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Analysis of NOM-026-STPS-2008 in the manufacturing laboratory to improve productivity

Análisis de la NOM-026-STPS-2008 en el laboratorio de manufactura para mejorar la productividad

Rivera-Domínguez Claudia
Instituto Tecnológico Superior de Guanajuato
E-mail: industrial_rivera@hotmail.com
https://orcid.org/0000-0002-5538-4713

Villanueva-Martínez Ignacio
Instituto Tecnológico Superior de Guanajuato
E-mail: ivillanueva@itesg.edu.mx
https://orcid.org/ 0000-0002-7385-060X

Piñón-Peña Paloma María
Instituto Tecnológico Superior de Guanajuato
E-mail: pena.plm@gmail.com
https://orcid.org/0000-0001-8322-025X

Abstract

This paper presents a diagnostic to detect that the safety and health signals comply was made with the requirements of NOM-026-STPS-2008 within a manufacturing laboratory, the study was carried out in concordance with the provisions of the afore mentioned regulations pertaining to the Secretaría del Trabajo y Previsión Social, which is the government entity in charge of carrying out the corresponding compliance inspections in Mexico in terms of colors and signs of safety and hygiene which a work center is operating. This study was made based on the measurements of the architectural plan of the place to the location of the machinery and tools. Was made to the location of safety and hygiene signs within the place, the identification of the existence of emergency facilities, of risks and hazards within the work area, the detection of the use of signage of obligation and prohibition that helps to control the risks. The most important limitation for the arrangement of the signals is the inadequate distribution in the work area, however, the study had to adapt to this circumstance. With the aforementioned, a proposal is made to rearrange the signage that is located in incorrect points, as well as mentioning the safety signals that are needed in the points identified within the site with their technical specifications. Finally, an area of opportunity is detected to improve the working conditions manufacturing laboratory and thereby contribute to avoid accidents and occupational diseases therefore preventive and corrective measures are applied with the proper use of signage in an area of work.
Keywords: Safety and health, safety and hygiene sign, manufacturing laboratory, nom-026-stps-2008, hazards, risks and productivity.

Resumen

En este artículo se realizó un diagnóstico para detectar que las señales de seguridad y salud cumplan con los requerimientos de la NOM-026-STPS-2008 dentro de un laboratorio de manufactura, el estudio se realizó conforme a lo establecido por la normatividad antes mencionada perteneciente a la Secretaría del Trabajo y Previsión Social, que es la entidad gubernamental encargada de realizar las inspecciones correspondientes de cumplimiento en el país de México en materia de colores y señales de seguridad e higiene con las que se encuentra operando un centro de trabajo. Dicho estudio se realizó con base en las medidas del plano arquitectónico del lugar a la ubicación de la maquinaria y herramientas. Se procedió a la ubicación de señalización de seguridad e higiene dentro del lugar, la identificación de existencia de instalaciones de emergencia, de riesgos y peligros dentro del área de trabajo, la detección del uso de señalética de obligación y prohibición que contribuya a controlar los riesgos. La limitación más importante para el acomodo de las señales se encuentra en la distribución inadecuada en el área de trabajo, sin embargo; se tuvo que adaptar el estudio a esta circunstancia. Con lo antes mencionado, se realiza una propuesta de reacomodo de la señalética que se ubica en puntos incorrectos, asimismo se mencionan las señales de seguridad que hacen falta en los puntos identificados dentro del lugar con sus especificaciones técnicas. Finalmente, se detecta un área de oportunidad para mejorar las condiciones de trabajo en un laboratorio de manufactura y, con ello, contribuir a evitar los accidentes y enfermedades ocupacionales aplicando medidas preventivas y correctivas con el uso adecuado de señalética en el área de trabajo.
Descriptores: Seguridad y salud, señal de seguridad e higiene, laboratorio de manufactura, NOM-026-STPS-2008, peligros, riesgos y productividad.

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Introduction

The study started from a problem in which it is detected that the signage within the work area is deficient therefore this distorts the preventive messages that are wanted to be made known to those who make use of the machinery, to avoid incidents and accidents during the performance of the aforementioned activity. Therefore, the study realized contributes critically to the productivity and safety of people who carry out manufacturing activities such as machining parts.

