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## RISK ANALYSIS OF MACHINERY AND EQUIPMENT BASED ON NOM-004-STPS-1999 IN A FOOD INDUSTRY COMPANY

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DOI: <https://doi.org/10.61273/neyart.v3i1.99>

| Received: 03/10/2025 | Accepted: 05/16/2024 | Published: 06/28/2025

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**Summary:** Risk analysis for machinery and equipment, under regulation NOM-004-STPS-1999 (Government, 1999), is crucial for establishing safe conditions in the workplace. This Mexican standard establishes the minimum safety requirements for the prevention of accidents and illnesses resulting from the use of machinery and equipment in the workplace, with the aim of reducing the following cases: Workplace accidents. (IMSS, 2024). Reduce the incidence of accidents related to the operation of machinery and equipment, such as entrapments, cuts, burns, falls, among others. Occupational illnesses: Prevent occupational illnesses that may arise as a result of the use of machinery and equipment, such as musculoskeletal injuries due to repetitive strain or exposure to chemical agents. The objective of this project was to identify, evaluate, and manage the risks associated with the corn flour production process and the packaging area in order to ensure a safe working environment and protect the health and safety of workers, verifying that the working conditions related to the operation of machinery and equipment are safe and free of risks that could cause accidents or occupational diseases.

**Keywords:** Occupational accidents, occupational diseases, risk, unsafe condition, industrial safety , unsafe acts.

**Abstract:** The risk analysis of machinery and equipment, under the NOM-004-STPS-1999 standard, (Gobernación, 1999) is crucial for establishing safe conditions in the workplace. This Mexican standard sets the minimum safety requirements for preventing accidents and illnesses resulting from the use of machinery and equipment in workplaces. Its main objective is to reduce the following cases: Work accidents (IMSS, 2024). Decreasing the incidence of accidents related to the operation of machinery and equipment, such as entanglements, cuts, burns, falls, among others. Occupational diseases: Preventing work-related illnesses that may arise from the use of machinery and equipment, such as musculoskeletal injuries due to repetitive strain or exposure to chemical agents. The objective of this project was to identify, assess, and manage the risks associated with the corn flour production process and the packaging area, in order to ensure a safe work environment and protect workers' health and safety. This was achieved by verifying that working conditions related to the operation of machinery and equipment are safe and free of risks that could cause accidents or occupational diseases.

**Keywords:** Occupational accidents, Occupational diseases, Risk, Unsafe condition, Industrial safety, Unsafe act.

## INTRODUCTION

Within any company, safety is responsible for protecting the health of workers, so that accidents related to work activities can be prevented (Ripipsa, 2022). Therefore, it is important to carry out a risk analysis on machinery and equipment to avoid any failures in the product manufacturing process and also to protect the health and well-being of workers. To this end, operators and workers are provided with mandatory safety and protective equipment depending on the area. This project sought to improve the interaction between operators and equipment based on NOM-004-STPS-1999. (Gensuite, 2024) Industrial safety is a technical-administrative activity aimed at preventing accidents, the end result of which is damage that in turn translates into losses. Industrial safety is defined as a set of rules and procedures to create a safe working environment in order to avoid personal and/or material losses. According to Kayser (2007), the objective of industrial safety and hygiene is to prevent workplace accidents, which occur as a result of production activities. Therefore, production that does not take safety and hygiene measures into account is not good production. Good production must satisfy the necessary conditions of the three essential elements: safety, productivity, and product quality. Therefore, it contributes to the reduction of its partners and customers. Knowing the needs of the company in order to offer them the most appropriate information aimed at solving their problems and communicating the discoveries and innovations achieved in each area of interest related to accident prevention. (Kayser, 2007).

## DEVELOPMENT

This study was conducted at a well-known company that produces nixtamalized corn flour, located in the city of Los Mochis, Sinaloa. Below, we will delve into the concepts and guidelines of the research:

Protective systems and safety devices in machinery and equipment in the workplace. Protective systems and safety devices in machinery for workplaces are regulated by Mexican Official Standard NOM-004-STPS-1999. Some of the elements that can be used to protect workers are:

- Guards: Cover the machinery to prevent access to the point of operation.
- Fixed guards: Protect operators from hazards at operating points.

- Safety devices: These are installed to prevent a dangerous phase from occurring when the presence of a worker is detected in the risk area. Some examples are:
  - Safety sensors and switches.
  - Photoelectric safety barriers and safety laser scanners.
  - Safe radar systems and safe camera systems.




