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Expert Information Assurance of Selected Groups of Machine with European Requirements and Safety Norms

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Abstract
The article presents an approach to information assurance of machines with European requirements and safety standards. Systematization for product groups and standards for them is established. An initial systematization of data on European harmonization legislation is created while directives of New and modular approach are divided into 4 categories. Two approaches to classification of groups and types of products in regard to Directives are developed. For product group Electric passenger and goods passenger lifts a study is presented involving systematization of applicable essential requirements, harmonized standards and norms of harmonized standards. In order to optimum safety requirements the relationship between elements of the product group and the corresponding requirements of the directives and rewarding those rules of harmonized standards is specified. The result of expert research is presented in the Expert Information System.

Keywords
directive 2014/33/EU, harmonized standard, essential requirements for safety, lift, expert information system

1. Introduction

Safety of machinery placed on the European market is ensured through the implementation of European technical legislation (ETL). Numerous norms of the ETL, the rate of change and replacing his legislative acts and the need for detailed analysis of harmonized standards in ensuring product safety lead to mistakes by manufacturers in applying the ETL. To solve these problems, the authors of this article are set to develop a formalized description (model) of performance requirements and safety standards of selected groups of machines in expert information system. To realize the objective the following tasks need to be solved: research and analysis of directives and harmonized standards pertaining to selected groups of machines; formalized description of the expert specified European requirements and standards to selected groups of machines; designing a user interface for expert information system.

The proposed expert information system will facilitate:

- Manufacturers in determining the Directives under which their machine falls;
- Manufacturers in establishing the essential safety requirements;
- Manufacturers and experts working in the field and shorten the time to define the necessary harmonized standards for a specific machine, and determining the appropriate norms of standards;
- Training institutions in stating in detail all the necessary steps in conformity assessment of machinery;
- All persons interested in the safety of machinery, offering expert defined and systematized knowledge of the correct application of the ETL.

2. Approach for Information Assurance of Products with European Requirements and Safety Norms

In order to build an expert information system with European requirements and safety standards it needs to create a primary systematization of data for European harmonization legislation (ESHL) [1].

The directives of New and modular approaches are systematized and presented in four categories. The presented systematization of groups and types of products is based on analysis and synthesis of data from the directives and related harmonized standards.

2.1. Primary systematization of data on European legislation for harmonization

The following systematization of product groups and standards for them is proposed:

- Group of products –they have common requirements in a Directive and a group of standards;
- Type products - have the same harmonized standards;
- Standardization mandates of the European Commission to develop harmonized standards (HS), which are designed for different types of products in one group;
- Total Mandates for harmonized standards (MHS) for a Directive;
- Total Bulgarian standards BDS, who agreed to a Directive ESHL.

The data of Bulgarian Institute of Standardization (BIS) on the number and names of BDS that introduce European harmonized standards and are consistent with directives ESHL are:

- BDS is operational, in force (F);
- BDS is cancelled (Canc.), but can be purchased from BIS;
- BDS introduces European standardization documents "Methodical Instructions" - "TR", "Technical Specification / Project - "TS/CD", "Technical Report -"CR".

The number of BDS for all directives of sector ESHL is approximately 6820.

The required completeness of data Directives List includes Modular Procedures, as well. They are formed by modules that are prescribed in the specific Directives of the Ist and IInd category. The modular approach was introduced for Directives IIIrd and IVth category (except (30) 2014/90/EU Marine Equipment (96/98/EC)). Sample data from a detailed study [1] are listed below.

I CATEGORY

Directives implementing the principles of the New and Modular approach. They are divided into two types: Horizontal and Specialized. The category includes 21 directives.

Ia. Horizontal Directives

(1) 2014/35/EU (2006/95/EC) Electrical equipment designed for use within certain voltage limits:
63 groups ≈ 788 MHS; ≈ 2339 BDS (F., Canc., TR, TS, CR).
Standards: 614 HS.
Modular Procedures: A; B.

