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IMPLEMENTATION OF A FOOD DEFENSE PLAN TO PREVENT FOOD TERRORISM IN AN AIRLINE CATERING

End of Degree Project

Food Engineering

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Resum

El concepte de Food Defense inclou totes les activitats emprades per prevenir la contaminació intencional dels productes alimentaris per agents biològics, químics, físics o radiològics.

El projecte es basa en la realització d'un pla de Food Defense per prevenir el terrorisme alimentari en un càtering d'aerolínies. Això es durà a terme a partir de les mesures de seguretat ja existents de l'empresa, amb l'objectiu de complementar-les i millorar-les amb les eines necessàries per assegurar la seguretat i protecció de la producció alimentària de l'empresa. Es tracta d'un tema de vital importància donades les brutals conseqüències que podria desencadenar la falta de prevenció contra el bioterrorisme.

Per això, es farà un estudi exhaustiu de totes les instal·lacions posant especial èmfasi en les zones més crítiques i sensibles que presenten més vulnerabilitat i poden ser més fàcilment alterades, creant un pla de defensa eficient perquè el risc d'aquest tipus de successos sigui el mínim.

A més, s'inclourà una valoració econòmica per analitzar i descriure el gran impacte que podria tenir un atac de bioterrorisme en una empresa alimentària.

Resumen

El concepto de Food Defense incluye todas las actividades empleadas para prevenir la contaminación intencional de los productos alimentarios por agentes biológicos, químicos, físicos o radiológicos.

El proyecto se basa en la realización de un plan de Food Defense para prevenir el terrorismo alimentario en un catering de aerolíneas. Esto se llevará a cabo a partir de las medidas de seguridad ya existentes de la empresa, con el objetivo de complementarlas y mejorarlas con las herramientas necesarias para asegurar la seguridad y protección de la producción alimentaria de la empresa. Se trata de un tema de vital importancia dadas las brutales consecuencias que podría desencadenar la falta de prevención contra el bioterrorismo.

Para ello, se hará un estudio exhaustivo de todas las instalaciones poniendo especial énfasis en las zonas más críticas y sensibles que presentan más vulnerabilidad y pueden ser más fácilmente alteradas, creando un plan de defensa eficiente para que el riesgo de este tipo de sucesos sea el mínimo.

Además, se incluirá una valoración económica para analizar y describir el gran impacto que podría tener un ataque de bioterrorismo en una empresa alimentaria.



Abstract

The Food Defense concept includes all the activities used to prevent intentional contamination of food products by biological, chemical, physical or radiological agents.

This project consists of the implementation of a Food Defense Plan to prevent food terrorism in an airline catering. The plan will be carried out based on the company's existing security measures, to complement and improve them with the necessary tools to assure the safety and protection of the company's food production. It is a vital importance aspect of food safety given the brutal consequences that could have the lack of prevention against bioterrorism.

To do this, an exhaustive study of all the facilities will be done, placing special emphasis on the most critical and sensitive areas that are more vulnerable and can be more easily altered, creating an efficient defense plan to minimize the risk of food adulteration.

In addition, an economical valuation will be done to analyze and describe the amount of impact that could have a bioterrorism attack in a food company.

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1. Introduction

The food industry considers the safety of the products as the most important aspect to take care of. Over the years, there have been developed several food safety management systems, such as the Hazard Analysis Critical Control Points (HACCP) principles, which has proven to be effective against accidental contamination but not against food fraud.

The main cause of deliberate acts is people. They can be from another food business, can be unsatisfied employees, or can be outsiders with no connection to the food business. The one thing they have in common is the aim to cause damage in many ways like human health or business reputation. They can also expect to make financial gains at the expense of the business. Either way, it is vital for the food business to protect itself from these kind of attacks. [1]

To do that, the main objective of food industry is to minimize the risk. There is risk if an attacker has the ability, the opportunity (where to do harm) and the desire to damage the product. Eliminating the opportunity is the only way to manage this risk. [2] Some frequent risks are:

- Possibility of introducing the polluting agent in the less controlled stages of a process.
- Ability to perform the act intentionally with enough time to alter the product and without being discovered.

It is important to effectively protect 100% of the production chain. There has to be priorities and an organized way to establish this protection. Goals are identifying, mitigating and monitoring possible sources of intentional contamination of food. [2]

Food Defense is not the same as Food Safety. Food Defense focuses on protecting the food supply from intentional or deliberate contamination, with a variety of chemicals, biological agents or other harmful substances by people who want to cause damage.

These agents include a wide variety of materials and are often difficult to detect once in the food. Additionally, these incidents do not regularly occur, so we cannot predict when and if they will even occur. [3]



In the other hand, Food Safety identifies physical, chemical and biological harmful agents that are non-intentional but can appear due to a food chain negligence.

Many food companies now have a Food Defense plan in place to protect food from intentional contamination. The Food Defense plan includes policies and procedures to prevent, maintain, protect, respond to and recover from the intentional or deliberate contamination of the food production. The management is responsible for developing a company's Food Defense plan, and there is a responsibility of following the appropriate procedures included in the plan.

The objective of this document is to create a Food Defense plan for an airline catering, due to the vulnerability of this kind of company in case of a bioterrorist attack. Even though there is no law in Europe claiming that a Food Defense plan must be established in all food companies, there is a potential risk of an act like this happening and it is in everyone's interest to control it in the best possible way.

The motivation of the Food Defense plan does not come up from the economic benefit but from the need to protect human lives and avoid a bioterrorist attack. This is reflected on the multiple cases where food intentional contamination has taken place over the years, for example, in 1984 the Rajneeshee bioterror attack in Oregon (USA) through the deliberate contamination of salad bars with Salmonella. [4] Also, in 2008 the Chinese milk scandal involved milk and infant formula along with other food materials and components being adulterated with melamine. [5]

In addition, this plan provides a differentiation from the competition, an improvement in the company reputation and a confidence increase by the clients, due to the strict additional security measures and the intensification of the ones already established in the company.

First, we will mention some of the legislation and regulations that actually apply to Food Safety. Secondly, we will introduce the subject by explaining the principles in which Food Defense is based. After that, we will deepen every stage of a Food Defense plan implementation to show every step of the process and apply it to the airline catering. Last of all, we will evaluate an economic impact considering the risks and the possibility of an attack, and its consequential loss.