On the other hand, guards are elements that cover machinery and equipment to prevent access to the point of operation and avoid risk to the worker.

NOM-004-STPS-1999 establishes that safety devices must meet the following conditions:

- Be accessible to the operator.
- When their operation is not obvious, it must be indicated that a safety device is present.
- Machinery and equipment must be equipped with easily activated emergency stop safety devices.
- Check that the machinery has its safety devices in place before starting to operate it.
- Avoid placing your hands, fingers, arms, or other body parts in areas where they could become trapped.
- Keep a safe distance from the machinery.

As a first step, an assessment of areas, machinery, and equipment was carried out, as can be seen in Table 1.

**Table 1.** Areas, machinery, and equipment for producing nixtamalized corn flour.

<p>Packaging area with Richard; 20-kilogram sacks.</p> 	<p>Double packaging area; 1-ton and 1-kilogram sacks.</p> 	<p>Shipping area; loading of shipments.</p> 
<p>Premix area.</p>	<p>Quality assurance and packaging.</p>	<p>Basement, floor 1.</p>

		
Basement, floor 2.	Level 1, floor 2.	Level 1, floor 2.
		
Level 2, floor 1.	Level 2, floor 2.	Level 3, floor 1.
		
Level 3, floor 2.	Level 4, floor 1	Level 4, floor 2.
		
Level 5, floor 1.	Level 5, floor 2.	AREAS OF PROCESSING FROM RAW MATERIAL TO FINISHED PRODUCT.

Source: Own elaboration.

In order to identify all the machinery, a tour was carried out to determine the area or level where each machine was located. For this purpose, a logbook was used that complies with the

specifications of NOM-044-STPS-1999 to understand the safety measures that each machine must comply with for use by each authorized person, who is responsible for operating each one.

Risk analysis of machinery and equipment:

Risk analysis is a systematic process used to identify, assess, and control hazards associated with the use of machinery and equipment in the workplace. The purpose of this analysis is to ensure that workers are protected from accidents or occupational illnesses resulting from interaction with machinery, equipment, or tools. The process not only helps to comply with regulations such as NOM-004-STPS-1999, but also promotes a safer and more efficient working environment. In order to carry out the analysis, a tour was conducted to learn about the machines on the plant floor and identify them by name. This was facilitated by the machinery and equipment inventory log, which provided the opportunity to review each machine with its name, image, location, type of energy, and control measures.

Below is an example of the log:

**Figure 1.** Example of a machinery and equipment log.

UBICACIÓN	MAQUINARIA Y EQUIPO	NOMBRE DEL EQUIPO
P.B. ENV		ENTOLETER ENV. RICHARDSON
P.B. ENV		BANDA VOLTEADORA DE SACOS DE RICHARDSON
P.B. ENV		BANDA COCEDORA DE MAGLINA RICHARDSON
P.B. ENV		MAQUINA ENVASADORA GRAVEL 20 PACK LINE

**Source:** Prepared by the company.

**Figure 2.** Example of machinery and equipment risk analysis.

Análisis de riesgo de maquinaria y equipo  
Minsa Planta Norte  
Los Mochis, Sinaloa

00F-24

TIPO DE ENERGÍA						Tipos de riesgo				¿Cuenta con paro de emergencia?		¿Cuenta con sistema de		¿Se encuentra etiquetado?		¿Se encuentra el área delimitada?		Nivel de riesgo	Medidas de control
ELECTRICA	HIDRAULICA	PNEUMÁTICA	TÉRMICA	CINÉTICA	GRAVITACIONAL	Partes en movimiento	Electricidad estática	Generador de calor	Superficies cortantes	Si	No	Si	No	Si	No	Si	No		
X		X				<input type="checkbox"/>	SI	NO	NO	X			X		X		X	MEDIO	MANTENER LAS GUARDAS DE SEGURIDAD DE LOS EQUIPOS Y COORDINAR LOS SISTEMAS DE PUESTA A TIERRA, USO DEL EQUIPO DE SEGURIDAD PERSONAL.
X		X				<input type="checkbox"/>	SI	NO	NO	X			X		X		X	MEDIO	MANTENER LAS GUARDAS DE SEGURIDAD DE LOS EQUIPOS Y COORDINAR LOS SISTEMAS DE PUESTA A TIERRA, USO DEL EQUIPO DE SEGURIDAD PERSONAL.
X		X				<input type="checkbox"/>	SI	NO	NO	X			X		X		X	MEDIO	MANTENER LAS GUARDAS DE SEGURIDAD DE LOS EQUIPOS Y COORDINAR LOS SISTEMAS DE PUESTA A TIERRA, USO DEL EQUIPO DE SEGURIDAD PERSONAL.
X		X				<input type="checkbox"/>	SI	NO	NO	X			X		X		X	MEDIO	MANTENER LAS GUARDAS DE SEGURIDAD DE LOS EQUIPOS Y COORDINAR LOS SISTEMAS DE PUESTA A TIERRA, USO DEL EQUIPO DE SEGURIDAD PERSONAL.
X		X				<input type="checkbox"/>	SI	NO	NO	X			X		X		X	MEDIO	MANTENER LAS GUARDAS DE SEGURIDAD DE LOS EQUIPOS Y COORDINAR LOS SISTEMAS DE PUESTA A TIERRA, USO DEL EQUIPO DE SEGURIDAD PERSONAL.