(2) 2006/42/EC Safety of machinery:
7 product groups with ≈ 88 MHS; ≈ 1161 BDS (F., Canc., TR, TS, CR).
Standards: 762 HS.
Modular Procedures: A; H; B + C.

(3) 2014/30/EU Electromagnetic Compatibility:
49 groups ≈ 1187 MHS; ≈ 450 BDS (F., Canc., TR, TS, CR).
Standards: 165 HS.
Modular Procedures: A; B.

Ib. Specialized Directives

(4) 2014/68/EU (97/23/EC) Pressure Equipment:
31 groups ≈ 243 MHS; ≈ 412 BDS (F., Canc., TR, TS, CR).
Standards: 191 HS.
Modular Procedures: A; A1; D1; E1; G; H; B + D; B + F; B + H1; B + D; B + F; B + E; B + C1.

II CATEGORY

Directives in charge only of the principles of the Global Approach. Types of products they regulate are listed in their texts. The category includes 4 directives.

Directives/Regulations applying only Modular approach, marked "CE"

(22) 2000/14/EC Noise emitted by machinery and equipment, working outdoors:

63 types of machinery and equipment

Modular Procedures: A; H; B + C1/C2;

III CATEGORY

Directives in charge only of the principles of the New approach. The European Commission has notified the "harmonized" with them European standards, but Directives in this category no prescribed modules of the "Global" approach. Therefore, III-rd category Directives conformity of

products with harmonized standards is not demonstrated by marking "CE."

(2b) 2008/57/EO Interoperability of the rail system within the Community:

4 groups of products ≈ 177 MHS; ≈ 148 BDS (F., Canc., TR, TS, CR).

Standards: 139 HS;

IV CATEGORY

Directives draw on the principles of "New" approach and the Modular approach. In European sources available no data harmonized with relevant European standards. In the website of the Bulgarian Standards Institute (BSI) for these Directives BDS are not listed.

(30) 2014/90/EU (96/98/EC) Marine equipment:

Standards: HS - no data; 0 BDS (F., Canc., TR, TS, CR).

Modular Procedures: G; H; B + C; B + D; B + E; B + F; B + H1.

(31) 2010/30/EU Labelling of household appliances in terms of energy consumption:

Standards: HS - no data; 0 BDS (F., Canc., TR, TS, CR).

2.2. Formalization of the description "Product - European standard for safety"

The relationship "Product - European norm for safety" is constructed by applying the following algorithm:

- Determining the types of products regulated under Directives by analysing the title and the scope of the harmonized standards under the Directive. Grouping the types of products paying attention to the series of harmonized standards and the scope of products (e.g. a series of BDS EN ISO 11111:1 to BDS EN ISO 11111:7 forms group Textile machinery and contains seven types of products).
- Study and analyse the essential requirements for the type of product selected by Directive. Designation of applicable essential requirements.
- Study and analyse other Directives to establish the applicable essential for the type of product
- Designation of the decision to meet the essential requirements of the Directives on the type of product - implementation of harmonized or non-harmonized standards or other technical solutions.
- In applying the harmonized standard, non-harmonized standards or other technical solution to indicate the relationship between the essential requirement of the Directive and its meeting rate of the standard for product type.
- Determination of the components of the product type.
- Designation of the relationship between the components of the product type and essential requirements.

3. Expert Determination Product Groups Covered by Directive 2006/42/EC and 2014/33/EU

To establish the machines that are in the range of 2006/42/EC an analysis of the scope of the Directive and additional essential requirements to it being used in management recommendations for its implementation is done [2, 3].

To identify lifts covered by Directive 2014/33/EU Lifts and safety components for lifts an attention is drawn to art.1, paragraph 1 of the 2014/33/EU [4] where the scope of the directive is indicated.