Because of a relevant factor within companies is the adequate is the adequate management of safety and health systems, this is reflected significantly in the reduction of accidents and occupational diseases, influencing the attitudes and behavior of employees in a positive way (Vinodkumar & Bhasi, 2010). There are risk factors to which employees are exposed when developing work activities, these risks can cause accidents, therefore, disabilities can be generated and as a result, effective hours of work are lost (Nag & Patel, 1998). One of the most important consequences for business administration are the economic losses caused by occupational accidents derived from low productivity (Shalini, 2009). Among the most important operational controls, it is considered to implement adequate management to eliminate, replace or reduce the likelihood of risk, to which workers are exposed, studies show that investing in safety is reflected in a positive way in reducing accidents, better worker performance, increase in productivity and quality of manufactured products or services provided. (Shirali *et al*., 2018).

The implementation of a security management system is an operational control to be used with the use of security signs and symbols. Which are a system that provides information on safety and hygiene, consist of a geometric shape, a security color, a contrasting color and a symbol (Secretaría del Trabajo y Previsión Social, 2008). It is considered that, for the use of safety signals, the worker must know and be familiar with this type of information for an adequate understand the warning or message that is being transmitted and then avoid accidents.

Worldwide there are organizations that contribute to standardize the application of signals in the industrial sector within which are ISO and ANSI (Davoudian & Azari, 2017). These signs are effective as long as they are designed in compliance with ergonomic principles, human factors, and cognitive features. (Moradi *et al*., 2014). In addition, they provide interaction between the human being and the environment, it is a method of control and prevention of the most used (Davoudian *et al*., 2015). The International Organization for Standardization (ISO) has a Technical Committee (ISO TC 145) that addresses the problems of standardization in the field of graphic symbols, establishing principles for the preparation, coordination and application of graphic symbols (Neves *et al*., 2018). Within the standards are the following: ISO 3864 - Graphical Symbols Package, ISO 3864-1: 2011-Graphical symbols - Safety colors and safety signs - Part 1: Design principles for safety signs and safety markings, ISO 3864-2: 2016 -Graphical symbols - Safety colours and safety signs - Part 2: Design principles for product safety labels, ISO 3864-3: 2012 Graphical symbols - Safety colours and safety signs - Part 3: Design principles for graphical symbols for use in safety signs and ISO 17398: 2004- Safety colours and safety signs - Classification, performance and durability of safety signs.

The American National Standards Institute (ANSI) provides up to date information and guidance on safety signals, focused on the transmission and visual understanding of information so that people can distinguish between safety signals, labels or other information that they want to transmit by visual message. The standards proposed by ANSI are mentioned below: ANSI / NEMA Z535 SET-Safety color code, ANSI Z535.1-2017-Safety Colors, ANSI Z535.2-2011 (R2017) -Environmental and Facility Safety Signs, ANSI Z535. 3-2011 (R2017) Criteria for Safety Symbols, ANSI Z535.4-2011 (R2017) Product Safety Signs and Labels, ANSI Z535.5-2011 (R2017) Safety Tags and Barricade Tapes (for Temporary Hazards), ANSI Z535.6 -2011 (R2017) Product Safety Information in Product Manuals, Instructions and Other Collateral Materials, ISO 3864-4: 2011-Graphical symbols - Safety colours and safety signs - Part 4: Colorimetric and photometric properties of safety sign materials (American National Standards Institute, 2018). In Mexico there are regulations that help rule the implementation of safety and health signals in work centers, the government entity faculted for inspections of the aforementioned is the STPS (Secretaría del Trabajo y Previsión Social), which issues the following standards: NOM-018-STPS-2000-System for the identification and communication of hazards and risks by hazardous chemical substances in a workplace (Secretaría del Trabajo y Previsión Social, 2000) and NOM-026-STPS- 2008- Colors and signs of safety and hygiene, and identification of risks by fluids driven in pipes (Secretaría del Trabajo y Previsión Social, 2008).

Application and contributions for security signals are described below; the first study is applied to Italian users on the understanding or interpretation of safety graphics used in agricultural machinery, in which the

need for training courses that focus on safety graphics and their meanings is discussed, as well as the need for improving the graphics to make them easily understandable (Caffaro *et al.,* 2017).