SECCIONES: SECADO | AIREACION | NIVEL 1 | NIVEL 2 | NIVEL 3 | **NIVEL 4** | NIVEL 5

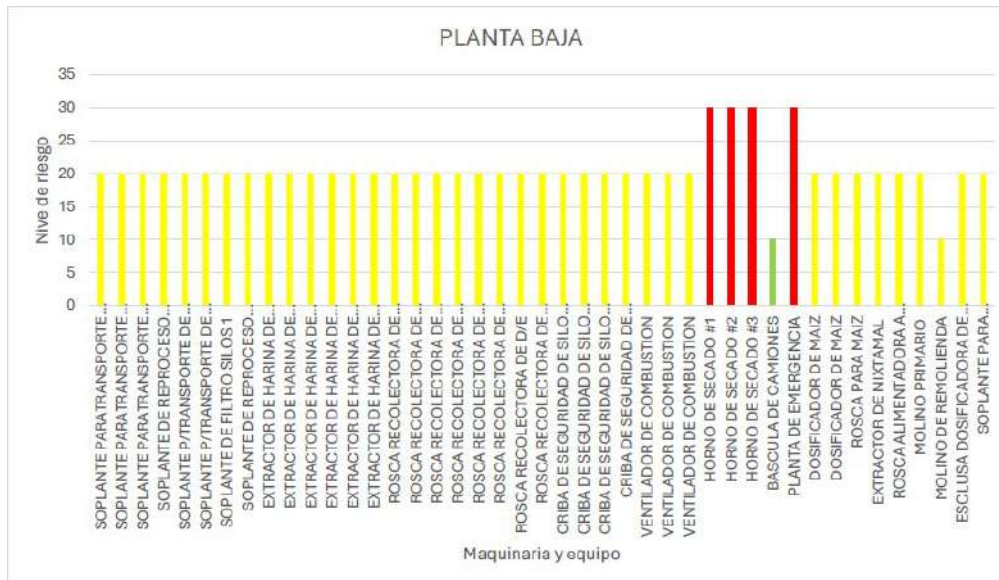
Source: Prepared by the company.

With this digital analysis, we obtained the results we needed to generate graphs that would give us a more specific idea of the level of risk involved in each machine and the solution to them. We plotted a risk level assessment to distinguish which ones are compliant and which ones we should focus on to avoid high-level risk.

Below are graphs showing the name of the machinery, the area in which it is located, and the level of risk to workers. Each risk level was assigned a rating: low (10) in green, medium (20) in yellow, and high (30) in red, which helped us distinguish each risk level.

These graphs are essential because they show the levels of risk presented by the machines and equipment when they are operating and the worker is in control of them. In general, we carried out an in-depth analysis of each area where machinery and equipment were located, which revealed 15 different areas where there is a risk of accidents for workers.

**Graph 1.** Risk level on the ground floor.



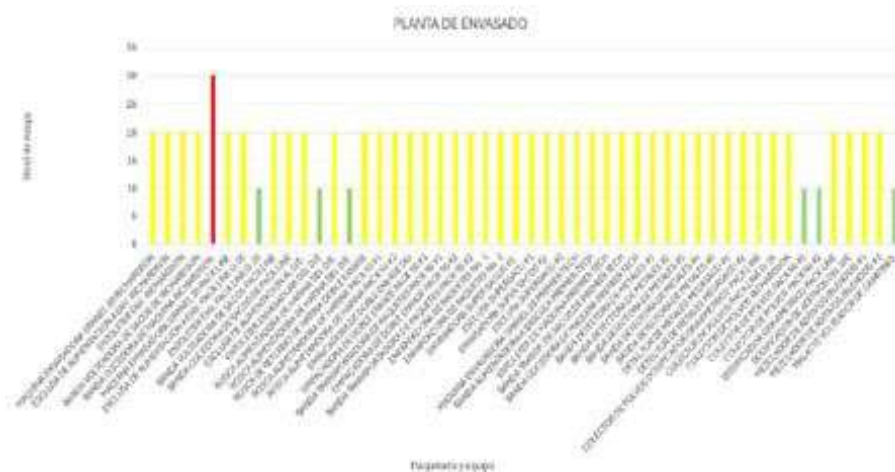
As can be seen

Source: Own elaboration.