Special attention is paid to products that are specifically mentioned as being outside the scope of directives 2006/42/EC and 2014/33/EU in order to create a complete and correct list of species and groups of products under both Directives. To create a list of types of products and product groups in the two directives the lists of harmonized standards under them are analysed and two approaches to classification of product groups is applied [5]:

- Selection of harmonized standards by a "family" i.e. based on the numbers of the standard. Table 1 is an example of a series of standards BDS EN 1010, grouped together "Printing machines and paper converting," which consists of 3 types of machines.
- Selection by the name of the harmonized standard and the respective field of action. The group "Machine Tools" consists of 14 types of machines that are grouped in this way. The title of the group is contained in each of the standards defining the types of machine tools in this group. This group is shown in Table1.

Table 1. Sample of results from the study determining the groups and types of products covered by Directive 2006/42/EC

Product groups	Product types (subgroups)	Harmonized standards under Directive 2006/42/EC
Printing and paper converting machines		BDS EN 1010-1:2004+A1:2011 Safety of machinery - Safety requirements for the design and construction of printing and paper converting machines - Part 1: Common requirements
	Printing and varnishing machines including pre-press machinery	BDS EN 1010-2:2006+A1:2010 Safety of machinery - Safety requirements for the design and construction of printing and paper converting machines - Part 2: Printing and varnishing machines including pre-press machinery
	Cutting machines	BDS EN 1010-3:2002+A1:2009 Safety of machinery - Safety requirements for the design and construction of printing and paper converting machines - Part 3: Cutting machines
	Book binding, paper converting and finishing machines	BDS EN 1010-4:2004+A1:2009 Safety of machinery - Safety requirements for the design and construction of printing and paper converting machines - Part 4: Bookbinding, paper converting and finishing machines
Machine tools	Drilling machines	BDS EN 12717:2001+A1:2009 Safety of machine tools – Drilling machines
	Machining centers	BDS EN 12417:2001+A2:2009 Machine tools - Safety – Machining centers
	Hydraulic press brakes	BDS EN 12622:2009+A1:2013 Safety of machine tools – Hydraulic press brakes
	Electro-discharge machines	BDS ENISO 28881:2013 Machine tools - Safety - Electro-discharge machines (ISO 28881:2013)
	Milling machines (including boring machines)	BDS EN 13128:2001+A2:2009 Safety of machine tools – Milling machines (including boring machines)
	Stationary grinding machines	BDS EN 13218:2002+A1:2009 Machine tools - Safety – Stationary grinding machines
	Pneumatic presses	BDS EN 13736:2003+A1:2009 Safety of machine tools – Pneumatic presses
	Sawing machines for cold metal	BDS EN 13898:2003+A1:2009 Machine tools - Safety – Sawing machines for cold metal
	Guillotine shears	BDS EN 13985:2003+A1:2009 Machine tools - Safety – Guillotine shears
	Transfer and special-purpose machines	BDS EN 14070:2003+A1:2009 Safety of machine tools – Transfer and special-purpose machines
	Work holding chucks	BDS EN 1550:1997+A1:2009 Machine-tools safety - Safety requirements for the design and construction of work holding chucks
	Mechanical presses	BDS EN 692:2005+A1:2009 Machine tools – Mechanical presses - Safety
	Hydraulic presses	BDS EN 693:2001+A2:2011 Machine tools - Safety – Hydraulic presses
	Turning machines	BDS EN ISO 23125:2010 Machine tools - Safety – Turning machines (ISO 23125:2010)

In applying approaches to systematization, 115 groups of products with different number of subgroups within the scope of Directive 2006/42/EC and 1 group Elevators with 5 sub-groups within

the scope of Directive 2014/33/EU are created.

4. Formalized Description of Expert Specified European Requirements and Norms Related to the Selected Group Elevators

The object of this study is the group Electric passenger and goods passenger lifts falling within the scope of Directive 2014/33/EU. Relevant essential requirements of Directives 2014/33/EC, 2006/42/EU and 2014/30/EC have been identified [6]. Directive 2014/35/EU Electrical equipment designed for use within certain voltage limits excludes from its scope electrical equipment for passenger and freight elevators, as evidenced by Annex II of the 2014/35/EU. The essential requirements for electrical equipment Electric passenger and goods passenger lifts are set out in Directive 2014/33/EU.