In another investigation, the understanding of Chinese and Korean citizens about the security symbols of the United States are assessed, and how successfully they could interpret the meaning of them, the assigned ratings are related to how adequately the symbols transmit the message, how Appropriate is the design of each of these, the results of this study underscore the importance of developing safety symbols with end users in mind and within the results should be provided useful information to assist in the design of easier safety symbols to use (Chan *et al.,* 2009).

In addition, a study was conducted that measured how people say they interpret hazard levels associated with signal words and colors in a laboratory situation. However, the only really strong finding is that of all the combinations tested DANGER on a red background is associated with the greatest amount of hazard. Perceptions about the levels of hazard represented by CAUTION and WARNING are much less consistent. Some people associate CAUTION with the least amount of hazard, others think WARNING occupies that position and, on the average, people perceive CAUTION and WARNING as closer to each other than either is to DANGER, (Chapanis, 1994; Chan & Courtney, 2001).

Finally, it is important to mention, in order for warnings to be effective, they must accomplish two objectives: they must be noticed and encoded; and they must provide understandable information needed for recipients to make informed decisions regarding compliance. A number of variables or factors have emerged as being especially significant in determining whether or not a warning achieves these objectives. These factors include both warning system design variables as well as characteristics of the target audience and the situation in which the warning is presented. (Laughery, 2006).

Methods

The safety signals contribute to improve working conditions, within a manufacturing laboratory it is intended to detect operational controls to improve productivity and avoid accidents during the development of activities with the use of machinery. Therefore, in order to carry out a diagnostic on safety signage in this workplace, it is necessary to use a comparison standardized to carry out such evaluation, in Mexico the regulations issued are the NOM-026-STPS, which is responsible for establishing the requirements in terms of colors and signs of safety and hygiene and the identification of risks by fluids driven in pipes. According with this study is carried out in which a diagnostic is developed of compliance with the 026 standard on the correct use of safety signals, which is applied in the following order:

1. *Recognition of the place: The workplace is identified according its dimensions, the machinery that is used and the risks involved with the use in this are known:*

By using AutoCAD software, the technical drawing of the 2D workplace is represented, which contains the following measures:

Figure 1 shows the measurements of the manufacturing laboratory plan and the distribution of the work team, based on these measurements was located the midpoint or geometric center of the work area, to calculate the distances of location of the signage, as well as the width and height measurements of each one of the safety signs and symbols that are required in this laboratory.

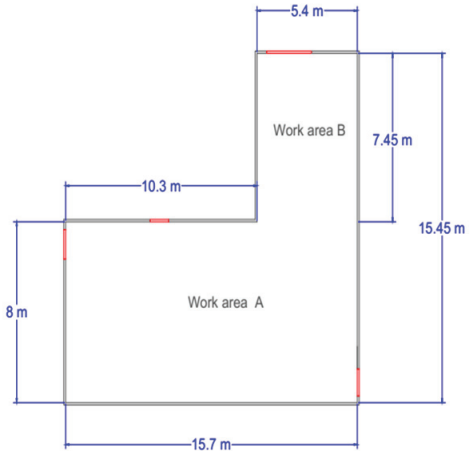

Figure 1. Drawing of the manufacturing laboratory

The workplace is divided in two; A and B, each with its respective geometric center, as shown in Figure 2 and Figure 3, to later perform the calculations applying the NOM-026-STPS standard. In Figure 2 it can be seen that the work area (A) is divided into different sections that form a triangle where it is necessary to calculate the distances c, which is the distance at which the signal will be located from the geometric center, this is necessary to calculate of base and height dimensions.

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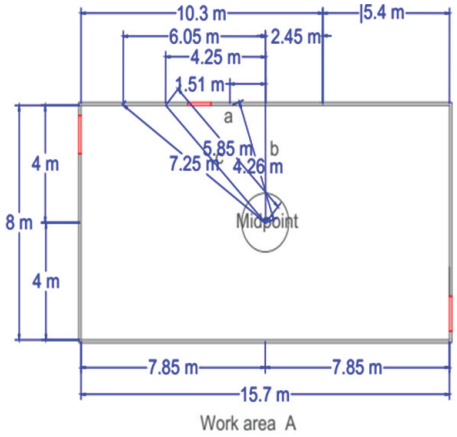

Figure 2. Location of the midpoint of workplace A

The distance c, is calculated from (1) known as the Pythagorean theorem:

$$c = \sqrt{a^2 + b^2} \tag{1}$$

From this equation the distance c = L for its substitution in the equations that will be applied based on the norm.

