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Analysis of open resources from INSHT for application to university teaching of industrial safety technology

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Abstract

This work is developed in the teaching context of the subject "Technological Aspects of Safety" (ATS) as part of the University Master's Degree in Occupational Safety and Health (OSH) of the National University of Distance Education (UNED). A classification of Industrial Safety Technologies, grouped in ATS, has been developed that links basic rules applicable to the technical guides (TG) and Technical Notes Prevention (NTP) of the National Institute of Safety and Health at Work (INSHT). The TG are essential tools for the technical interpretation of associated regulations, as their updates are generally adequate, not so for the NTP, especially considering that 54% of those analyzed predate 1997 (beginning of basic regulatory development). However, the characteristics of the classification aids the design of teaching activities, focused on the analysis and knowledge of the industrial safety technologies.

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Keywords: industrial safety; occupational risk; prevention; teaching; technology

1. Introduction

This work is developed in the teaching context of the of the subject "Technological Aspects of Safety" (ATS) as part of the University Master's Degree in Occupational Safety and Health (OSH) of the National University of Distance Education (UNED).

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Industrial Safety Technologies (IST) applied in general terms on to occupational safety and health (OSH) and the prevention of accidents at work in particular, cover a wide area, being applicable from the infrastructure and general installations of the firm, passing through the characteristics of its production process to reach each of the workstations of its organizational structure, available different and numerous technical resources freely accessible on the National Institute for Safety and Health at Work (INSHT) website.

Thus, the IST are integrated in each of the stages that configure the overall process of occupational risk management, from identification and risk assessment to planning, implementation and monitoring of preventive measures.

2. Goals

Therefore, given the breadth, dynamics and relevance of IST in OSH, the general objective of this study the following is: develop a specific classification of IST linked basic compulsory regulations apply to those complementary technical resources of the INSHT, particularly Technical Guides (TG) and Prevention Technical Notes (NTP), freely accessible through its website [2], which allows the study, analysis and interpretation of the IST by the student of ATS.

3. Methodology

For the development of this paper the following methodology is structured in three phases:

Phase 1: Identify and classify the IST from literature search and analysis;

Phase 2: Identify the technical resources available on the website of the INSHT [2] linked to IST, compatible with the requirements of Article 5.3 of Royal Decree 39/1997 [3] (result of regulatory development in Spain of Directive 89/391/CEE [4]) whose scheme is described below:

- Identify the basic compulsory regulations;
- Identify TG of the INSHT associated with the basic regulations of the preceding section;
- Identify NTP of the INSHT linked to TG the preceding section and associated in turn with the IST;
- Identify other NTP of the INSHT associated with IST not considered in the above sections.

Phase 3: Analyze the degree of coverage and updating of technical resources identified in the previous phase of the IST field.

4. Analysis of resources freely accessible from INSHT

4.1. Phase 1: identification y classification of IST

The general criteria for establishing projects and training programs, for the performance of the basic, intermediate and advanced levels functions are regulated in Spain by Royal Decree 39/1997 [3], covering preventive disciplines of Occupational Medicine, Occupational Safety, Industrial Hygiene and Ergonomics and applied Psychology. The educational objectives consist in acquiring the necessary expertise for the development of the functions of each level.

For the scope of this paper, the higher-level functions applies to the IST as part of the specialty of Occupational Safety in the context of the University Master's Degree in OSH of the UNED, the minimum content of the educational program associated with this specialty is defined by said RD 39/1997 [3] in its Annex VI under the heading "Technical of Safety and Health" [1]. These contents shape the subject of the first semester called "Safety. General Part", so that the ATS subject taught in the second semester is an in -depth study of specific safety techniques by analyzing related IST.

In the title "Risk prevention techniques¨ specific safety techniques are listed in its paragraph "i" under the following areas: "Analysis, evaluation and control of specific risks: machines; equipment, installations and tools; places and workplaces; handling, storage and transport; electricity; fires; chemicals". At this point there should be a

distinguishing between safety techniques and IST themselves. For this purpose the definition of the term "technology" contained in the 22nd edition of the Dictionary of the Royal Spanish Academy [5], will be taken as reference. Thus, in the first meaning it is defined as a: set of theories and techniques that enable the practical use of scientific knowledge. And in the fourth meaning: a set of instruments and industrial processes in a particular sector or product.

