could not be applied to these actuators. It was suggested to complete a definition of an actuator yield pressure. The same suggestion concerned the definitions of a “stationary overflow valve”, “internal valve” and a “bottom valve”.
- It seemed to be worth considering an introduction of a correlation between the standard requirements and the requirements included in the 2006/42/EC Directive.
- In the Leakage Test there was a requirement of applying load for eleven minutes and in Annex B2 there was a requirement that the test time should last three minutes. As an assessment criterion one requirement should be met: “without external leakages”.
- In the case of central axial load the range of applied pressure (from 1.1 to 0.1 maximum permissible working pressure) should be increased by a tolerance of  $\pm 5\%$  in analogy to the pressure during an application of eccentric load. The measured yield or extension force was agreed to be within  $+10\%$   $-5\%$  of the rated leg or support ram force.

#### Draft Proposal pr EN 1804-3 Standard

- The yield of a pressure limiting valve, in the new draft standard, is hydraulic pressure to which a pressure limiting valve is adjusted and at which it should operate (pressure specified by manufacturer).
- As leaktightness is concerned the following formulation of the requirement was proposed: valves shall be leaktight. Type A valves shall be leaktight to 95% of adjusted pressure.
- In the case of endurance test a pressure reduction to 10% of adjusted pressure (yield pressure) was accepted.
- Normative references should be updated. Several standards are mentioned e.g. EN 853, EN 854, EN 857. However, in each of them there is information that they do not concern underground mining. Hazards are classified according to EN 1050 which is out-of-date. It is indispensable to complete the new standard with the hazards/risk as in the EN ISO 12100 Standard. It was also recommended to consider an introduction of a correlation among the requirements included in the 2006/42/EC Directive.
- Values of pressures are given in bar instead of MPa.
- As regards the switching test a schematic diagram of each service part connections should be given.

#### 4. Agreed changes in the EN 1804-1; 2; 3:2020 Standards

In the result of discussions among the Members of the Working Group 3 and consultations with the CEN representatives the changes were introduced into the final versions of the aforementioned standards.

In 2020, CEN/TC 196 “Mining machinery and equipment – Safety” finalized the revision of the EN 1804 series in support of the Machinery Directive (2006/42/EC) on “Safety requirements for hydraulic powered roof supports” which consists of three parts:

##### **Final EN 1804-1:2020 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 1: Support units and general requirements (approved 2020-12-23) versus EN 1804-1:2001+A1:2010**

- Normative references were updated.
- List of significant hazards in Annex C was revised.

- Requirements for prop anchorages were deleted.
- Requirements for steel for welded components were updated and modified.
- List of tests for confirmation was updated.
- Acceptance criteria for test results were modified.
- Measurements and criteria for deformations after the test were added.
- Requirements for convergence test were modified.
- Cyclic fatigue test for canopy side shield was added.
- Figures, formulae and pictures were revised, modified and added.

**Final EN 1804-2:2020 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 2: Power set legs and rams (approved 2020-12-23) versus EN 1804-2:2001:2001+A1:2010**

- Normative references were updated.
- Terms and definitions were modified.
- List of significant hazards in Annex C was revised.
- Requirements for steel were updated and modified.
- Requirements for static and dynamic overload were revised and modified.
- Requirements for overload in fully retracted conditions were deleted.
- List of tests in Annex B was updated.

**Final EN 1804-3:2020 Machines for underground mines - Safety requirements for hydraulic powered roof supports - Part 3: Hydraulic and electrohydraulic control systems (approved 2020-12-23) versus EN 1804-3:2006+A1:2010**

- Normative references were updated.
- Terms and definitions were revised, modified and enhanced.
- List of significant hazards in Annex B was revised and enhanced.
- Requirements for automatic hydraulic functions were deleted.
- Requirements for in- and inter-shield hose routing were added.
- Requirements for pipe and hose assemblies were updated.
- Requirements for type “A” valves were modified.
- Requirements for electrohydraulic control systems were added.
- List of verification tests was updated and enhanced.

According to the CEN procedures voting on the standards started on 30<sup>th</sup> July and it ended on 24<sup>th</sup> September 2020. The EN 1804-1; 2; 3 documents have been prepared by the Technical Committee CEN/TC196 “Mining Machines and equipment – Safety”, the secretariat of which is held by the DIN – Normenausschuss Maschinenbau (NAM). This European standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2021, and conflicting national standards shall be withdrawn at the latest by June 2021.

## 5. Conclusions

A definition and implementation into use of uniform settlements in the scope of technical requirements on an international level undoubtedly has a positive impact on a liquidation of technical barriers. It can be stated that the European Standardization activity serves gaining an optimum, in given circumstances, degree of settlements in the determined scope, as these standards are based on best practices. Their creation results from experience of stakeholders and they meet the requirements of the society and technology.

Where standards are developed in response to a standardization mandate from the European Commission and are listed in the Official Journal of the EU, they are deemed "harmonized", and give rise to the "presumption of conformity". Users of the standard can presume that by applying it, they satisfy the essential requirements of the EU directives covered by the standard. Where standards are up to date and reflect the state of the art, a high level of safety can be assured.



However, it is worth highlighting that meeting the essential safety requirements, described in directives and relevant standards, cannot be sufficient without exception to protect a manufacturer against claims resulting from his responsibility for a product. It should be borne in mind that in directives the basic requirements should be applied for a given product.

In 2020, CEN produced 1150 documents in which 982 European Standards can be found. The activities of the Technical Committee “Mining Machinery and Equipment – Safety” over the years 2017-2020 are presented in the article as an example of procedures oriented onto a formulation of European standards. The revision of EN 1804: Part 1 and Part 2 addresses the practical requirements of the test procedures. Uniform requirements are defined in the scope of designing as well as conducting tests. Due to such an approach the results of tests and analyses, in the fields connected with applying powered roof support in the mining industry, are reliable and precise. The EN 1804: Part 3 introduces requirements for electrohydraulic control systems, thus reflecting the introduction of new technologies. The authors of this article decided to share their knowledge and experience in a creation and a revision of standards to make the European standardization process easier to understand.

The European Standard EN 1804-1; 2; 3 shall be given the status of a national standard, either by a publication of an identical text or by an endorsement, at the latest by June 2021, and conflicting national standards shall be withdrawn at the latest by June 2021.

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