can

, there are a total of 43 machines, all of which present a medium level of risk. However, four machines stand out: the drying ovens, which contain electrical energy and, due to their function, reach very high temperatures. Without risk or prevention signage, accidents involving personnel could occur.

**Graph 2.** Risk level graph for the packaging area.



Source: Own elaboration.

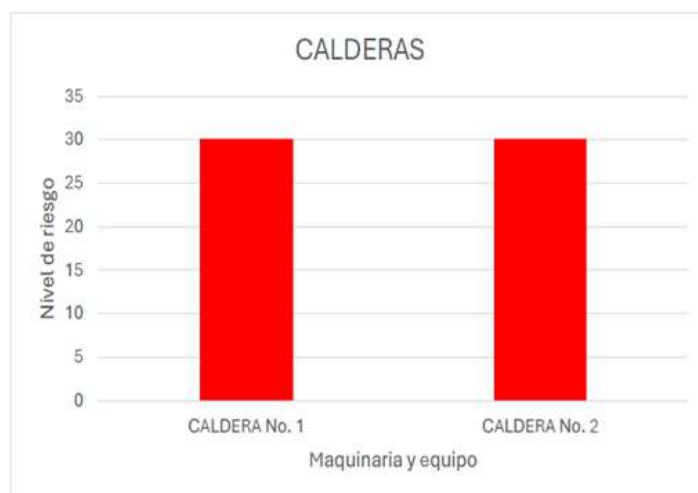
The packaging area has a total of 50 machines, which also gives us a medium risk level. Only one machine is classified as high risk, namely the Richardson machine's cooking belt, whose function is to cook the sacks containing the finished product. This machine has a mechanism that pierces the sacks with needles and then sews them with polypropylene or synthetic thread. For this reason, personnel must use the personal safety equipment provided to them when they enter the plant.

**Figure 3.** Compressor area risk.

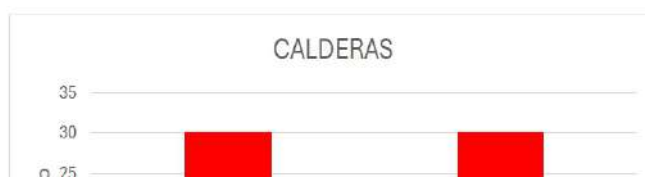


**Source:** Prepared by the authors

**Graph 4.** Risk in boiler area.



**Source:** Prepared by the author.



In the compressor and boiler areas, the results were as expected, with a medium level of risk in the compressor area, which is responsible for compressing air and gas with rotary movements that are directed to the plant; while boilers are responsible for generating heat and steam for the operation of some electrical or mechanical power machines, which must have risk signage and mandatory personal safety equipment.

**Graph 5.** Risk level in the Necojote area.



Source: Own elaboration

**Graph 6.** Risk in the B.T.A. area



Source: Own elaboration.

In this section of the necojote area (which is the residue between the mixture of solid corn and water, in this case the liquid component), the function is to separate the substances contained in the raw material; the pump area is where the water treatment for the entire plant begins. There is treated water and drinking water; in these two areas, we were given a medium risk level, taking into account that we must always use personal protective equipment to have

treated water and drinking water

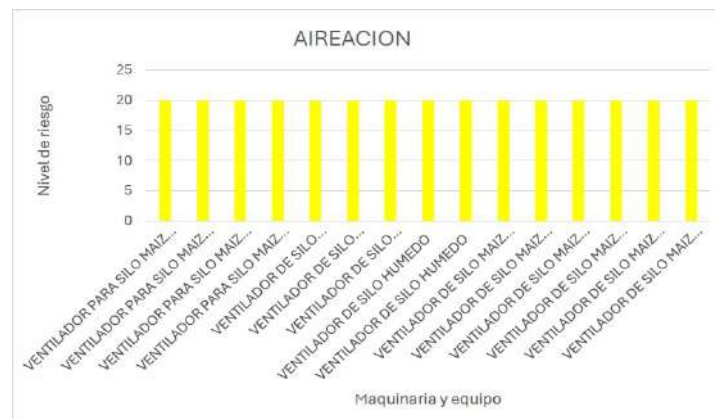
pump area is where water treatment for the entire plant begins. There is treated water and drinking water; these two areas presented a medium level of risk, taking into account that we must always use personal safety equipment to take care and avoid the risk of accidents.