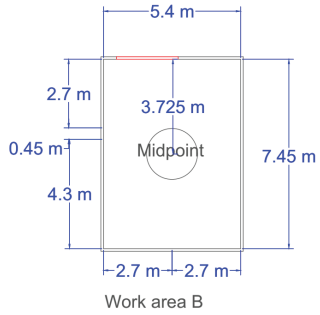

Figure 3. Location of the midpoint of workplace B

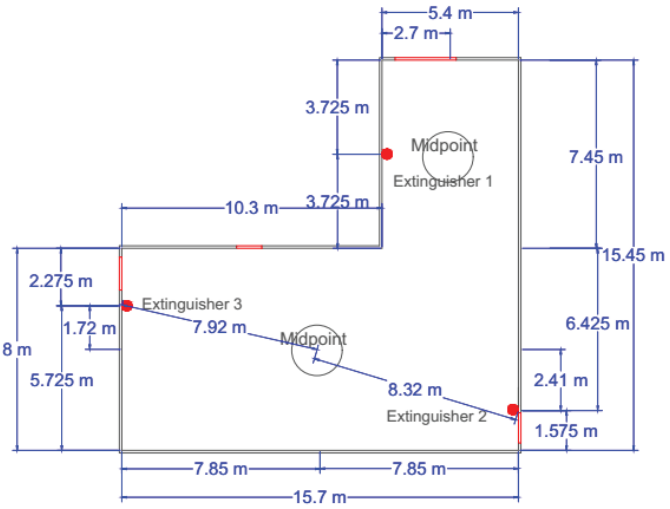

Figure 4. Distribution of fire extinguishers in the manufacturing laboratory

In the manufacturing laboratory should be located signals in case of fire, as: fire extinguisher and hydrant. However, only extinguishers are detected in the work area which do not comply with the permissible distance established by NOM-002-STPS, which mentions that fire extinguishers must be at least 23 m away from each other. The proposed distribution is shown in Figure 4 with the distance between them is:

The extinguisher 1 is at a distance of 23 m from the extinguisher 2, the extinguisher 2 is at a distance of 23 m from the extinguisher 3 and finally the extinguisher 3 is located at a distance of 16.3 m from the extinguisher 1.

2. *The machinery that is inside the workplace:*

As the NOM-026-STPS mentions, a safety symbol can be drawn up in case the standard does not present it in its appendices, it must have the written indication and its associated image, therefore, in the risks associated with the use of the machinery a suggestion of this safety signal is not presented and this will be proposed according to another standard that can supply with this need. In addition, these signals must have a triangular geometric shape, a yellow background, a contour band and a black symbol (See Table 1).

Table 1. Risks associated with the use of machinery and its corresponding safety signals

Equipment	Hazards and associated risks	There is safety signals according to the risk		Safety signals to be used according to NOM-026-STPS	Safety signals proposed by the UNE-EN ISO 7010 that not found in NOM-026-STPS
		Yes	No		
Conventional lathe 1	Risks caused by entrapment, chip detachment		✓	Signs of obligation: Wear eye protection.Wear protective footwear	Signs of obligation: Wear protective clothing 
					Signs of caution: Risk of entrapment 
Plastic injection molding machine	Risks caused by electrical contacts, fires, cuts and blows		✓	Signs of obligation: Wear protective gloves Wear eye protection Wear protective footwear	Signs of obligation: Wear protective clothing 
				Signs of caution: Danger electrical hazard. Caution high temperature	Signs of caution: Risk of cutting 
Drill milling machine	The risks presented are cuts, abrasions caused by the tool rotation (drill)		✓	Signs of obligation: Wear protective eyes Wear protective footwear	Signs of obligation: Wear protective clothing 
					Signs of caution: Risk of cutting 
CNC machining center	Chip detachment, cuts and entrapments with mobile elements.		✓	Signs of obligation: Wear protective eyes Wear protective footwear	Signs of obligation: Wear protective clothing 
					Signs of caution: Risk of entrapment  Risk of cutting 

(continuous...)