2. Legislation and regulations

2.1. United States legislation

There is a law of the Food and Drug Administration (FDA) that guarantees consumer safety throughout the entire food chain. The law against bioterrorism comes into force on December 12, 2003. This law includes legal provisions with the purpose of improving the ability of prevention and response of the US in the case of a terrorist attack with biological, chemical and radiological agents. [6]

Food bioterrorism is considered the premeditated action of deliberate adulteration or contamination of food and beverages for human or animal consumption; or of the raw materials or additives used in their elaboration through biological agents, microorganisms or pathogens (bacteria, fungi, viruses, parasites...), which can seriously endanger public health and even cause death. [6]

The FDA also created an initiative to raise awareness in the preparation of Food Defense, as described in Table 1.

Table 1. ALERT initiative [7]

A	Assure	Ensure that the ingredients come from safe and harmless sources
L	Look	Monitor the safety of products and ingredients
E	Employees	Know the employees and the people who enter the facilities
R	Reports	Keep reports about the safety of the products
T	Threat	Notify when there is a threat or any suspicious activity on the facility

The United States Department of Agriculture (USDA) states that: “An informed and alerted staff is more likely to detect weaknesses in a Food Defense system and to detect and properly respond to signs of intentional contamination.” [3]



2.2. European legislation

There is no specific European legislation on Food Defense. The risk management is done from the Hazard Analysis and Critical Control Points (HACCP), which is based on accidental contamination.

There is no similar law in Europe as the one in the United States because there is not that much of awareness of this matter. Only the International Food Standard (IFS) and the British Retail Consortium (BRC) partially cover the gap.

Food Defense in Europe could be a competitive advantage at the export level of the European community products.

2.2.1 Food Defense referential

As previously mentioned, in Europe there are two certification standards: the IFS and BRC Global Standard for Food Safety. Another reference that applies Food Defense is the International Organization for Standardization (ISO) 22000 since January 2017.

These certification standards have the following requirements:

- Creation of a Food Defense team

This is based on the responsibility assignment to the right employees of the company to assure an effective defense planning. These members can be from human resources, maintenance, production, quality assurance...

- Hazard and critical areas analysis

First, possible hazards must be listed and critical areas identified. Then, different zones must be assigned a score based on the result of the hazard analysis. Various methods can be used in this analysis.

- Review of the hazard analysis

A review of the hazard analysis should be done, minimum once a year or whenever there is evidence that the system does not work or there is a change in the system. Also, an alert system has to be established to notify that.

- Control measures assessment

Measures such as simulation or a checklist of control measures to see if they are applied. If it is not effective, it is necessary to re-evaluate hazards and start training programs.

- On-site regulatory inspections and reports

This final step is necessary to check if the Food Defense program is really working out.

2.3. Spanish legislation

In Spain, Law 8/2011 on legislation, there is a national center for the protection of critical infrastructures (CNPIC), where food is included. This is the only approach to Food Defense. A critical infrastructure provides essential services, it does not allow alternative solutions and its destruction or disturbance is a serious impact. [2] It has the following structure:

Sector strategic plans → Operator safety plan → Specific protection plan → Support plans



3. Principles to establish and implement Food Defense

3.1 Principle of risk assessment

The risk assessment is the basis of the Food Defense plan. In this case, vulnerabilities are identified as a risk that can affect food production in the catering and decrease the efficiency of the prevention measures to avoid a terrorist attack in an airplane. The accuracy and precision of the risk assessment determines the effectiveness of the entire Food Defense plan. [8]

3.2 Principle of prevention

The Food Defense plan includes an evaluation of the current preventive measures counting on the severity of the risk and impact. In this way, the risk of intentional destruction is minimized. [8]

3.3 Principle of confidentiality

The process of evaluating the defense and the protective details of the scheme should be confidential to prevent food security risks. [8] In this case, the plan carried out for the airline catering will be fictional in many aspects and sensitive information of the company will not be revealed.

3.4 Principle of communication

Communication can help identify the possibility of deliberate contamination and respond on time. It can also help improve the relevance and precautionary measures, to improve its effectiveness and prevent most Food Safety incidents. [8] There has to be a proper communication between the catering and the airline to detect and respond to any potential attack.

4. Implementation of the Food Defense plan

The Food Defense plan it is a written plan to record the activities implanted in a company to control and reduce the potential for the occurrence of an intentional contamination event. [2] This plan must identify vulnerabilities and actionable process steps, mitigation strategies, and procedures for food defense monitoring, corrective actions and verification.

To prepare a proper Food Defense plan it is essential to analyze the vulnerabilities found on the company system. This is called the vulnerability assessment, which is shown on the following pages of this document. Once the vulnerabilities are defined, it is necessary to establish a control plan to prevent them or apply adequate corrective measures to minimize the damage. The best way of prevention against food terrorism is staff training. Making sure employees know the risks and the consequences of intentional contamination can help create awareness and a better detection of suspicious or unusual activities, increasing the efficiency of the plan.

Finally, verification tests of the plan and documentation is needed, so it is known that the plan is working correctly. In addition, at least once a year a complete audit of the plan should be made. The plan should be modified and evaluated whenever there is a change in the system. [7]

All the steps included in the food chain must be considered to control the risk of introducing the polluting agent in the most vulnerable and less controlled stages. The hazard analysis must be carried out based on the conditions that suppose a risk of adulteration intentional acts. Some aspects to consider are: the nature of the product (type, lot size, shelf life...), the location and accessibility to both the facility and the product, and the people working in the facility. [2] For the implementation of the Food Defense Plan to be successful, it is essential to assure the accomplishment of the FIRST rule for all personnel, as shown in Table 2.

Table 2. Steps of the FIRST rule [8]

F	FOLLOW	Follow the plan and established procedures
I	INSPECT	Inspect your work area and surroundings
R	RECOGNIZE	Recognize anything out of the ordinary
S	SECURE	Secure all ingredients, supplies and finished products
T	TELL	Notify someone of something unusual or suspicious



5. Stages of the Food Defense plan

5.1. Assignment of responsibilities: Creation of the Food Defense team

The members of the Food Defense team should not only have a sense of responsibility and integrity, but also necessary knowledge, experience and be qualified. The overall responsibility for the plan will be assigned to a single employee with decision-making capacity who understands the safety requirements. Employees will have their responsibilities defined and documented. [9]

The team should be integrated by the responsible of different areas of the company creating a multidisciplinary team, as well as external support from experts when necessary.

All procedures and operating rules that the team establishes in the company are confidential, as well as the obtained results, to avoid possible attacks.