Therefore the IST can be defined as follows: a set of instruments and industrial processes that enable the practical use in analysis, evaluation and control of specific risks being able to be classified into: work equipment; places and workplaces; handling, storage and transport; electricity; fires; chemicals.

In order for the above definition to be compatible with the paragraph "i" (Annex VI) of RD 39/1997 [3], work equipment will be understood as, any machine, apparatus, tool or installation used at work [12]. The installations considered work equipment are for example: surface treatment installations, painting installations, installations composed of a combination of machines that work interdependently, etc. [13]. As for the general service installations or protection, such as electrical installations, gas or fire protection, annexed to the workplace, are considered as an integral part thereof [13].

Regarding the classification of IST, other authors establish similar classifications, such as Stranks [6], who carried out the following with more general scope: engineering safety (machinery and work equipment); fire prevention; electrical safety; structural safety; construction and contractors; mechanical handling; the working environment; safety in offices, workshops and catering operations.

Other authors also have similar classifications, although under different categories. For example Cortés [7], makes the following classification under the heading "Specific techniques", following the terminology of RD 39/1997 [3]: safety techniques applied to machines; risk of fire and explosions; electrical risks; risks in the operations manual and mechanical handling; risks in technological processes of mechanical industry; risks in industrial operations; maintenance; hand tools and hazardous chemical substances and preparations. Gil et al., for example, [8] have conducted a general classification of specialty safety at work according to their fields of action, being: the place and the work surface; tools; machinery; electricity; fires and explosions; storage, handling and transport of loads; signaling and maintenance.

Ultimately, preventive aspects of safety at work covered by different authors, such as those considered in the previous examples, agree on the essentials. In this regard there are logical variations in categories and in the approaches based on the objectives of each case, as happens with the present study, which given their objectives of a teaching nature, the IST should consider from the perspective of practical use of the set techniques specific safety, based on the definition already made.

4.2. Phase 2: Identification and analysis of the technical resources available on the website of the INSHT linked to IST

This phase will be developed using the outline provided in the methodology section. In this regard it is of interest to note that all the citations made hereinafter refer to legislation, TG and NTP and are freely accessible on the INSHT website.

4.2.1. Basic compulsory regulations and associated TG of the INSHT

In the first place it is necessary to identify the basic compulsory regulations linked to the classification of IST previously done. For basic compulsory regulations it will be understood as those derived directly from the development of the Law 31/1995 of OSH [9] (result of regulatory development in Spain of Directive 89/391/CEE [4]). In this respect the regulatory spectrum is not increased in order to establish a simple base, but solid base in order to establish the links followed.

Once this base is designed, it will be possible to establish other levels of correspondence with standards and regulations other than those indicated that are also applicable in the field of OSH, such as different industrial safety regulations (Low Voltage Regulation [10], Storage of Chemicals Regulation [11], etc.).

With these criteria, by analyzing the basic compulsory regulations on OHS and the associated TG developed by the INSHT, especially considering the scope of each rule, relationships shown in Table 1 can be established. This table shows that each IST considered is linked directly and / or transversely to one or more of the regulations as indicated above, and consequently to one or more guides, thus responding to sections a and b of the methodology established. For example, IST applied to machines, are linked directly in a first approximation to RD 1215/1997 on work equipment [12], and consequently to the TG associated with such legislation developed by the INSHT [13]. As for the RD 485/1997 on signaling [24] and RD 773/1997 on Personal Protective Equipment (PPE) [26] and associated guides, [25] and [27] respectively, it shall be considered cross field regarding the IST. However, the relationships shown in Table 1 cannot be considered exhaustive, but as indicated above, should be understood as a starting point for considering IST in the field of OSG in terms of the objectives of this work.

Table 1. TSI linked to TG of the INSHT.