**Graph 7.** Substation area risk.



**Source:** Own elaboration.

**Graph 8.** Aeration area risk.



**Source:** Prepared by the author

In the aeration or fan area, a medium risk level was obtained. These have guards that prevent contact with the blades, and they are stopped when maintenance is performed.

**Graph 9.** Risk in plant area level 1.



**Source:** Prepared by the authors.

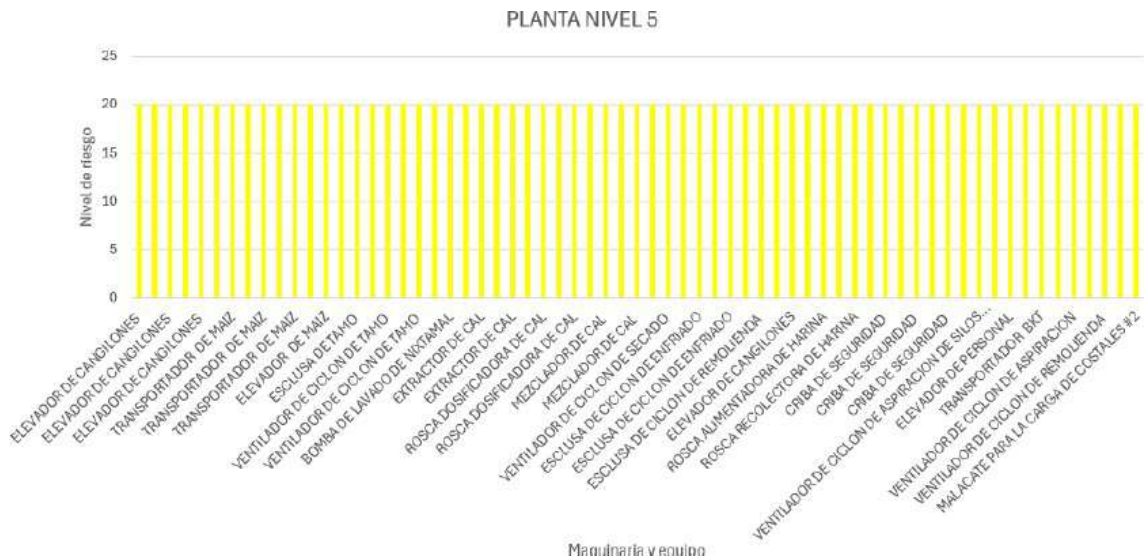
**Figure 10.** Level 2 plant area risk.



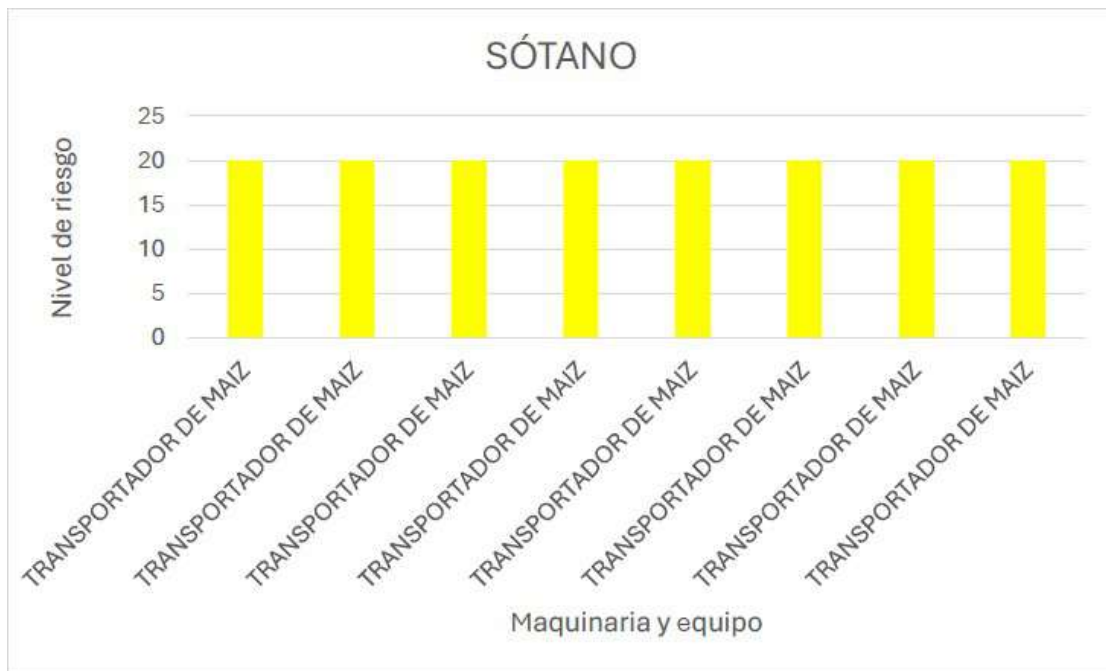
**Source:** Prepared by the authors.