Table 1. Risks associated with the use of machinery and its corresponding safety signals (... continuation)

Column drill machine	Risk caused by chip detachment and cuts	✓	Signs of obligation: Wear protective eyes Wear protective footwear	Signs of obligation: Wear protective clothing  Signs of caution: Risk of cutting 
Milling machine	Risk caused by chip detachment, entrapments, blows, cuts with objects and falls	✓	Signs of obligation: Wear protective eyes Wear protective footwear	Signs of obligation: Wear protective clothing  Signs of caution: Risk of entrapment  Risk of cutting 
Bending and shearing machine	Cuts, blows and entrapments	✓	Signs of obligation: Wear protective eyes Wear protective footwear Wear protective gloves	Signs of obligation: Wear protective clothing  Signs of caution: Risk of entrapment.  Risk of cutting. 
Grinding machine	Blows, detachment of the tool	✓	Signs of obligation: Wear protective eyes Wear protective footwear	Signs of obligation: Wear protective clothing 

3. *Guarantee that the application of color, signaling and identification of the pipeline are subject to maintenance that ensures visibility and readability at all times:*

A checklist was made to detect if the safety signs are visible and if they are receiving maintenance, which is shown below according to Table 2.

Table 2. Checklist for obstruction of safety signals

Signs	Number of detected signals	They are obstructed		Number of Obstructed signals	Maintenance is performed		Observations
		Yes	No		Yes	No	
Emergency facilities	6	✓		1		✓	- The signal evacuation route, is obstructed by machinery and infrastructure of the building. - There is signage on a meeting point which is in the wrong place, you should consult the NOM-003-SEGOB-2011 which addresses this signal
Risks or hazards	0			0		✓	- There are no safety symbols inside the work area that warn of the risks to which they are exposed during the development of the machining activities
Mandatory action	11	✓		7		✓	- Signs wear protective footwear, wear protective eyes and wear protective gloves are obstructed by machinery and infrastructure. - Safety signs use face shield, wear protective footwear, wear protective eyes and wear protective gloves are obstructed by their incorrect placement and are not visible from the geometric center
Prohibition	1		✓	0		✓	- It is visible
Pipeline	0			0		✓	- The pipeline doesn't have any standard according to signaling

Table 3. Location of safety signs in the workplace

4. *Locate the existence of safety signals in the workplace:* The following checklist was made to identify which safety signals are missing and which are incorrect (See Table 3).

Safety signals	There is a signal in the workplace		Number of safety signals	Observations
	Yes	No		
Emergency facilities	✓		6	- The signage corresponding to the first aid kit doesn't correspond to what is marked by the standard, which must have a rectangular or square geometric shape, a green background. - The emergency shower doesn't have the corresponding safety signal. - The eyewash doesn't contain the corresponding safety signal.
Risks or hazards		✓	0	- It is suggested to use the electrical safety warning symbol, entrapment and cuts.
Mandatory action	✓		11	- It is suggested to arrange the security symbols in a more visible point since the geometric center doesn't perceive these safety signals. - According to the norm it is established that the text must be located below the safety and hygiene sign, and 100% of the symbols have the description aside. - Excess signage is detected because it saturates visual information to the operator in addition to being obstructed.
Prohibition	✓		1	- The symbol complies with geometric circular, white background, circular and diagonal bands in red and symbol in black, but the text is not in the lower part of the symbol. - It is suggested to incorporate the safety sign of prohibited the use of metal things or wrist watches and no smoking.
In case of fire	✓		3	- The safety signs comply with the established requirements, which must have a square or rectangular shape, a red background, a symbol and, if applicable, a directional arrow in white. The directional arrow may be omitted in the event that the signaling is in the vicinity of the signal element. Additionally, you can add the image of a flame in white. - The extinguishers must be arranged according to NOM-002-STPS, which mentions the distance between one and another must be 23 m according to the classification of the extinguisher that in this case is for class C fire.

