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DETERMINACIÓN DEL GRADO DE RIESGO DE INCENDIO Y EVALUACIÓN COMPLEMENTARIA DE LA CARGA DE FUEGO EN UN ESTABLECIMIENTO COMERCIAL



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DETERMINATION OF FIRE RISK LEVEL AND COMPLEMENTARY ASSESSMENT OF FIRE LOAD IN A COMMERCIAL ESTABLISHMENT

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Abstract—Fire prevention in commercial establishments requires consideration of both regulatory criteria and actual operating conditions. The objective of this study was to determine the degree of fire risk in a commercial establishment by applying NOM-002-STPS-2010 and to supplement that assessment with a fire load estimate, using engineering criteria and the methodological framework of NFPA 557. A descriptive and technical case study was conducted, based on on-site data collection, identification of combustible materials, determination of inventories, and evaluation of operating conditions. The facility contained 8,000 kg of combustible solids and 430 L of Class B liquids. Application of the criteria established in Appendix A of NOM-002-STPS-2010 resulted in a determination of an “Ordinary Fire Hazard Rating.” As a supplementary analysis, a potential energy of 146,600 MJ was estimated for an area of 600 m², resulting in a specific fire load of 244.33 MJ/m², which is considered low according to the adopted criteria. However, operational conditions were identified related to electrical installations, the storage of combustible materials, the handling of flammable liquids, and possible obstructions of evacuation routes. The results show that compliance with regulatory parameters does not eliminate the need to maintain permanent operational controls. The integration of regulatory classification, fire load analysis, and field observations allows for a broader understanding of fire safety conditions.

Keywords—fire load, NOM-002-STPS-2010, fire risk, fire safety.

Abstract—Fire prevention in commercial establishments requires consideration of both regulatory criteria and actual operating conditions. The objective of this study was to determine the fire risk level of a commercial establishment through the application of NOM-002-STPS-2010 and to supplement this assessment with a fire load estimation using engineering criteria and the methodology as a reference. A descriptive and technical case study was conducted based on on-site data collection, identification of combustible materials, inventory assessment, and evaluation of operating conditions. The establishment contained 8,000 kg of combustible solids and 430 L of Class B liquids. Application of the criteria established in Appendix A of NOM-002-STPS-2010 resulted in an Ordinary Fire Risk Level. As a complementary analysis, a potential energy of 146,600 MJ was estimated over an area of 600 m², resulting in a specific fire load of 244.33 MJ/m², considered low according to the adopted criterion. Nevertheless, operating conditions related to electrical installations, the storage of combustible materials, the handling of flammable liquids, and possible obstruction of evacuation routes were identified. The results show that compliance with regulatory classification parameters does not eliminate the need for permanent operational controls. Integrating regulatory classification, fire load analysis, and field observations provides a broader understanding of fire safety conditions.

Keywords—fire risk, fire load, fire safety, NOM-002-STPS-2010.

INTRODUCTION

Fire prevention and protection are fundamental components of workplace safety, as a fire can have serious consequences for people, facilities, property, business continuity, and the surrounding environment. In self-service retail establishments, various conditions converge that can contribute to the start and spread of a fire. These include the presence of solid combustible materials, flammable and combustible liquids, live electrical equipment, and ongoing activities such as the storage, display, and restocking of merchandise.

The materials used during commercial operations do not, in and of themselves, pose an unacceptable hazard; however, their quantity, distribution, storage method, and proximity to potential ignition sources can significantly alter safety conditions.

In this context, identifying combustible materials and determining the level of fire risk are important tools for establishing preventive and protective measures. In Mexico, the Ministry of Labor and Social Welfare establishes, through NOM-002-STPS-2010, criteria for fire prevention and protection in workplaces, including parameters for determining the degree of fire risk. The standard was published in the Official Gazette of the Federation on December 9, 2010.

The study on which this article is based used these criteria as a foundation for evaluating a self-service retail establishment. Additionally, an estimated fire load analysis was incorporated to complement the regulatory classification by providing an approximation of the amount of energy potentially available during a fire.

The objective of this study is to analyze the determination of the fire risk level of a commercial establishment through the application of NOM-002-STPS-2010 and to supplement this assessment with a fire load estimate, identifying the main operational conditions that may contribute to the initiation or spread of a fire.