**Graph 13.** Plant risk level 5.



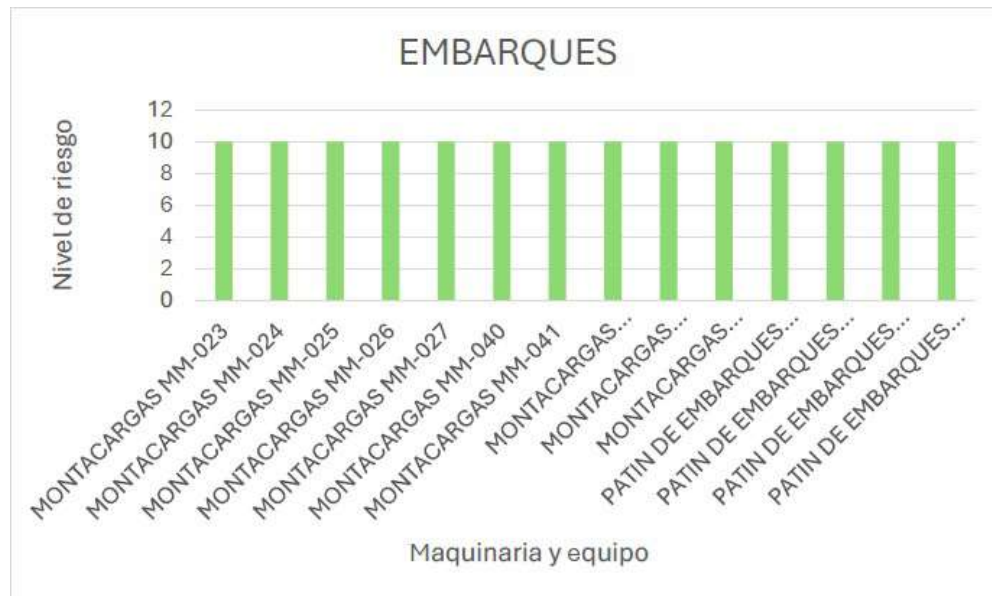
**Source:** Own elaboration.  
**Figure 14.** Basement area risk.



**Source:** Prepared internally.

This section gives us a medium level of risk, as there is supervision by the person in charge of operating this machinery, as well as the level 5 operator and personnel authorized to enter the basement.

Graph 15. Shipping area risk.








Source: Prepared by the author.

The study in this area showed a low level of risk, as there is adequate training to operate the machinery used, which in this case is forklifts and pallet trucks that allow the finished, packaged product to be stored. There is adequate labeling and emergency systems in place.

Specific recommendations based on regulatory survey NOM-004-STPS-1999.

Table 2. Machinery with regulatory recommendations.

N	MAQUINARIA Y/O EQUIPO	ANOMALIA	PRORIDAD DETECTADA	EVIDENCIA	RECOMENDACION	RESPONSABLE
1	MAQUINAS ENVASADORAS		MEDIA			HIGIENE Y SEGURIDAD
8	SOPLADORES DE TRANSPORTE DE HARINA	Se detecta que en algunas maquinas envasadoras no cuentan con señalizaciones de partes en movimiento y no cuentan con delimitaciones de área en el piso que indique los límites de acercamiento de personal	MEDIA		Colocar señalizaciones correspondientes a riesgos por partes en movimiento y señalización de delimitación de área de maquinaria y equipo.	HIGIENE Y SEGURIDAD
9	CALDERAS	Se detecta que no cuentan con señalizaciones de superficie caliente en la maquinaria que indique el riesgo latente que este representa	ALTA		Se deberá colocar señalizaciones correspondientes a las superficies calientes de esta maquinaria	HIGIENE Y SEGURIDAD
10	MOTORES DE BOMBAS DE AGUA	Se detecta que no cuenta con delimitaciones de los motores que nos indiquen el acercamiento máximo del personal	MEDIA		Deberá colocar señalizaciones adecuadas para delimitar el área de estos equipos que nos indiquen el acercamiento máximo del personal	HIGIENE Y SEGURIDAD
11	BOMBAS PARA AGUAS NEGRAS #1 Y #2	Se detecta que estos equipos no cuentan con señalizaciones y tampoco con una base 100% segura para su operación	ALTA		Se deberá colocar unas bases con señalizaciones que cumplan el 100% sobre los riesgos de las caídas de los equipos	HIGIENE Y SEGURIDAD