5. *The identification of the pipeline in workplace according Table 4:*

Table 4. Identification of pipes within the workplace

Pipeline	It contains these elements:				Observations
	Security color	Contrasting color	Additional information	Indication of flow direction	
Fire fight	The use of this pipe in the work area is not detected				- The use of this pipe in the work area is not detected.
Dangerous fluids	The standard on the existing pipeline doesn't apply				- There is a hydraulic pipeline which must contain: a yellow safety color covering the whole pipe, a black contrast color, complementary information about the risk or the name of the substance, and the direction of flow must be adjacent to the complementary information.
Low risk fluids	The standard on the existing pipeline doesn't apply				- There is a pipeline for drinking water. Which should have a green security color covering the whole of the pipeline, complementary information on the name of the substance in white and the direction of flow adjacent to the complementary information in white or black.
Electric pipe	The standard in this pipeline doesn't apply				- There is electrical piping. Which must contain the following: legends, symbols, marks or colors to communicate the electrical risk, for example the legend "electrical risk", the value of the potential, "220 V" or the electric risk symbol.

6. *Finally, the proposal of the missing safety signals and the one that is incorrect or deficient according to the standard of the standard must be made:*

The equations for calculating the size of the safety signal are mentioned below:

The safety signals of Emergency facilities should be Square or rectangle. The relation of sides will be at most 1: 2. Using the following equations

$$S = \frac{L^2}{2000} \tag{2}$$

$$h = \sqrt{\frac{s}{2}} \tag{3}$$

$$S = b \cdot h \tag{4}$$

The safety signals of Risks or hazards should be Equilateral triangle; the base should be parallel to the horizontal. Using the equations 2 and 5

$$S = \frac{L^2}{2000}$$

$$S = \frac{L^2}{4}\sqrt{3}$$

$$L = \sqrt{\frac{4S}{\sqrt{3}}} \tag{5}$$

The safety signals Mandatory action should be circle. Using the following equations

$$S = \pi \cdot r^2$$

$$r = \sqrt{\frac{s}{\sqrt{\pi}}} \tag{6}$$

The safety signals of prohibition should be circle with circular band and diagonal oblique band at 45 °, with the horizontal arranged from the upper left to the lower right. Using the equations 6:

$$S = \pi \cdot r^2$$

$$r = \sqrt{\frac{s}{\sqrt{\pi}}}:$$

The safety signals in case of fire should be Square or rectangle. The relation of sides will be at most 1: 2. Using the equations 2 and 4:

$$S = \frac{L^2}{2000}$$

$$S = b \cdot h$$

The formula for calculating the signage is applied as shown below:

Based on the area of Figure 2, the triangle with points a, b, c is taken; the distance c is calculated from the geometric center to the place where the signal will be located, where a = 4.25 m and b = 4 m. Using Eq. (1), it has

$$c = \sqrt{(4.25m)^2 + (4m)^2}$$

$$c = 5.83m$$

$$S = \frac{L^2}{2000} = \frac{(5.83m)^2}{2000} = 0.01703m^2$$

For a signal of rectangular shape, the relation of the dimensions must be 1: 2, the base will be twice the height, the height is calculated as follows

$$h = \sqrt{\frac{S}{2}} = \sqrt{\frac{0.01703m^2}{2}} = 0.09228m = 9.28cm$$

The base is obtained to find b from the following equation

$$2 \cdot h = b$$

$$b = (2) \cdot (9.28)cm = 18.45cm$$

Below is the calculated measurements for each of the safety signals according to the application of the NOM-026-STPS (See Table 5).

Table 5. Safety signals proposal

Signs	Measurements						Proposal
	Square	Circle	Triangle	Rectangle			
	(Distance: per side) (m: cm)	(Distance: diameter) (m: cm)	(Distance: per side) (m: cm)	(Distance: Height 1: Base 2) (m: cm: cm)			
Emergency facilities				7.24	11.4	22.8	The eyewash
				5.8 4.26	9.28 6.7	18.45 13.4	The emergency shower
							First aid
Risks or hazards			7.85 26.6				Entrapment and cuts
			4 13.5 2.7 9.17				Caution high temperature.
							Danger electrical hazard.
Mandatory action		7.85 9.9					Wear protective eyes. Wear protective footwear. Wear protective gloves.
		2.7 3.4					
Prohibition		8.431 10.63					Prohibited the use of metal things or wrist watches and no smoking.

(continuous ...)