Classification of tsi	RD/TG 1215/1997 Work equipment [12,13]	RD/TG 486/1997 Work-Places [14,15]	RD/TG 487/1997 Handling [16,17]	RD/TG 374/2001 Chemical [18,19]	RD/TG 614/2001 Electrical [20,21]	Rd/tg 681/2003 Explosive atmos [22,23]	RD/TG 485/1997 Signal. [24,25]	RD/TG 773/1997 PPE [26,27]
Work equipment	•	○	-	•	•	•	○	○
Places and workplaces	○	•	○	•	•	•	○	○
Handling, storage and transport	•	•	•	•	•	•	○	○
Electricity	•	•	-	•	•	•	○	○
Fires	•	•	-	•	•	•	○	○
Chemicals	•	•	○	•	•	•	○	○

• Direct link ○ Cross link RD/TG: Royal Decree and linked TG

Continuing with the example of the IST associated with work equipment, according to the characteristics of each case, the analysis in the first instance of the TG linked to RD 1215/1997, may lead to other GT, even to those not included in Table 1. Also as a result of this initial analysis, there may be connections to other regulations such as the RD 1644/2008 [28] on commercialization and commissioning of machines, which can be considered a fundamental regulation in the field of safety of machinery. However, such regulations have not been considered in the results shown in Table 1 for two reasons. In the first place there are no basic regulations arising directly from the implementation of Law 31/1995 of PRL [9]. Secondly, the study along with other technical materials of interest will be carried out by the student naturally, through teaching activities planned. Continuing the example, these activities will have their start in the RD 1215/1997 [12] and GT associated [13] as well as in related NTP that will be identified in the following section. Equivalent arguments can be carried out with other technologies considered, so that such an approach may be generalized according to the diagram shown in Figure 1.

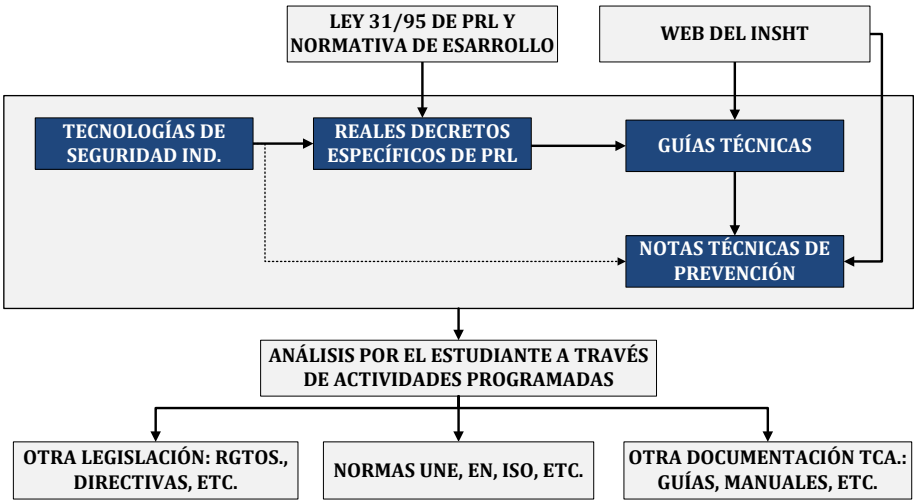

Fig. 1. Teaching Scheme of the ATS subject.

4.2.2. NTP of the INSHT associated with IST not considered in the above sections

On the website of the INSHT where the whole of the NTP is, there is a thematic classification of 8 blocks, that are: (1) Prevention / Management; (2) sectors; (3) Buildings and installations; (4) Work equipment and PPE; (5) chemicals; (6) environmental agents; (7) Specific Groups and (8) Ergonomic / Psychosocial risks and specific tasks. From this classification, and considering the whole set of NTP published, those linked to the IST have been identified, not considering the NTP that conform to the same criteria described in the previous section. From NTP identified they have been grouped in the following sequence, showing the results in the Appendix:

1. Each NTP, depending on their content and objectives, has been linked to that nearest TSI. In this regard it is of particular interest to note that the INSHT can classify a particular NTP in one or more of the thematic blocks, depending on the affinity. However, multiple selection criteria has not been chosen in order to obtain a less relational rating complexity. In any case, note that in practice preventive, the use of one or more NTP must be done with interdisciplinary vision (from [3]);
2. Each TSI, has been divided into different ATS, grouping in each, those NTP (one or more) with content and related objectives, annotating each ATS with representative assembly preventive terminology such as content and objectives;
3. The NTP seen in Table 2 that have not been identified in previous steps, have been integrated into the process using the same criteria.

4.2.3. Phase 3: Analysis the degree of coverage and updating of technical resources identified in the previous phase of the IST field.