12	TRANSFORMADOR ES TRIFÁSICOS	Se detecta que no cuentan con señalizaciones de riesgo eléctrico ni señalizaciones sobre las delimitaciones de estos equipos	ALTA		Se deberá colocar señalizaciones adecuadas para los riesgos eléctricos y riesgos por acercamiento a estos equipos	HIGIENE Y SEGURIDAD
13	CENTRIFUGAS SEPARADORES DE SOLIDOS	Se detecta que no cuentan con señalizaciones de partes en movimiento	MEDIA		Deberá colocar señalizaciones de partes en movimiento que indique el riesgo latente al que están expuestos los colaboradores	HIGIENE Y SEGURIDAD
14	HORNOS DE SECADO	Se detecta que no cuentan con señalizaciones de superficie caliente en la maquinaria que indique el riesgo latente que este representa	ALTA		Se deberá colocar señalizaciones correspondientes a las superficies calientes de esta maquinaria	HIGIENE Y SEGURIDAD
15	TODO EL CENTRO DE TRABAJO	En el área de las maquinarias, en su mayoría no se encuentran delimitadas que nos indiquen el riesgo que representan hacia la integridad física de los colaboradores	MEDIA		Se deberá colocar señalizaciones sobre las delimitaciones de acercamiento del personal de la empresa y que este expuesto a partes en movimiento de estos equipos	HIGIENE Y SEGURIDAD
16	TODO EL CENTRO DE TRABAJO	Se detecta que el centro de trabajo no cuenta con un sistema de bloqueo (LOTO) para la maquinaria que manejan en estos maquinas	ALTA		Se deberá adquirir un sistema de bloqueo y etiquetado de maquinaria	HIGIENE Y SEGURIDAD

## DISCUSSION AND ANALYSIS OF RESULTS

After conducting a risk analysis on machinery and equipment based on NOM-004-STPS-1999, in compliance with the provisions of this standard, we found the solution to the level of risk that exists in the plant when investigating this case of accidents and problems that occur when an operator is on duty. The solution from this analysis is to ensure compliance with the labeling of machinery that requires it, specifying its signage and also taking into account the delimitation.

of the area that personnel can approach, taking into account the risks that exist in order to avoid them. This discussion is clarified and argued based on the study of the previous context, which coincides with (Hurry, 2017) in which she also used NOM-004-STPS to perform a risk analysis of machinery, in her case for a single screw extruder for polymer synthesis or processing. In addition to this, a company-specific methodology for the application of NOM-004-STPS can also be designed to prevent accidents and occupational diseases, as proposed by (Abonza Alvarez, Espino M, Espino Minero, González González, Posible Villa, & Ramírez López, 2017) in their thesis entitled "Proposal for a methodology for the application of NOM-004-1999, at the supplier RIMOVA, S.A. de C. V." It is also suggested to use the LOTO brand lockout tagout (OSHA, 2021), which is a set of safety procedures and practices used to ensure that machines and equipment are turned off and disconnected during maintenance, repair, or cleaning work, as carried out by (Gresely Rodríguez & Guamán Anilema, 2020) in their degree project.

In implementing and complying with the regulations on which we base our work, it is essential that when operating any machine that is present or involved in the manufacturing process, we take into account that we must use the mandatory safety equipment provided by the company. as well as being aware of the signage in the plant, on the machines, and on the equipment. Personnel are given an induction in industrial safety to learn about the rules and regulations that must be followed, as well as mandatory, prohibitive, risk, and emergency signage. (Brady, 2022).

**Figure 3.** LOTO padlock.



**Figure 4.** LOTO labeling.



Table 2. Plant safety measures.