5.2. Food Defense evaluation: Vulnerability analysis and Critical Control Points (CCP)

The evaluation of the defense is the basis of the entire Food Defense plan, and is carried out mainly with the Food Defense team. The purpose is identifying the risks of deliberate acts and possible damage to the products, which is the main concern.

This part of the plan is based on the identification of the vulnerabilities and the action steps for each type of food manufactured, processed, packed or held at the food facility. It is about evaluating how vulnerable a facility is for the presentation of a certain danger and the possibility of harm from that danger. [2]

Vulnerability depends on the flow diagram of the products manufactured and the processing conditions: products that require intense mixing, large production lots, easily accessible products, long-term products...etc. [2]

A vulnerability analysis must be carried out with the degree of threat and associated level of risk. For each point, step, or procedure in the facility's process, different elements must be evaluated: [10]

- The severity and scale of the potential impact on public health. This would include such considerations as the volume of product, the number of servings, the number of exposures, the quickness of the distribution, the potential contaminated agents and their infection degree; and the possible number of illnesses and deaths.
- The degree of physical access to the product. Things to be considered would include the presence of physical barriers like doors, lids and seals.
- The ability to successfully contaminate the product.

The analysis can be concretized in some important aspects, such as: employees (trained in Food Defense procedures and policies), visitors (limiting the access to restricted areas), raw material warehouse, finished product warehouse, chemical agents warehouse, water security, security in the processing area, loading and shipping of finished products...etc.

5.2.1. Risk assessment tools

5.2.1.1. Hazard Analysis and Critical Control Points (HACCP)

HACCP is the standard procedure based on accidental contamination. However, HACCP principles are not that reliable when it comes to deliberate attacks on a system or process. Such attacks include deliberate contamination, electronic intrusion, and fraud. Deliberate acts may have food safety implications but can harm organizations in other ways, such as damaging business reputation or extorting money. [1]

Many companies nowadays use the HACCP method, indicated in Figure 1, instead of a real Food Defense method because maybe economically they can not afford all the security measures or because the law in Europe does not force any food industry to establish a Food Defense plan.



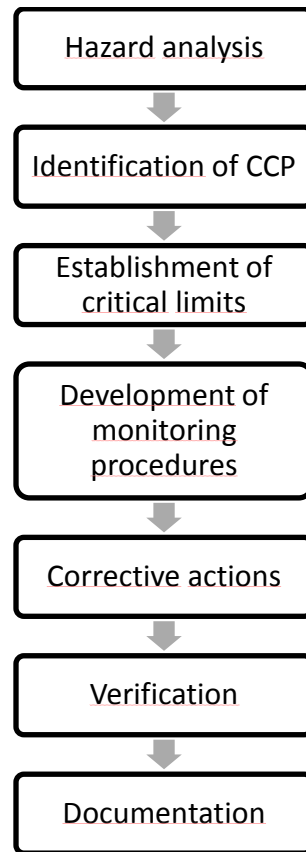


Figure 1. HACCP diagram process

5.2.1.2. Threat Assessment of Critical Control Points (TACCP)

Unlike the previous method, the TACCP aims to reduce the chance and the consequences of a terrorist attack by taking in consideration several factors: the motivation of the attacker, the probability of the attack to happen, the opportunity and capability of carrying out the attack, the vulnerability of the process and the severity of the attack (the impact on the human health). [1]

Then, assessing the potential impact by considering the consequences of a successful attack and judging the priority to be given to different threats by comparing their likelihood and impact, it establishes a priority of threats based on the risks.

In addition, it decides upon proportionate controls needed to discourage the attacker and give early notification of an attack. [1]

In this way, this method demonstrates that reasonable precautions are taken and due diligence is exercised in protecting food. So it also helps the company reputation.

As we can see in Figure 2, there are several steps to complete a TACCP process, and like every other method, every step of the process should be revised to make sure a proper prevention.