The harmonized standards to Directives 2014/33/EU, 2006/42/EC and 2014/30/EU satisfying the essential requirements applicable to the object of study are: BDS EN 81-1:1998 + A3:2009 [7], BDS EN 81-28:2004, BDS EN 81-58:2004, BDS EN 81-70:2004, BDS EN 81-71: 2005 + A1:2007, BDS EN 81-73:2006, BDS EN 81-77:2013, BDS EN 12015:2014, BDS EN 12016:2013, BDS EN 13015:2001 + A1:2009, BDS EN 12100:2011. For those standards (with the exception of BDS EN 12100:2011) connections between relevant essential requirements of Directives 2014/33/EC, 2006/42/EC, 2014/30/EC and specific norms of the standards are defined and systematized. A sample of the study is presented in Table 2.

Table 2. Sample of connection between the essential requirements of Directive 2014/33/EC and norms of the harmonized standards BDS EN 81-1:1998+A3:2009

Directive 2014/33/EC, Essential requirements	**Harmonized standards**	**Requirements of harmonized standards**
Annex I, 1.4.1. Lifts must be so designed, constructed and installed as to prevent normal starting if rated load is exceeded	BDS EN 81-1:1998+A3:2009	14.2.5.,14.2.5.1., 14.2.5.2., 14.2.5.3. a), 14.2.5.3. b), 14.2.5.3. c), 14.2.5.3. d).
Annex I, 1.5.1. All passenger lifts must have their own individual lift machinery. This requirement does not apply to lifts in which the counterweights are replaced by a second car	BDS EN 81-1:1998+A3:2009	6.,6.1., 6.4., 6.4.1., 6.4.1.1.,6.4.1.2., 6.4.1.3., 6.5., 6.5.1., 6.5.2., 6.5.2.1., 6.5.2.2. a), 6.5.2.2. b), 6.5.2.2. c), 6.5.4., 12.,12.1.

The object of study Electric passenger and goods passenger lifts is represented by structural parts, which are referred to the relevant essential requirements of Directives 2014/33/EU and 2006/42/EC and norms of harmonized standards satisfying these requirements [6]. Sample from the survey results is presented in Table 3.

Table 3 Sample of relationship of constructive parts of the lift with the essential requirements of the Directives 2014/33/EU (LD) и 2006/42/EC (MD)

Structure elements of lift	**Direc tive**	**Points of essential requirements of Annex I to referred Directives**					
Car	LD	1.2.	3.1.	4.7.	4.8.	5.1.	5.2.
	MD	1.6.1.	1.6.2.	1.7.3.	4.1.2.3.	1.1.3.	1.5.15.
	MD	1.1.3.	4.1.2.2.				
Means of suspension and means of support	LD	1.3.	1.4.4.				
	MD	1.4.2.3.	4.1.2.4.				

As a result of the research presented in this article methods for formalized description of European requirements and standards for electrical elevators and model providing elevators with European safety requirements are established [6].