Table 5. Safety signals proposal (... continuation)

In case of fire		2.7	6.03	Fire extinguisher 1
				Fire extinguisher 2
	8.32	18.6		
	7.92	17.7		Fire extinguisher 3

Discussion and analysis of results

1. Recognition of the place:
   In this initial stage, the first approach was made with the work area to design the plan with the measurements that helped the calculation of the proposed signage. This area is divided into two zones to identify its geometric center, which is necessary for the calculation of the size of the proposed safety signals.

2. The machinery that is inside the work area:
   It proceeded to the location and knowledge of the machinery that is used within this laboratory, to identify the risks to which those who perform machining activities are exposed. The identified risks are: entrapment, cutting, (UNE-EN ISO 7010) exposure to high temperatures, electrical risk (NOM-026-STPS).

3. Guarantee the application of color, signaling and identification of the pipeline are subject to maintenance that ensures visibility and readability at all times:
   The safety signals are not maintenance of any kind and the obstruction of an emergency signal and seven warning signs are detected, which are obstructed by bad location, infrastructure and machinery.

4. Locate the existence of safety and hygiene signs on emergency installations, risks or dangers, mandatory action and prohibition:
   Emergency facilities: the signage corresponding to the first aid kit doesn't correspond to what is marked by the standard, which must have rectangular or square geometric shape, green background. The emergency shower doesn't have the corresponding safety signal. The eyewash doesn't contain the corresponding safety signal.

   Risks: the use of the electric safety warning symbol, entrapment, cuts and high temperatures is suggested.

   The norm 026 doesn't count in the appendices with all the aforementioned risks, therefore the standard UNE-EN ISO 7010 was used for the risk of entrapment and cutting.
   Signals of obligation: there is signage in non-visible points, for which the geometrical point was not considered when it was placed.
   According to the norm it is established that the text must be located below the safety and hygiene sign, and 100 % of the symbols have the description aside. Excess signage is detected because it saturates the operator with visual information.
   Prohibition signal: the text of the safety signal is not in the lower part of the symbol as the norm indicates. It is suggested to incorporate the safety sign of prohibited the use of metal things or wrist watches and no smoking. Signage in case of fire: The proposal to accommodate extinguishers according to NOM-002-STPS is presented, which mentions the distance between one and another must be 23 m according to the classification of the extinguisher that in this case is for class C fire.

5. The identification of the pipes:
   The work area doesn't comply with any standard for the identification of pipes according to the fluids that are detected: electrical piping, dangerous fluids (hydraulic pipe), low risk fluids (water), there is no firefighting piping.

6. Finally, the signage proposal must be made:
   In the last phase, the required signage is specified and the size it should have according to the formulas established by the standard, considering security color, contrast and geometric shape.

Conclusions

The study previously conducted arose from the need to correct the safety signals that was placed in a Manufacturing Laboratory, the personnel who placed existing safety signals are unaware of the regulatory compliance for the correct placement of these in Mexico. It is worth

mentioning that the results and analysis are totally attached to the compliance requested by the NOM-026-STPS, therefore, the interpretation and proposals are based on following up on the regulatory obligations acquired by the organizations in the Country.

A diagnosis was made of the regulatory compliance with the NOM-026-STPS about signs of emergency installations, risks or hazards, mandatory action and prohibition. We detected great opportunities for change that are proposed in the development of this article to improve the work environment avoiding accidents and occupational diseases, resulting in improved productivity.

Among the most important findings is the safety signals deficiency on: emergency facilities, risks or dangers and prohibition.

It is important to mention that the distribution of the machinery is not the most appropriate according to its use, since the spaces are very small to delimit corridors and there is obstruction of the emergency exit for this should be important before its accommodation use of the method (Systematic Layout Planning). However, in this study the design and rearrangement of machinery and equipment is not within the scope.

There is obstructed signage in the work area and maintenance is not provided on the colors and visibility of the same. There is electrical piping next to the eyewash, which represents an electrical risk. There is also hydraulic pipe (compressor) next to pipes or electrical installations, this represents a risk of fire in the event of a short circuit.

Finally, it is concluded that the signage does not comply with the specifications according to the Mexican regulations, no standard for the identification of the pipeline is applied. But it is important to highlight that corrective measures are proposed that will change the conditions and above all avoid sanctions by Civil Protection or the Secretaría del Trabajo y Previsión Social in a future audit on the compliance of the same without leaving aside integrity of those who work within this area of work.