DEVELOPMENT

Methodology

A descriptive and technical case study was conducted, based on gathering information about the establishment, identifying materials and operating conditions, analyzing regulations, and performing a complementary fire load estimation.

The methodology was structured to ensure traceability between:

observed conditions → inventories → regulatory classification → fire load analysis → risk identification → improvement actions.

The survey covered the facility's main functional areas:

- sales area;
- refrigeration area;
- warehouse or storage area;
- checkout area;
- electrical room;
- restrooms and office.

In addition, the following factors were considered: structural characteristics, storage conditions, distribution of goods, location of firefighting equipment, and potential sources of ignition.

Identification and Classification of Materials

The materials were identified and grouped according to their fire behavior.

Class A: cardboard, paper, plastics, wooden pallets, and dry goods.

Class B: ethyl alcohol, aerosols, oils, and products with flammable or combustible properties. **Class C:** live electrical equipment, including refrigerators, light fixtures, electrical panels, and computer equipment.

The consolidated inventory included **8,000 kg of combustible solids**, as well as **430 L of Class B liquids**, consisting of **180 L of flammable liquids and 250 L of combustible liquids**.

Determination of Risk Level

The inventories obtained were compared with the criteria established in Table A.1 of Appendix A of NOM-002-STPS-2010.

The following parameters were considered:

- built-up area;
- flammable gases;
- flammable liquids;
- combustible liquids;
- combustible solids;
- pyrophoric or explosive materials.

The classification was established by comparing the values obtained during the survey with the limits set by the standard.

Supplementary Fire Load Analysis

As a technical supplement, the specific fire load was estimated by considering the main combustible materials present in the sales and storage areas.

The potential energy was determined based on the mass of each material and its corresponding calorific value. Subsequently, the estimated total energy was related to the analyzed area.

The analysis was conducted using fire engineering criteria and based on the methodology of NFPA 557. This analysis was used exclusively as a technical supplement and not as a substitute for the regulatory classification established by NOM-002-STPS-2010.

DISCUSSION AND ANALYSIS OF RESULTS

Determination of the Fire Risk Level

The results obtained were compared with the criteria established in Table A.1 of Appendix A of NOM-002-STPS-2010.

The comparison took into account the building area, inventories of flammable and combustible liquids, combustible solids, and the presence or absence of pyrophoric or explosive materials. Based on the determined inventories, none of the evaluated parameters exceeded the limits used for the “High Risk” classification. Therefore, the facility was classified as: **Fire Risk Level: Ordinary.**

This classification specifically corresponds to the result obtained using the methodology established in Appendix A of NOM-002-STPS-2010.

Supplementary fire load analysis. Table 1 presents the main combustible materials considered for estimating the fire load.

Table 1. *Estimate of the specific fire load for the workplace.*

Material	Mass	Heat of combustion	Energy
Cardboard	2,000 kg	16 MJ/kg	32,000 MJ
Plastic	1,500 kg	32 MJ/kg	48,000 MJ
Paper	800 kg	15 MJ/kg	12,000 MJ
Dry groceries	3,000 kg	14 MJ/kg	42,000 MJ
Wood	700 kg	18 MJ/kg	12,600 MJ
Total	8,000 kg	—	146,600 MJ

Source: Author's own calculations (2026).

Note. Prepared by the author based on the inventory of combustible materials considered for the study and the calorific values used in the analysis. The estimated total energy was **146,600 MJ**. Under the classification criteria adopted in the study, this value corresponds to a **low fire load**.

The analysis was used exclusively as a technical supplement to the regulatory classification

ANALYSIS OF RESULTS

Determination of the Risk Level

A comparison of the evaluated parameters determined that none of the inventories considered exceeded the limits established for high-risk classification.

The result obtained determined that the commercial establishment has an Ordinary Fire Risk Level; this result represents the classification obtained using the methodology established in Appendix A of the standard (NOM-002-STPS-2010).

Fire Load

The estimated potential energy of the main combustible materials was 146,600 MJ. Considering an analysis area of 600 m², the result was 244.33 MJ/m². According to the classification criteria adopted in the study, this value falls within the range considered to be a low fire load.

It is important to note that this result corresponds to a supplementary engineering analysis and does not replace the regulatory classification established in Table A.1 (NOM-002-STPS-2010).

Identified Operational Conditions

The evaluation identified four main groups of conditions requiring preventive attention.

Electrical Installations

Conditions associated with overloads, multiple connections, temporary extensions, deteriorated conductors, and lack of maintenance were identified as potential sources of ignition.