MEDIDAS DE SEGURIDAD PARA MANEJO DE LA MAQUINARIA Y EQUIPO Y PARA INGRESAR AL ÁREA LABORAL	
1. La operación de los equipos, instrumentos, máquinas y herramientas se hará solo con la autorización y supervisión del operador del área	<p><b>PROHIBIDO UTILIZAR LA MAQUINA SIN AUTORIZACION</b></p>
2.-El usuario deberá usar el equipo de seguridad (casco, zapatos de seguridad, cofia, guantes, tapabocas, protectores auditivos, etc.) necesario para realizar la actividad e ingresar a planta.	
3.-Los usuarios de la celda de manufactura tendrán prohibido utilizar aretes, cadenas, anillos o pulseras que pongan en peligro la integridad de quien utilice la maquinaria y de igual manera para ingresar a planta.	<p><b>PROHIBIDO USAR ANILLOS Y RELJES</b></p>
4.- Los usuarios deben respetar las áreas asignadas para el uso de cada equipo.	<p><b>PRECAUCIÓN ZONA DE CARGA Y DESCARGA</b></p>
5.- No está permitido mover el equipo ni el mobiliario de su lugar.	



Source: Own elaboration

The implementation of a risk analysis of machinery and equipment yields various positive results that impact both worker protection and operational efficiency by preventing accidents and production stoppages. Some of the expected results are detailed below:

- 1.- Reduction in workplace accidents: The application of safety measures, such as signage, emergency stop devices, and locks, contributes significantly to reducing accidents in the vicinity of high-risk machinery. (IMSS, 2024)
- 2.- Increased Safety Awareness and Culture: Training personnel in safe procedures and fostering a culture of safety strengthens workers' awareness of potential risks, promoting safe behavior and informed decision-making. (SafetyCulture, 2024).

3.- Regulatory Compliance: A well-implemented safety system ensures compliance with labor and industrial safety standards and regulations, avoiding penalties and ensuring the legal integrity of the operation.

4.- Reduction in Accident Costs: Accident prevention not only safeguards the health and safety of workers, but also reduces the costs associated with injuries, workers' compensation, and equipment repairs. (Gómez, 2023)

5.- Longer Equipment Life: Implementing preventive maintenance routines and responding quickly to problems identified during inspections helps extend the useful life of machinery and related equipment.

6.- Incident Recording and Analysis: Establishing a protocol for recording and analyzing incidents provides valuable data for identifying areas for continuous improvement in the safety system and operational processes. (Tools, 2021)

7.- Continuous Improvement: Constant feedback from employees and periodic review of procedures allow for continuous improvement of the safety system, adapting it to changes in operations and current regulations. (Stromberg, 2025).

## CONCLUSIONS

The results show that a risk analysis of machinery and equipment based on NOM-004-STPS-1999 not only protects workers but also contributes to the long-term efficiency and sustainability of the operation. A risk analysis of machinery and equipment is essential for an industry, as it is necessary to have a diagnosis or analysis of the entire inventory of machines that are in operation and to know the level of risk each one poses to operators or workers (Imaz, 2024). NOM-004-STPS-1999 establishes safety conditions and protection systems, devices to prevent and protect workers from occupational hazards generated by the operation, as well as the maintenance of machinery and equipment. It is proposed that a short-term study be conducted on the company's preventive, predictive, and corrective maintenance system plan, as well as an emergency plan, to minimize the risk of accidents and injuries (MPE, 2024). By prioritizing worker safety and smooth operation, not only is productivity promoted, but also peace of mind in the workplace. A proactive approach to machinery and equipment risk analysis not only complies with established regulations, but also demonstrates an ongoing commitment to the well-being of

all those involved in the process. In addition, it is proposed that a study be carried out on the importance of risk level signage and zone demarcation signage, which should be displayed on all machines and in all areas mentioned in this analysis; Thanks to these signs, workers will feel calm and worry-free, knowing the level of risk and also knowing which areas they should be most careful in, remembering that when approaching equipment or machinery, they must always wear personal protective equipment (Corporación Mexicana de Casetas, S.A. de C.V., 2017).

### **FUTURE WORK**

Based on this research, it is suggested that in the short term, risk analysis and maintenance plans and programs within the company continue to be strengthened in order to fully comply with Standard 004-STPS. To this end, the following is proposed:

Conduct a short-term study on the company's preventive, predictive, and corrective maintenance system plan, as well as an emergency plan.

Conduct a study on the importance of risk level signage and zone demarcation signage.

Implement the use of LOTO labeling on company equipment and machinery. Conduct a psychosocial risk assessment for the prevention of work-related stress. **REFERENCES**

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