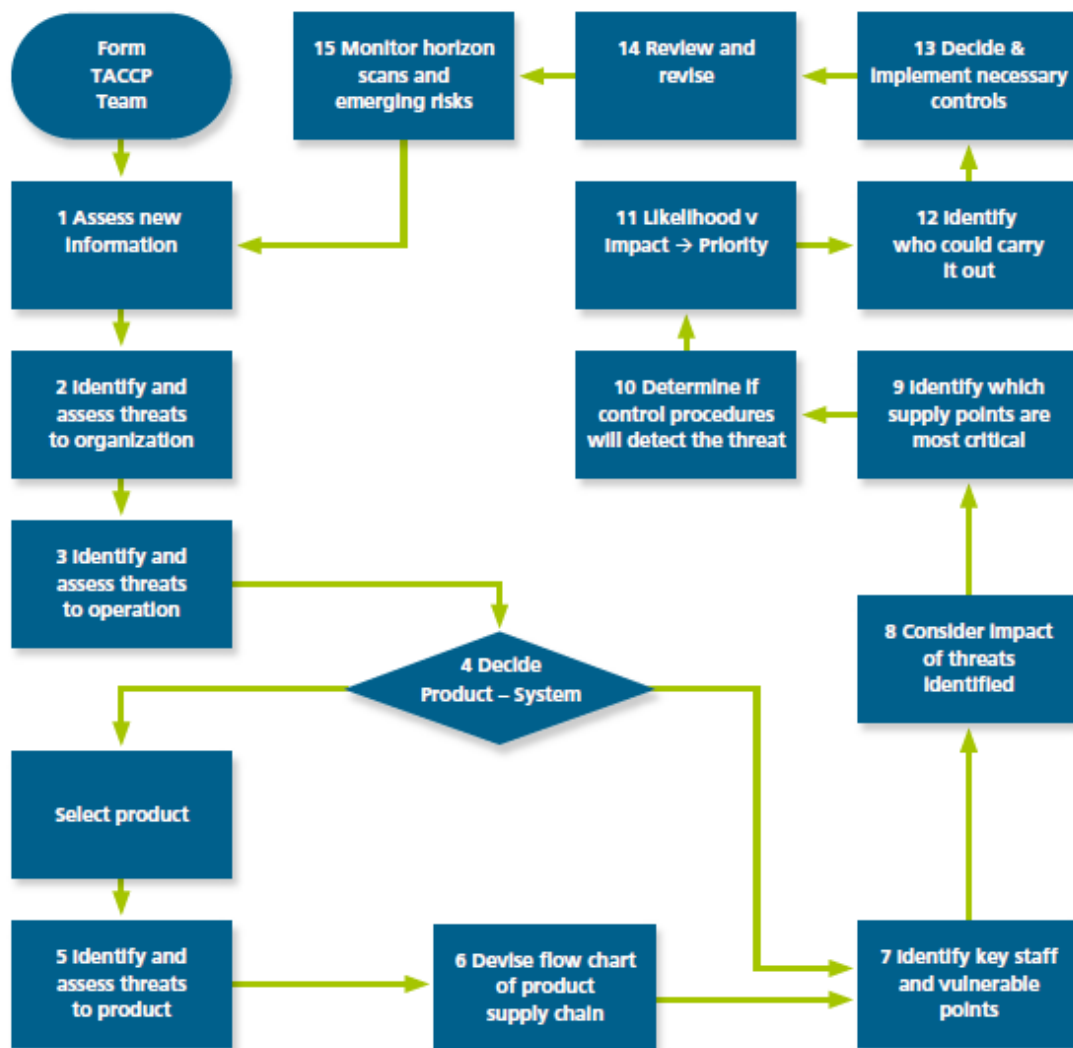


Figure 2. TACCP process flowchart [1]

5.2.1.3. CARVER + Shock

This method has similar conditions to the TACCP, but instead of identifying the threat of food adulteration, it identifies how vulnerable various points in the supply chain are to the threat. Therefore, it is an offensive prioritization methodology to assess the vulnerabilities of food supply chains. These seven concepts shown in Table 3 are scored for each zone and part of the process. Next, an action plan is established by the Food Defense team based on the punctuation of each risk. The more score has the parameter, the more significance it gets.

Table 3. CARVER analysis method [11]

C	Criticality	Impact that an attack would have on the public health or the economy of the company
A	Accessibility	Ease of access to the critical point by a terrorist and to attack without being detected
R	Recoverability	Difficulty to recover productivity after the attack to that critical point
V	Vulnerability	Ease with which a polluting agent can be introduced in sufficient quantities to achieve a significant act of sabotage, once the facility has been accessed
E	Effect	Direct loss resulting from an attack per loss of production
R	Recognition	Ease of a terrorist to identify the target
Shock	Limitation of the impact that may affect public health, depending on the number of deaths	

5.3. Food Defense prevention: Security measures

After obtaining the most vulnerable regions to intentional tampering and other vulnerabilities in daily operational procedures, we must formulate effective and preventive control measures to minimize the possibility of deliberate harm. Food Defense measures should be set after analyzing all the steps, including the existing defense measures of the facility.

The mitigation strategies should be identified and implemented at every critical process step to provide assurances that vulnerabilities will be minimized or prevented. These strategies must be tailored to the facility and its procedures.

They include monitoring (establishing and implementing procedures, including the frequency with which they are to be performed), corrective actions (in case they are not properly implemented), and verification activities to ensure that monitoring is being conducted and appropriate decisions about corrective actions are being made. [10]

5.3.1. People controls

Controlling the people that have access to the facility is one of the most important methods of control. In a food processing facility, there are basically employees (those working at the facility on a regular basis) and visitors (including vendors, contractors, tour groups, and inspectors).

A basic control could be wearing an ID badge. For employees it may include a picture and a bar code or magnetic strip that allows them to access the building. For visitors, ID badges should clearly identify the person was approved to enter the facility, there should be a system for checking visitors in and out, and they must never be left alone.

As previously mentioned, staff training is the best way of prevention towards food intentional contamination. So employees should be trained to notice unusual behavior and report every warning sign when necessary. [3]

5.3.2. Physical controls

Access points where aggressors can enter a critical area of the facility need to have adequate control measures. For this reason, access should be limited through a common door and all other doors should be locked to the outside. The main door can be locked or guarded to restrict the access of unauthorized people.

Securing and monitoring the exterior perimeter of the facility is very important because there may be water tanks or air handling units that can be a target for aggressors. [3]

5.3.3. Receiving and shipping controls

This kind of controls are especially important because control of food and other items during the transportation process may be compromised. Trucks and other distribution vehicles should be inspected before reception and delivery to detect possible signs of tampering.



A great way to control that is the use of tamper evident seals on in-coming and out-going shipments, to verify and notify if there has been manipulation. This will prevent unauthorized deliveries or vehicles to enter the facility. [3]

5.3.4. Product controls

Controlling products is another important step of the Food Defense plan. These controls may include procedures such as receiving a certificate of analysis indicating the safety of an ingredient, restricting access to ingredients and finished products, and ensuring that the finished product is properly sealed and coded.

Suspected product tampering may be noticed in receiving, processing or packaging. There are several signs easy to identify, such as compromised packaging, unusual product smell, appearance or taste, tamper-evident tags removed from tanks, tampering with locks...etc. [3]

5.3.5. Suspicious behaviors

When it comes to suspicious behaviors, it is important to remember the motives and tools an aggressor has to attack food. Missing items that could be used to the contamination of a product should be immediately reported or located.

It is essential to know who should be in the facility and forbid personal items into production areas. Employees should have as another job requirement being aware of suspicious behaviors that may point to someone being a potential aggressor. [3]

5.3.6. Security measures

Total and permanent security does not exist. In order to assure a proper prevention it is necessary to install security systems combining several technologies and implement the corresponding rules and procedures. Each company must establish a limit of the investment in security.

There are three security rings that should be considered: the external perimeter, the external area between the perimeter and the building, and the direct access to the facility. [2]

The more the outer rings are protected the less need of protection there will be in the interiors.

External security

- ✓ Perimeter
- ✓ Outdoor illumination
- ✓ Access control of people and vehicles
- ✓ Windows
- ✓ Locks
- ✓ Doors and gates

Internal security

- ✓ Surveillance system
- ✓ Alarms
- ✓ Areas of restricted access
- ✓ Computer control system
- ✓ Cybersecurity (passwords, firewalls...)

Productive process security

- ✓ Verification of non-handling of ingredient packages
- ✓ Traceability
- ✓ Finished product registration
- ✓ Procedures for suspicious activities

Storage security

- ✓ Restricted access to sensitive areas
- ✓ Inventories
- ✓ Procedures to send and receive products
- ✓ Schedules of deliveries and shipments
- ✓ Elimination of dangerous substances

Staff security

- ✓ Staff background check
- ✓ Safety procedures training
- ✓ Access control of employees and contractors
- ✓ Visible method to identify the staff in each shift
- ✓ Restriction of personal items in production areas



6. Food Defense plan of an airline catering

In this chapter, we are going to apply everything previously mentioned with a practical example by focusing on the most important stages of the Food Defense plan. The company we are talking about is a leading provider of airline catering and provisioning services.