In the first place, the results obtained in relation to TG of the INSHT must be analyzed. The same, as is apparent from Table 1, covering each of the IST set, both from the perspective of each regulation considered from a technical perspective of the INSHT. As a complement and support, the technical aspect included in each guide, is generally used the same as UNE standards and NTP. As for the UNE standards they are beyond the scope of this paper, and in relation to the NTP considered in each guide, as can be seen with the results shown in Table 2, it appears that the most immediate and relevant, degree coverage based on the NTP linked to IST, is generally very heterogeneous, being very low for TG on Electrical risk, PPE, Signaling and Explosive Atmospheres, and null for those on workplaces and load handling. Regarding the degree of updating the guides, it is observed that the first five were

reissued in the past seven years, and the last two have not been reissued, beating the 15 year period, the latter coinciding with those which are not cited NTP.

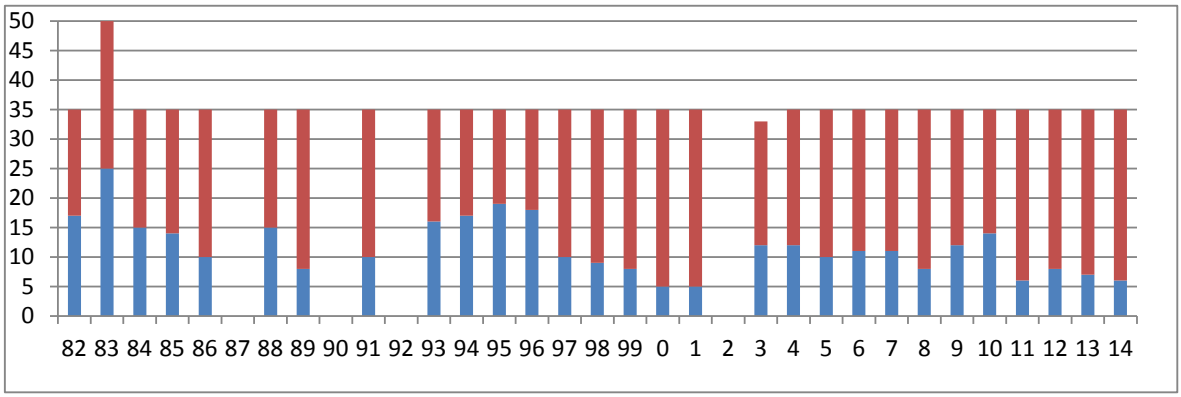

Fig. 2. No. NTP linked to TSI (blue) on the total published annually (1982 -2014)

The above results are clearly insufficient in relation to the number of NTP linked to TSI, which after analysis of the NTP associated to thematic classification of the INSHT, the number has increased significantly going from 78 to 338 NTP identified, and has also enabled the division of each IST in different ATS, as shown in the Appendix.

Thus, with 1030 the total number of NTP published to date, the number of NTP identified in Appendix, represents 33% of this total. Regarding the degree of updating, this 33% has been taken as a point of reference that allows the general assessment of the whole. 1997 is considered a time reference where different regulations and guides were published. Thus, 46% of the NTP were published in 1997 or later. In Figure 2 the NTP linked to the IST since 1982 (first year of publication) to the present can be seen.

5. Conclusions

The objective to develop a specific classification of the IST that links the basic regulations with the associated TG and NTP developed by the INSHT has been covered. The TG are essential tools for the technical interpretation of the relevant rules that are generally appropriate to their update grade. As a complement to such guides, the NTP can also be considered essential for the development of OSH, so their grouping into ATS for each IST allows well-structured and documented teaching strategies to be developed.

However, the degree of updating the NTP cannot be considered optimal, especially considering that 54% of the NTP listed in Appendix predate 1997. However, all NTP allows further study and updates through its literature, being composed normally by standards, regulations, guides and professional criteria of Spanish and international prestigious institutions. This circumstance allows the extension of teaching opportunities, oriented to design of activities focused on the analysis and knowledge of considered IST.

Finally, this paper should be considered a first step in relation to the objective pursued, since the teaching application will allow the necessary adjustments over time to be made.

Appendix A.