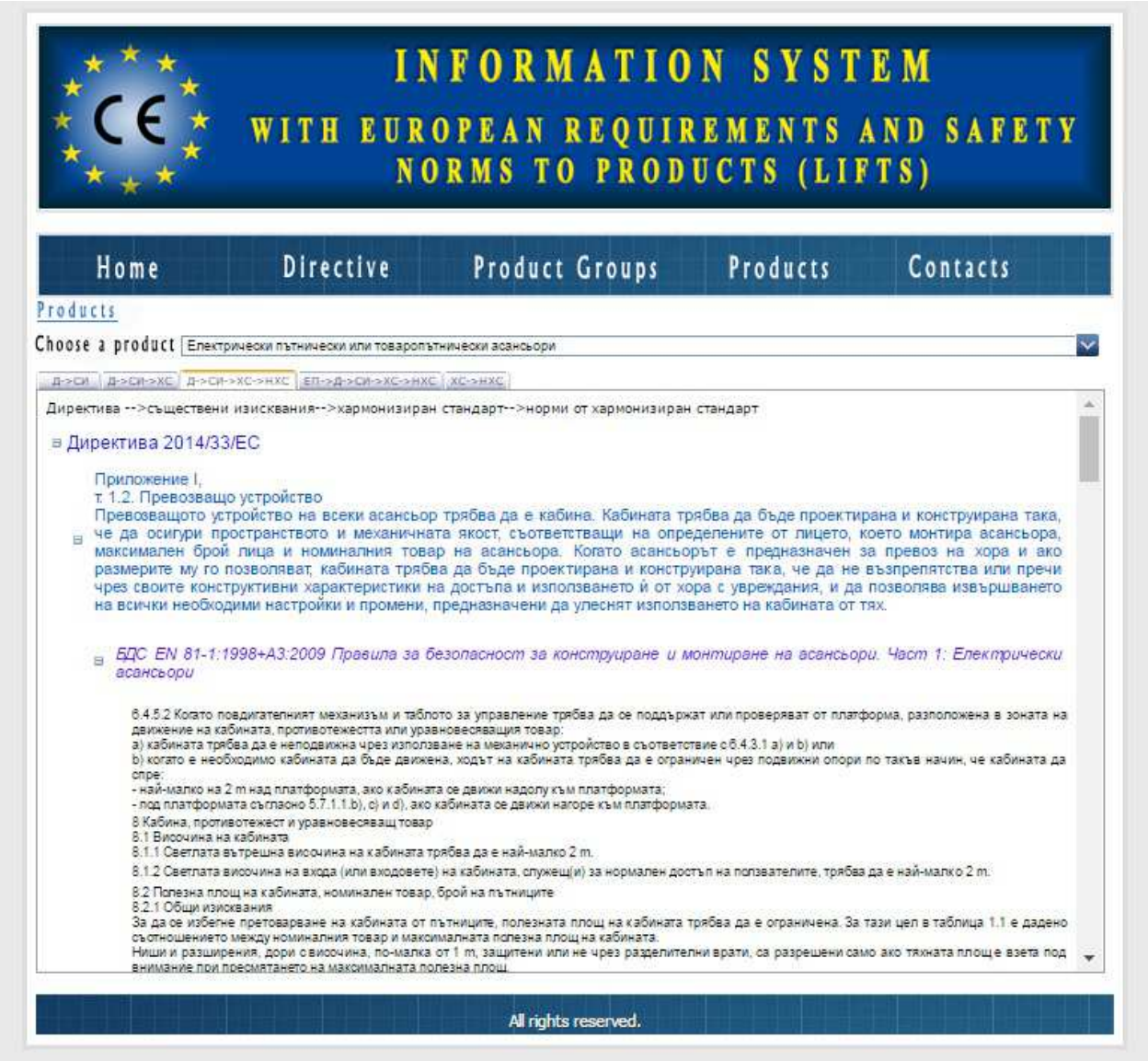

Fig. 1. Computer realization of expert information system - Products / Д → СИ → ХС → НХС
(Д - Directives, СИ - essential requirements, ХС - harmonized standards, НХС - norms of harmonized standards)

The final result of the research is presented in the expert information system. It consists of a database containing data from completed studies. To create a database software used MS SQL Server Management Studio 2012, and information system Microsoft Visual Studio Professional 2013. In Figure 1 and Figure 2 expert information system with European requirements and safety standards for products are presented on computer screens realization.

The results of this study enable manufacturers, designers, supervisors and others interested in securing the safety of elevators and machines for the European market, to save time by obtaining expert systematic and easily understandable information.

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Fig. 2. Computer realization of expert information system - Products / ЕП→Д → СИ → ХС → НХС
(ЕП - elements of the product, Д - Directives, СИ - essential requirements, ХС - harmonized standards, НХС - norms of harmonized standards)

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