In order to do that, we will use the FDA's Food Defense Plan Builder software. This program helps creating the Food Defense plan by providing a standard pattern easy to adapt on any kind of company. This tool provides examples of questions that the company should ask itself to prove if there is an adequate security in the facility. Then, you provide the missing information about the actual state of the company prevention measures and create an action plan.

To begin with, we will determine the mitigation strategies of every section of the facility by analyzing the measures already taken, indicating several critical points that need to be controlled and deciding which ones need action steps. This is shown in Table 4.

Table 4. Mitigation strategies

Section	Measure	Response	Plan Content	Comments	Action Steps
Outside Security					
1. Property Perimeter	1a. Is the property perimeter secured to prevent entry by unauthorized persons (e.g., by security guards, fence, wall, or other physical barriers)?	Currently Doing	A fence secures the property perimeter against unauthorized entry. There are two access doors, one for employees and visitors, and the other one for vehicles. Both entries are guarded by security cameras and a private surveillance service of the facility.		
	1b. Is there adequate lighting around the property perimeter?	Currently Doing	Exterior lights are installed around the property perimeter. These lights adequately illuminate the property perimeter to deter and aid in the detection of suspicious or unusual activities.	The lighting around the dock is adequate due to the need of the trucks to the trolley loading and transport to the airport. However, the lighting in the supplier area, next to the warehouse entry, is not good enough because of the lack of activity at night in that area. A properly lighting system would be needed, such as LED lighting, to save energy.	
2. Building Perimeter	2a. Is there adequate lighting outside each building and in between buildings?	N/A		There is just one building in the property perimeter.	
	2b. Are primary entrances to the buildings and operating areas monitored and secured?	Currently Doing	All primary entrances to the buildings and operating areas are secured. All doors have properly functioning locks or alarms that are checked on a regular basis.		
	2c. Are emergency exit doors self-locking from the outside, with alarms that activate when the doors are opened?	Gap	Emergency exit doors are not locked from the outside and there are no alarms that sound when an emergency exit door is opened, so there is a number of entrances and access points that are vulnerable to unauthorized entry.		Yes
	2d. Are operational entrances, such as the loading dock doors, secured when not in use?	Gap	The loading dock is regularly monitored.	The facility is always operating, and some accesses like vehicle entries are frequently opened when needed.	Yes
	2e. Are all possible access points into the buildings covered, locked, or otherwise secured?	Currently Doing	All potential access points into the facility, including windows, roof openings, and ventilation openings are secured and monitored regularly. All doors other than the primary entrances are configured as emergency exits only.	There is just one access point to the facility and it is placed right next to the control center to watch over every person who enters the building.	
	2f. Are products and ingredients that are stored outside the secured building protected by fences, tamper-evident seals, and/or locks?	Gap	Outside storage is not protected from unauthorized access.	The are security guards and a surveillance system looking after the outside storage.	Yes
3. Vehicles	3a. Does the property have a controlled or guarded entrance for vehicles?	Currently Doing	The entry of vehicles and people to the facility property is controlled through a single access point. Authorization to enter is confirmed by the use of a key-card, access code or display of identification.		
	3b. Are all vehicles entering the property identified by decals or other form of company-issued visual identification? This may include forms of permanent identification for employee vehicles, and temporary identification for vehicles belonging to visitors, contract workers, suppliers, and customers.	Currently Doing	Authorized employee and business vehicles must display a vehicle identification card provided by the company. Vehicles without this card are required to sign in with security and once approved, they are provided a visitor entry tag to display in the windshield.	Vehicles left or abandoned at the facility can be easily identified.	
	3c. Where practical, is there some distance (i.e., a buffer zone) between parking areas and entrances to food storage or food processing areas or utilities?	Currently Doing	Vehicle parking areas are separated from the building by a buffer area to increase visibility and difficult the act to enter the facility without detection.		



General Inside Security					
4. Facility/Plant	4a. Is there adequate lighting throughout the facility?	Currently Doing	Lighting throughout the facility is adequate and maintained. It also enhances the ability of closed circuit television (CCTV) to record events.	The lighting of the warehouse palletized area could be improved, although there are no products vulnerable to intentional manipulation.	
	4b. Is there an emergency lighting system in the facility?	Currently Doing	Emergency lighting is installed at the facility and is tested regularly, to assure and facilitate the detection of suspicious or unusual activities.		
	4c. Does your facility have monitored and recorded security cameras such as a closed circuit television (CCTV) system?	Currently Doing	A CCTV system is in place that records all major areas of the facility, including restricted areas. Recordings from the CCTV are reviewed regularly.	Recordings of CCTV may help prove or disprove a threat of intentional contamination.	
	4d. Does your facility have established emergency procedures, including procedures for responding to an intentional contamination?	Gap	There is no emergency procedures, including procedures for responding to an intentional contamination, to prepare the facility and personnel for emergencies.	Emergency procedures that include shutdown of production can limit the impact of a possible intentional contamination incident.	Yes
	4e. Does your facility have an emergency alert system that is tested regularly?	Currently Doing	The facility has an emergency alert system that is tested regularly. Employees are trained on what to do if the emergency alert system goes off. The system is reviewed regularly with emergency contacts.		
	4f. Is access to production, storage and other sensitive areas restricted to a small number of employees?	Currently Doing	Restricted areas of the facility are clearly identified and its access is limited. Uniform color is used to distinguish employees who are allowed access to restricted areas.		
	4g. Is there a procedure in place for individuals who normally do not have access but have a legitimate need to gain temporary access to the restricted areas? This would include all visitors, contractors, salespeople, and employees.	Currently Doing	A policy and procedure for granting temporary access to restricted areas for visitors or employees is in place. Individuals who are not normally authorized to be in restricted areas require escort by an authorized employee at all times. Non-employees may not bring personal items into the processing areas. A log of visitors entering the facility is maintained.		
	4h. Are copies of the facility's site plan and blueprints stored in a secured location at the facility and in an offsite location?	Currently Doing	An up-to-date copy of the facility's site plan and blueprint is stored in the facility manager's office. Access to any copy is controlled.		
	4i. Are procedures in place to check maintenance closets, personal lockers, and storage areas for suspicious items or packages?	Gap	Regular inspections of the facility are required and documented, including all utility areas, storage areas, maintenance areas, and production areas.		Yes
	4j. Do you regularly take inventory of keys to secured/sensitive areas of the facility?	Currently Doing	Security access codes are deactivated when an employee leaves the company or when an employee no longer needs access. Physical keys are issued with documentation maintained. Keys of sensitive areas are constantly controlled.	There are no old keys and access codes that can allow unauthorized users access to the buildings or sensitive areas.	