Combustible materials

The temporary accumulation of cardboard, plastics, and pallets can increase the availability of fuel and facilitate the spread of fire.

Flammable and combustible liquids

The presence of alcohols, aerosols, and other products in sales areas requires maintaining proper storage and control conditions.

Evacuation routes

Restocking activities can create temporary obstructions caused by merchandise, boxes, pallets, or transport carts.

These conditions were identified as areas for improvement because they can alter the likelihood of a fire occurring or its consequences, even when inventory levels remain within the limits used for regulatory classification.

Flammable and combustible liquids

The presence of alcohols, aerosols, and other products in sales areas requires maintaining proper storage and control conditions.

Evacuation Routes

Restocking activities can create temporary obstructions caused by merchandise, boxes, pallets, or transport carts.

These conditions were identified as areas for improvement because they can alter risk behavior even when inventory levels remain within the limits used for regulatory classification. The original study specifically highlights this distinction between the classification obtained and the operational conditions that require control.

Discussion

The central finding of this research lies in the difference between the **formal regulatory classification of fire risk** and the **operational conditions observed during the field survey**. The facility was classified as having an Ordinary Fire Risk Rating and had an estimated specific fire load of 244.33 MJ/m²; however, conditions related to electrical installations, the storage of combustible materials, the handling of flammable liquids, and potential obstructions of evacuation routes were identified, all of which require preventive measures and monitoring.

These results can be compared with studies that have addressed fire risk assessment in commercial establishments from complementary perspectives. Liu et al. (2017) developed a fire risk assessment system for large-scale commercial buildings, taking into account fire characteristics and the maintenance of fire protection equipment. Their research included assessments of four commercial buildings in Chongqing, China, through detailed on-site investigations and a structured system of indicators.

A significant similarity between that study and the present work is the importance of **assessing actual operating conditions**. Liu et al. (2017) proposed a system aimed at evaluating fire protection performance, taking into account aspects related to the building's characteristics, protection systems, and their maintenance.

A comparable situation is observed in the present study: although the parameters used for regulatory classification remain within the limits corresponding to the Ordinary Risk Level, there are operational conditions that may favor the initiation or spread of a fire.

A key difference lies in the methodological approach. Liu et al. (2017) developed a multi-criteria evaluation system using indicators weighted by the entropy weight structure method. In contrast, this study employs the methodology established in NOM-002-STPS-2010 as its primary criterion and uses fire load analysis as a complementary tool.

Consequently, both approaches agree on the need to integrate different safety variables, although they differ in how they weight and classify them.

Another point of agreement is the importance of **field verification**. In the study by Liu et al. (2017), gathering information through detailed on-site investigations was a fundamental part of the evaluation process. In the present study, the physical survey made it possible to identify conditions that cannot be determined solely through inventory analysis,

such as storage practices, the condition of electrical installations, and the possibility of temporary obstruction of evacuation routes.

Fire load analysis also provides a complementary quantitative variable. The estimated potential energy of the main combustible materials was 146,600 MJ, and, considering an analysis area of 600 m², a specific fire load of 244.33 MJ/m² was obtained. This result allows for the characterization of the estimated amount of energy available per unit area, but does not in itself constitute a comprehensive measure of fire risk.

The interaction between fuel, potential ignition sources, propagation conditions, and response capacity is essential for interpreting the results. For example, a defect in an electrical installation may become more significant when it is in close proximity to combustible materials such as cardboard or plastic. Similarly, a temporary obstruction of evacuation routes can increase the consequences for people, even if the facility's regulatory classification remains "Ordinary."

Therefore, the results show that regulatory classification and operational conditions must be analyzed in a complementary manner. Compliance with the parameters established to determine the degree of risk does not eliminate the need to maintain ongoing controls over ignition sources, combustible materials, storage conditions, fire protection equipment, and evacuation routes.

In this regard, the main contribution of this study is to integrate the **regulatory classification with a quantitative estimate of the fire load and the identification of operational conditions**, establishing traceability between inventories, regulatory assessment, energy analysis, and prevention and control measures.

Proposed Prevention and Control Measures

Based on the identified risks and the assessment conducted, measures were proposed aimed at reducing both the probability of a fire occurring and its potential consequences. Table 2 summarizes the main proposed prevention and control measures, prioritized according to the relevance of the identified conditions.