IST: WORK EQUIPMENT	
ATS	**NTP**
BATTERIES	097, 104
LIFTING EQUIPMENT	078, 155, 167, 208, 221, 253, 264, 824, 841, 842, 861, 866
SAFETY DEVICES AND ELEMENTS	010, 011, 012, 013, 034, 052, 053, 070, 071, 086, 087, 132, 142, 169, 235, 316, 325, 331, 342, 346, 417, 418, 446, 456, 457, 509, 510, 552, 577, 588, 760, 761, 762, 946
SPECIFIC MACHINES	033, 067, 068, 069, 088, 091, 092, 096, 098, 129, 130, 131, 133, 149, 150, 152, 153, 186, 187, 256, 281, 645
TOOLS	391, 392, 393, 631
WELDING	494, 495, 1028
WORK EQUIPMENT CARRIED OR GUIDED MANUALLY	214, 319, 713, 714, 715, 736, 737, 738
WORK EQUIPMENT TO LIFT PEOPLE	207, 474, 634, 955, 956
WORK EQUIPMENT (INSTALATION)	029, 055, 089, 090, 094, 127, 646, 672, 677, 990, 1022, 1023, 1024
IST: PLACES AND WORKPLACES	
ATS	**NTP**
INSTALLATIONS	135, 198, 238, 267, 337, 338, 340, 363, 364, 369, 370, 383, 397, 430, 432, 433, 550, 551, 617
LIGHTING	181, 211
LOADING DOCKS	985
MAINTENANCE INSTALLATIONS	030, 300, 460, 682, 683, 684, 774, 809, 843, 893
METHODS FOR ASSESSMENT OF WORKING CONDITIONS	175, 176, 210, 451, 490, 626, 627, 825, 1003, 1004
METHODS OF ASSESSMENT / ACCIDENT INVESTIGATION	274, 291, 324, 328, 330, 333, 344, 360, 401, 405, 410, 415, 442, 578, 619, 620, 621, 679, 924
RAILS	123
SIGNALS	003, 004, 035, 188, 511, 566, 888, 889
STAIRS	239, 404, 408
WASTE	276, 359, 480, 675, 710, 711, 717, 781, 805, 806, 908, 909
WORKSPACES	223, 481, 917
WORK SURFACES	434, 435
IST: HANDLING, STORAGE AND TRANSPORT	
ATS	**NTP**
HANDLING	297
PPE	227, 228, 262, 263, 301, 517, 718, 747, 748, 769, 773, 813, 882, 887, 929, 940
ROAD TRANSPORT	103, 309, 356, 357, 786, 853, 868, 869
STORAGE	050, 051, 077, 220, 298, 307, 381, 382, 618, 725, 852
IST: ELECTRICITY	
ATS	**NTP**
EFFECTS OF ELECTRIC CURRENT ON HUMAN BODY	400, 437
ELECTRIC ARC	904, 957
SAFETY DISTANCES	073, 763
STATIC ELECTRICITY	225, 374, 375, 567, 827, 828
IST: FIRES	
ATS	**NTP**
ALARM AND FIRE DETECTION	040, 041, 125, 185, 215
ASSESSMENT METHODS EXPLOSION RISK	293, 321, 630, 826, 876
EMERGENCY PLANS	045, 046, 326, 339, 361, 390, 395, 436, 500, 791, 818, 884, 928
EXPLOSION PREVENTION SYSTEMS	294, 396, 402, 403, 427, 428,
FIRE FIGHTING	028, 042, 043, 044, 099, 420, 536, 666, 680, 975
METHODS OF EVALUATION OF FIRES	025, 026, 027, 036, 037, 038, 039, 047, 100, 200, 201, 599, 600, 766, 831, 832,
IST: CHEMICAL	
ATS	**NTP**
CLASSIFICATION, LABELLING AND PACKAGING (CLP) CHEMICALS	005, 008, 178, 219, 314, 371, 461, 635, 649, 650, 651, 726, 727, 754, 871, 878, 880, 881, 973, 974
HAZARDOUS REACTIONS	237, 302, 478, 479, 527, 528, 529
LEAK AND TRANSFER	362, 385, 399, 768
METHODS FOR ASSESSMENT RISKS RELATED TO CHEMICALS	379, 464, 663, 686, 749, 934, 987, 988
NANOPARTÍCLES	797
SUBSTITUTION OF CHEMICALS	673, 712