5. Utilities	5a. Are controls for the Heating, Ventilation, and Air Conditioning (HVAC) systems secured by a lock to prevent access by unauthorized persons?	Currently Doing	The control area for HVAC systems is kept locked. The main air intakes are in a fenced area.		
	5b. Are controls for refrigeration, including the main storage areas for combustible materials like ammonia, secured by lock to prevent access by unauthorized persons?	Gap	Refrigeration controls and receivers/storage vessels are in a unlocked but controlled area.	The refrigeration controls area is not locked because, in case of fire and if evacuation is needed, employees should go through this area.	Yes
	5c. Are the water systems used in the food production process, including any storage tanks or reservoirs and any water treatment components, protected from unauthorized access?	Currently Doing	All main water delivery, storage, and treatment areas are considered sensitive areas, with access restricted to authorized individuals.		
	5d. Are the controls to the electrical systems (main transformers and switchgear only) protected from unauthorized access?	Currently Doing	The main electrical supply and switchgear are controlled to allow authorized entry only to reduce the opportunity for potential tampering.		
	5e. Are cleaning/sanitization chemical dispensing systems secured from unauthorized access?	Gap	The access to cleaning and sanitation chemical systems is not restricted.		Yes
6. Laboratory	6a. Is access to the laboratory facility restricted to authorized employees (e.g., by locked door, pass card, etc.)?	N/A			
	6b. Is a procedure in place to receive and securely store reagents?	N/A			
	6c. Are laboratory materials restricted to the laboratory, except as needed for sampling or other authorized activities?	N/A			
	6d. Is a procedure in place to control and dispose of reagents?	N/A			
7. Process Computer Systems	7a. Is access to these process control systems restricted to trusted employees?	Currently Doing	A limited number of authorized employees have the password to the system, to provide better control and monitoring.		
	7b. Is access to process control computer systems password protected?	Currently Doing	Access to process control computer systems is protected through passwords to prevent unauthorized users access.		
	7c. Are firewalls built into the computer network used for process controls?	Currently Doing	Access to process control computer systems is protected through firewalls to prevent unauthorized communication over a computer network by outsiders.		
	7d. Is antivirus software installed on the process controls computer system and is it frequently updated?	Currently Doing	Process control computer systems are protected through antivirus software that is updated frequently, to eliminate threats of outsiders from gaining access to information stored on the system.		
	7e. When an employee's employment ends, is their access to process control computer systems disabled?	Currently Doing	Disabling an employee's access to computer systems is part of the close out and sign off process for all personnel when their employment ends.		

Logistics and Storage Security				
8. Suppliers and Vendors	8a. When choosing suppliers for your packaging materials, labels, ingredients, and raw materials, do you consider whether they have developed a Food Defense Plan?	Gap	On-site audits to verify that the supplier has documented safe conditions, manufacturing, storage, handling and transport of the products for purchase.	Yes
	8b. Do you have a supplier approval certification system in place to ensure that you purchase supplies only from known, reputable sources?	Currently Doing	All suppliers must be approved within a supplier certification program. The contractual agreements require the supplier to have adequate food security measures.	
	8c. Do you audit or inspect supplier food defense programs or require that they have third party audits or inspections?	Currently Doing	Audits of our suppliers include an assessment of their food security measures.	
9. Incoming Shipments	9a. Are trailers and trucks on the premises maintained under lock and/or tamper-evident seal when not being loaded or unloaded?	Currently Doing	All trucks and trailers with supplies, raw materials, or finished goods must be sealed until use. If the seal must be removed for inspection, a new seal is applied and documented.	This includes during any short-term storage before unloading or before shipping.
	9b. Is there close supervision of the unloading of vehicles transporting raw materials, finished products, ingredients or other materials used in food processing?	Currently Doing	Unloading of vehicles transporting raw materials, finished products, ingredients or other materials used in food processing is conducted with close supervision to ensure that inspections and controls are correctly performed and reduce the risk that material could be contaminated during handling.	
	9c. Are there procedures that require the acceptance of authorized, expected shipments only?	Currently Doing	Loading and unloading activities are scheduled and/or monitored. Only scheduled shipments are received. Unscheduled or unauthorized shipments are held until authorization is obtained.	Procedures can include scheduling deliveries, advance notification from suppliers of shipment, refusing or holding unscheduled deliveries and restricting after-hours deliveries.
	9d. Is access to loading docks controlled to avoid unverified or unauthorized deliveries?	Currently Doing	Loading dock access is controlled and monitored regularly. Only authorized personnel have access to handle incoming materials.	
	9e. Are incoming shipments of raw materials, ingredients, and packaging materials required to be sealed with tamper-evident or numbered seals (and documented in the shipping documents)?	Currently Doing	Incoming shipments are secured with tamper-evident seals. Procedures require personnel to inspect documents prior to receipt of the shipment.	
	9f. Are tamper-evident seals verified prior to acceptance?	Currently Doing	Procedures require personnel to inspect documents prior to acceptance of the shipment.	Adequate procedures for handling suspicious alterations and denial of acceptance will ensure a timely response to a potential intentional contamination event.
	9g. Are less-than-truckload (LTL) or partial load shipments vehicles checked?	Currently Doing	Upon arrival of the shipment, any less-than-truckload (LTL) or partial shipments are verified. Multiple delivery trucks have to provide documentation of all seal changes with approval by authorized signatures. Open trucks are checked for content and condition.	