References

American National Standards Institute. (2018). Safety signs and labels. Standards store. Retrieved from https://webstore.ansi.org/safety_standards/safety_signs_labels.aspx

Asociación Española de Normalización. (2017). UNE-EN ISO 7010:2012/A7:2017. Retrieved from https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma/?c=N0058384

Caffaro, F., Mirisola, A. & Cavallo, E. (2017). Safety signs on agricultural machinery: Pictorials do not always successfully convey their messages to target users. *Applied ergonomics*, 58, 156-166. http://dx.doi.org/10.1016/j.apergo.2016.06.003

Chan, A.H. & Courtney, A.J. (2001). Color associations for Hong Kong Chinese. *International Journal of Industrial Ergonomics,* 28(3-4), 165-170. https://doi.org/10.1016/S0169-8141(01)00029-4

Chan, A.H., Han, S.H., Ng, A.W. & Park, W. (2009). Hong Kong Chinese and Korean comprehension of American security safety symbols. *International Journal of Industrial Ergonomics*, 39(5), 835-850. https://doi.org/10.1016/j.ergon.2009.02.009

Chapanis, A. (1994). Hazards associated with three signal words and four colours on warning signs. *Ergonomics*, 37(2), 265-275. https://doi.org/10.1080/00140139408963644

Davoudian-Talab, A.H. & Azari, G.R. (2017). Safety signs perception and adoption with the ISO and ANSI Standards. *Jundishapur Journal of Health Sciences*, (In Pre). http://doi.org/ 10.5812/jjhs.12911

Davoudian-Talab, A.M.I.R.H.O.S.S.E.I.N., Meshkani, M., Mofidi, A. & Mollakazemiha, M. (2015). Evaluation of the perception of workplace safety signs and effective factors. International *Journal of Occupational Hygiene*, 5(3), 117-122.

Laughery, K.R. (2006). Safety communications: warnings. *Applied ergonomics*, 37(4), 467-478. https://doi.org/10.1016/j.apergo.2006.04.020

Moradi, M.S., Afshari, D., Hoseinzade, T. & Ahmadi, K. (2014). Psychological effect of safety signs on message transmission given signs designing features in petrochemical industry. *Journal of Ergonomics*, 2(2), 38-48.

Nag, P.K. & Patel, V.G. (1998). Work accidents among shiftworkers in industry. *International Journal of Industrial Ergonomics,* 21(3-4), 275-281. https://doi.org/10.1016/S0169-8141(97)00050-4

Neves, J., Da Silva, F.M., Raposo, D. & Silva, J. (2017, July). Ergonomics and warning design: standardization of graphical symbols for safety signs. On international Conference on Applied Human Factors and Ergonomics (pp. 233-240). Springer, Cham.

Secretaría del Trabajo y Previsión Social. (2000). Marco normativo de seguridad y salud en el trabajo. México: Autogestión en seguridad y salud en el trabajo. Retrieved from http://asinom.stps.gob.mx:8145/upload/noms/Nom-018.pdf

Secretaría del Trabajo y Previsión Social. (2008). Marco normativo de seguridad y salud en el trabajo. México: Autogestión en seguridad y salud en el trabajo. Retrieved from http://asinom.stps.gob.mx:8145/upload/noms/Nom-026.pdf

Secretaría del Trabajo y Previsión Social. (2010). Marco normativo de seguridad y salud en el trabajo. México: Autogestión en seguridad y salud en el trabajo. Retrieved from http://asinom.stps.gob.mx:8145/upload/nom/33.pdf

Shalini, R.T. (2009). Economic cost of occupational accidents: Evidence from a small island economy. *Safety science*, 47(7), 973-979. http://dx.doi.org/10.1016/j.ssci.2008.10.021

Shirali, G.A., Salehi, V., Savari, R. & Ahmadiangali, K. (2018). Investigating the effectiveness of safety costs on productivity and

quality enhancement by means of a quantitative approach. *Safety science,* 103, 316-322.

Vinodkumar, M.N. & Bhasi, M. (2010). Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Analysis & Prevention,* 42(6), 2082-2093 https://doi.org/10.1016/j.aap.2010.06.021