Table 2. *Proposed prevention and control measures based on the identified risks.*

Condition	Proposed Measure	Purpose
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Electrical Installations	Documented inspection and maintenance program	Reduce ignition sources
Overloads and connections	Periodic verification of circuits and connections	Preventing overheating
Combustible materials	Storage and organization control	Reduce fuel accumulation
Flammable liquids	Check storage and segregation	Reduce spread
Evacuation routes	Inspections during operation	Ensure accessibility
Fire extinguishers	Documented inspection and maintenance	Ensuring Availability
Emergencies	Training and drills	Strengthen response capabilities
Findings	Follow-up through preventive and corrective actions	Preventing recurrence

Source: Prepared by the author (2026).

Note: Prepared by the author based on risks identified during the workplace analysis. The proposed measures are not limited to the availability of firefighting equipment but aim to strengthen prevention by controlling ignition sources, managing the storage of combustible materials, maintaining evacuation routes, and preparing staff to respond to an emergency.

In this regard, operational discipline and documented evidence are fundamental elements for ensuring the continued effectiveness of the implemented controls.

CONCLUSIONS

The analysis conducted determined that the facility under study has an **Ordinary Fire Risk Level**, in accordance with the criteria established in Appendix A of NOM-002-STPS-2010.

The supplementary fire load assessment determined a value of **244.33 MJ/m²**, calculated from an estimated potential energy of **146,600 MJ** distributed over an analysis area of **600 m²**. Under the criteria adopted in the study, this value corresponds to a low fire load.

However, during the site survey, operational conditions were identified that were primarily related to electrical installations, the accumulation of combustible materials, the handling of flammable liquids, and possible obstruction of evacuation routes.

The results indicate that regulatory classification and operational conditions must be analyzed in a complementary manner. Compliance with classification parameters does not eliminate the need to maintain ongoing controls over ignition sources, combustible materials, storage conditions, and evacuation routes.

A comparison with previous research, particularly the work conducted by Liu et al. (2017), highlights the importance of supplementing documentary or regulatory assessments with field research and a review of the protection and maintenance conditions of fire protection systems.

Consequently, effective fire prevention requires a strategy of continuous improvement based on hazard identification, assessment, implementation of controls, verification, and follow-up on corrective actions. The case study demonstrates that integrating regulatory criteria with complementary fire load analysis tools can contribute to a broader understanding of fire safety conditions in commercial establishments.

Future Research Directions

As a follow-up to this study, we propose going beyond formal documentary verification to assess operational effectiveness, traceability, and actual risk mitigation capacity in commercial establishments. To this end, we propose two clearly differentiated lines of future research grounded in the applicable regulatory framework:

Development of an operational audit model focused on the effectiveness of engineering controls and emergency response.

The objective of this line of research is to design a performance-based auditing protocol, structured in accordance with the guidelines of ISO 19011:2018 and the criteria for evaluating operational controls in ISO 45001:2018, in order to assess the gap between the administrative existence of a control and its effectiveness in the field. The research will systematically integrate the requirements of NOM-002-STPS-2010, preventive maintenance programs, and functional tests of fire protection equipment aligned with NFPA 10 and NFPA 25 standards, as well as the objective verification of fire brigade response times and evacuation drills. The purpose is to quantitatively validate whether the implemented controls reduce the probability of ignition and increase the response capacity in the event of an incipient fire.

Implementation of *Multi-Criteria Decision Making* (MCDM) methodologies to prioritize the performance of the fire protection system.

This line of research proposes applying multi-criteria decision-making methods (such as the Analytic Hierarchy Process

- AHP, or TOPSIS) aligned with the risk analysis framework of NFPA 550 (Decision Tree Guide for Fire Protection) and the criteria for prioritizing preventive actions in NOM-030-STPS-2009. Through this quantitative approach, the goal is to link the traditional regulatory classification of “Ordinary Risk” to a dynamic risk index that weights fire load density (MJ/m^2) according to the parameters of NFPA 557, the presence of obstructions in exit routes, and the reliability of the electrical system. This will enable evaluators to prioritize corrective actions based on their actual impact on human safety.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY

All datasets relevant to the results of this study are available in full in the article.

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This study did not receive funding from any organization.

STATEMENT ON GENERATIVE AI

The authors declare that no generative artificial intelligence tools were used at any stage of this study.

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COLLABORATIVE WORK TABLE

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