10. Outgoing Shipments	10a. Are shipping vehicles (trucks, tankers, rail cars) inspected prior to loading to detect the presence of any foreign/hazardous materials?	Currently Doing	Outgoing vehicles are examined for suspicious activity, evaluated for previous use or presence of potentially hazardous materials. Inspections of outgoing shipments are documented.	Existing food safety inspections also cover this measure.	
	10b. Are outgoing shipments enclosed and sealed with tamper-evident seals (or locks)? Are the seal numbers on outgoing shipments documented on the shipping documents?	Currently Doing	Outgoing shipments are sealed with tamper-evident seals. Documentation of outgoing shipments is required. Multiple transports seals are documented and justified.		
	10c. Are chain-of-custody (possession) records maintained for all shipments of finished goods?	Currently Doing	Shipping documents are required for each load indicating the proper inventory, date and time, and the number of the tamper-evident seal that was applied to the load.	Proper documentation reduces the risk that the finished product is diverted for contamination and demonstrates to the customer that the product has remained within proper control.	
	10d. Are effective product recall procedures in place?	Currently Doing	A documented product recall plan is in place. It must be reviewed annually. Trace-back and trace-forward records are maintained and tested regularly. The recall plan ensures segregation and proper disposition of recalled product and documentation of disposition.		
11. Live Animals	11a. If you receive live animals, is there a procedure for immediately notifying the appropriate individuals when animals with unusual behavior and/or symptoms are received?	N/A			
	11b. Are the feed and drinking water supplies for live animals protected from possible intentional contamination?	N/A			
	11c. When transportation companies are selected, is the company's ability to safeguard the security of live animals during shipping considered?	N/A			
12. Returned Products/Goods	12a. Are all returned products/goods examined at a separate designated location in the facility for evidence of possible tampering before salvage or use in rework/reconditioning?	Currently Doing	Where possible, returned goods are inspected prior to return and disposed of if not suitable for reuse.		
	12b. Are records maintained of returned products/goods used in rework?	Currently Doing	Returned goods are documented, as are reused or discarded goods. When returned goods are suitable for reuse, original lot numbers are recorded and included in the record of products used.	This will allow for traceability if it becomes necessary to recall any finished products based on the reused or reworked product.	
13. Ice/ Water/ Processing Aids	13a. Is access to the piping systems used to transfer potable water, oil, or other ingredients limited?	Currently Doing	Access to lines that transfer water or ingredients are restricted.		
	13b. Are the piping systems used to transfer potable water, oil, or other ingredients inspected periodically?	Currently Doing	Water lines are regularly inspected for integrity.	There are no open access points for possible intentional contamination.	
	13c. Is access to water wells restricted (e.g., by locked door/gate or limiting access to designated employees)?	N/A		There are no water wells at the facility.	
	13d. Are there water storage tanks, reservoirs, or water treatment systems? Is access to them restricted?	Currently Doing	Access to potable water storage tanks and water reuse systems is restricted to authorized personnel only.		
	13e. Is access to ice-making equipment and ice storage areas restricted?	Currently Doing	Access to facility storage areas is restricted to authorized personnel only.	The is no ice-making equipment in the facility, the ice used is provided by a supplier.	
	13f. If a public water supply is used, have arrangements been made with local health officials to ensure they immediately notify the plant if the safety of the public water supply is compromised?	Currently Doing	An agreement has been established with the water supplier to notify the company directly if the water becomes unfit for use. It is required to review this agreement once each year.	This can reduce the risk that the suspect water will be used in the facility for food processing.	

14. Storage/ Warehouse	14a. Is access to raw material and ingredient storage areas restricted to designated employees (e.g., by locked door or gate)?	Currently Doing	Access to the storage areas for raw materials and ingredients is restricted to authorized personnel.		
	14b. Is an access record maintained to indicate who has entered raw material or ingredient storage areas?	Gap	Only authorized personnel have access to the storage areas. There is no registry of the entrance but there is a visual control of anyone who enters in this areas due to the uniform color code.		Yes
	14c. Is access to finished product storage areas restricted to designated employees?	Currently Doing	Access to finished goods storage areas is restricted to authorized personnel to reduce the risk of intentional contamination.		
	14d. Is access to any additional or temporary storage facilities, such as leased warehousing, shipping containers, storage sheds, or vehicles/trailers, restricted?	Currently Doing	Additional or temporary storage facilities are required to have access controls similar to the facility controls. Any temporary storage on the facility must be locked and accessible only by authorized personnel.		
	14e. Do you conduct random security inspections of all storage facilities (including temporary storage facilities)?	Currently Doing	Routine and random unscheduled checks include inspection of all warehouses and all storage areas, including temporary storage areas and storage outside the facility. Records are required for these regular inspections.		
	14f. Are product labels and packaging held in a controlled manner to prevent theft and misuse (e.g., counterfeiting)?	Currently Doing	Labels and packaging materials are controlled to prevent theft and misuse. Regular inspection and examination of these materials is conducted.		
	14g. Is finished product inventory regularly checked for accuracy?	Currently Doing	Periodic inventory and examinations for tampering of materials in storage are performed. Previously unattended materials are checked before use. Unexpected changes in inventory (product or equipment) are reported to appropriate personnel.		
15. Hazardous materials/chemicals	15a. Are storage areas that contain hazardous materials/chemicals—such as pesticides, industrial chemicals, cleaning materials, sanitizers, and disinfectants—restricted to allow access by authorized personnel only?	Currently Doing	Hazardous materials and chemicals, including cleaning chemicals and sanitizers, are in a restricted area. Only authorized personnel have access to the restricted area.		
	15b. Is a regular inventory of hazardous materials/chemicals maintained?	Currently Doing	A weekly inventory of hazardous materials and chemicals is required. Inventory controls are in place that require documentation. Any discrepancies are immediately reported to management and investigated.		