References

[1] UNED (The National Distance Education University), website of the UNED (2014): http://www.uned.es
[2] INSHT (National Institute for Safety and Health at Work), website of the INSHT (2014): http://www.insht.es/portal/site/Insht/
[3] Spain. Royal Decree 39/1997, January 17, adopting Regulations on Prevention Services. (BOE, No. 27, 31.01.1997).
[4] Directive 89/391/CEE of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work - "Framework Directive"
[5] RAE (Royal Spanish Academy). DRAE (Dictionary of the Royal Spanish Academy), 22nd edition, 2012.
[6] J. Stranks, Health and Safety at Work: An Essential Guide for Managers, Ninth Edition, Kogan Page Limited, London, 2010.
[7] J.M. Cortés, Técnicas de Prevención de Riesgos Laborales. Seguridad e Higiene del Trabajo, 9th Edition, Editorial Tébar, S.L., Madrid, 2007.
[8] P.R. Gil, et al. Prevención de Riesgos Laborales. Instrumentos de aplicación, 2nd Edition, Tirant Lo Blanch, Valencia, 2011Spain. Law 31/1995 of 8 November on Prevention of Occupational Risks. (BOE, No. 269, 10.11.1995).
[9] Spain. Royal Decree 842/2002, of 2 August, on Electrotechnical regulations for low voltages, (BOE, No. 224 18.09.2004).
[10] Spain. Royal Decree 379/2001, of 6 April, which approves the Regulation of storage of chemicals and instructions for additional technical MIE-APQ-1, MIE-APQ-2, MIE-APQ-3, MIE-APQ-4, MIE-APQ-5, MIE-APQ-6 y MIE-APQ-7. (BOE, No. 112 10.05.2001).
[11] Spain. Royal Decree 1215/1997 of 18 July, concerning the minimum safety and health requirements for the use of work equipment by workers (BOE, No. 188 07.08.1997).
[12] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos relativos a la utilización de equipos de trabajo (Royal Decree 1215/1997 – BOE nº 188), 2nd Edition, INSHT, 2011.
[13] Spain. Royal Decree 486/1997 of 14 April, laying down minimum safety and health in workplaces. (BOE, No. 97 23.04.1997).
[14] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos relativos a los lugares de trabajo (Royal Decree 486/1997 – BOE nº 97), INSHT, 1999.
[15] Spain. Royal Decree 487/1997 of 14 April concerning minimum safety and health relating to manual handling of loads entailing risks, particularly of back injury to workers. (BOE, No. 97 23.04.1997).
[16] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos relativos a la manipulación manual de cargas (Royal Decree 487/1997 – BOE nº 97), INSHT, 1998.
[17] Spain. Royal Decree 374/2001, of 6 April on the protection of health and safety of workers from risks related to chemical agents at work.. (BOE, No. 104 01.05.2001).
[18] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos relacionados con agentes químicos (Royal Decree 374/2001 – BOE nº 104), 2nd. Edition, INSHT, 2013.
[19] Spain. Royal Decree 614/2001, of June 8, of minimum rulings for the protection of health and safety or workers against electric risks. (BOE, No. 148 21.06.2001).
[20] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos relacionados con la protección frente al riesgo eléctrico (Royal Decree 614/2001 – BOE nº 148), 3rd. Edition, INSHT, 2014.
[21] Spain. Royal Decree 681/2003, of 12 june, concerns the protection of the health and safety of workers exposed to risks deriving from explosive atmospheres on the workplace. (BOE, No. 145 18.06.2003).
[22] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos derivados de atmósferas explosivas en el lugar de trabajo (Royal Decree 681/2003 – BOE nº 145), 2nd Edition, INSHT, 2008.
[23] Spain. Royal Decree 485/1997, of 14 April on minimum requirements concerning health and safety signs at work. (BOE No 97 23.04.1997)
[24] INSHT (National Institute for Safety and Health at Work). Guía Técnica sobre señalización de seguridad y salud en el trabajo (Royal Decree 485/1997 – BOE nº 97), 2nd. Edition, INSHT, 2009.
[25] Spain. Royal Decree 773/1997 of 30 May on minimum safety and health concerning the use by workers of personal protective equipment. (BOE No 140 12.06.1997).
[26] INSHT (National Institute for Safety and Health at Work). Guía Técnica para la evaluación y prevención de los riesgos para la utilización por los trabajadores en el trabajo de equipos de protección individual (Royal Decree 773/1997 – BOE nº 140), 2nd. Edition, INSHT, 2012.
[27] Spain. Royal Decree 1644/2008, of 10 October, laying down the rules for the market and putting into service of machinery. (BOE, No. 246 11.10.2008).