Management				
16. Personnel Security	16a. Are basic background checks and/or reference checks with previous employers conducted for all new employees?	Currently Doing	Background or reference checks are conducted for all new hires to reduce the risk that someone with a criminal history will have access to the facility.	
	16b. Are more comprehensive background checks conducted on employees who will be working in sensitive operations?	Gap	There is no more comprehensive background checks done for employees working in sensitive operations of the facility.	Yes
	16c. Are background checks and/or reference checks conducted on all contractors (both permanent and seasonal) who will be working in sensitive operations?	Currently Doing	Background and reference checks are conducted for temporary, seasonal, or contract workers that will have access to restricted or sensitive production areas.	
	16d. Do all employees receive training on security procedures and food defense awareness as part of their orientation training?	Gap	All employees receive training on security procedures as a part of their orientation training.	Yes
	16e. Are employees, visitors, and contractors (including construction workers, cleaning crews, and truck drivers) identified in some manner at all times while on the premises?	Currently Doing	A procedure to recognize or identify employees in the facility is in place. It consists of color-coded smocks and badges for visitors, contractors, cleaning crews and others.	Color codes and other tools can help identify who is allowed in what areas and who requires and escort.
	16f. Do you control employee and contractor access into the facility during working hours (e.g., coded doors, receptionist on duty, swipe card, etc.)?	Currently Doing	All employees and contractors are required to enter through a single employee entrance. They must also have valid identification and be verified before they are allowed into the facility. This single employee entrance is supervised during regular working hours and monitored during off hours.	
	16g. Does your facility control the entry of employees and contractors into the facility during non-working hours?	Currently Doing	During non-working hours, access to the facility is restricted to authorized personnel. Any employees or contractors who need access to the facility must be admitted by the supervisor on duty.	
	16h. Does your facility have a way to limit temporary employees and contractors (including construction workers, cleaning crews, and truck drivers) to areas of the facility relevant to their work?	Currently Doing	Contractors, temporary employees, and non-facility personnel are restricted only to the specific area they have been authorized. They must display temporary badges that list where they are authorized to be within the facility.	Providing dedicated areas for truck drivers or delivery personnel without allowing access to the main facility is an example of how access is restricted in the facility.
	16i. Is there a way to identify employees that correlates with their specific functions/assignments/departments (e.g., corresponding colored uniforms)?	Currently Doing	Color-coded smocks are used to identify different functions. Visitors and contractors that require an escort are required to use a specific colored smock.	
	16j. Does management maintain an updated shift roster (i.e., who is absent, who the replacements are, and when new employees are being integrated into the workforce) for each shift?	Currently Doing	Each supervisor is responsible for maintaining and reporting the employee roster for each shift. The roster must identify regular, seasonal, and temporary employees.	A small facility like this one with low employee turnover may not need this type of control if they know everyone by sight.
16k. Does your facility restrict personal items and food within production areas?	Currently Doing	Employees and visitors are restricted as to what they can bring in or take from the facility, including personal items, food, and cameras.		
16l. Is there a policy in place that prohibits employees from removing company-provided clothing and protective gear from the premises?	Currently Doing	Locker rooms and laundry services are available on the facility. Employee uniforms and protective gear may not be taken out of the facility.		

17. Food Defense Plan	17a. Is there a designated person or team to implement, manage, and update the Food Defense Plan?	Currently Doing	Leadership of the food defense plan is delegated to the Quality Manager.		
	17b. Have supervisors, management, and key personnel received additional food defense training geared towards management?	Gap	Reporting unusual activities is encouraged.		Yes
	17c. Do you conduct regular food defense exercises to test the effectiveness of your Food Defense Plan?	Currently Doing	Mock exercises to test the ability of unauthorized persons to enter the perimeter, the facility, or sensitive areas are performed annually. Routine inspections and annual audits are performed to confirm that procedures of the Food Defense Plan are being followed.		
	17d. Is the Food Defense Plan reviewed (and revised if necessary) periodically?	Currently Doing	The food defense leader is required to review and update the Food Defense Plan at least annually.	Self-assessments ensure that procedures are followed and give the food defense leader the opportunity to make any changes or corrections.	
	17e. Are the details of food defense procedures within the Food Defense Plan kept secure or confidential?	Currently Doing	The Food Defense Plan is a confidential document. A summary of the plan and a summary of results of audits may be shared. Detailed elements and vulnerabilities will not be shared.		
	17f. Is the emergency contact information for local, state, and federal government regulatory authorities and public health officials included in the Food Defense Plan?	Currently Doing	Facility personnel contact information is kept up to date and reviewed/updated annually. Emergency contact lists are kept up to date and are located in conspicuous areas.		
	17g. Are procedures for responding to threats and actual incidents of product contamination detailed in the Food Defense Plan?	Currently Doing	The food defense plan has established procedures for responding to threats as well as actual product contamination events. There is also pre-established communication with local, state, and federal incident response personnel for a more efficient response.		
	17h. Does the Food Defense Plan have procedures to ensure that contaminated or potentially harmful products are held at the facility?	Currently Doing	Established quality "HOLD" procedures will be used to mark and segregate products where an intentional contamination is known or suspected. In addition, the products will be physically isolated, locked where possible, to support potential criminal investigations.		
	17i. Does the Food Defense Plan have procedures for safe handling and disposal of contaminated products and decontamination of the facility in accordance with local environmental guidelines and regulations?	Currently Doing	Potentially hazardous waste (biological or chemical) is controlled and disposed of properly. Disposal and decontamination procedures are included as part of the food safety plan and are attached as a supporting document to this Food Defense Plan. Contact information for the local environmental agency is in the emergency contact section of the Food Defense Plan.		
	17j. Are employees encouraged to report signs of possible product contamination, unknown or suspicious persons in the facility, or breaks in the food defense system?	Currently Doing	Employees receive annual training and are encouraged to report unusual activities.	Active participation of all employees is the best way to prevent intentional contamination, ensure timely report of a possible incident and restrict the impact of contamination.	
	17k. Does your facility have evacuation procedures in case of an emergency that include controlling access to the facility during evacuation?	Currently Doing	Established facility evacuation procedures are required to address the physical security of the facility and entrances during an evacuation. Only properly identified emergency responders will be allowed access to the facility during an evacuation.		



Afterwards, we will establish the vulnerability assessment in the most critical areas of the facility by evaluating the risk, the current control measure, the threat degree and its possible prevention or correction. This analysis will be made from a template provided by the company, which follows the structure of the Food Defense Plan Builder sections.

In this case, we will use the CARVER + Shock method previously mentioned, because it is recommended to focus on the vulnerabilities and protect the facility towards any kind of threat.

As we can see in Table 5, the warehouse and the production area are the most sensitive areas according to the significance of the threat since these areas are the ones where food is manipulated or stored and there is a higher possibility of tampering.

To calculate the % of significance of the threat degree, we use the following formula:

$$\frac{A + C + V}{30} \times 100$$

Where:

A: Accessibility of the attacker

C: Criticality of the threat

V: Vulnerability of the objective

These three parameters are divided by 30 because is the maximum punctuation it can get. The score to these factors is given on own criterion according to the definitions of every parameter shown in Annex A. Risk assessment key

As a result of the vulnerability assessment, we obtain a percentage of every critical area, as shown in Annex B. Localization and significance of the critical areas



Table 5. Vulnerability assessment

V U L N E R A B I L I T Y A S S E S S M E N T															
LOCALIZATION		EVALUATION			THREAT DEGREE					PREVENTION	SUPERVISION			CORRECTIVE MEASURE	
Area	Critical Point	Threat	Risk	Control measure	Accessibility	Criticality	Vulnerability	Total	Significance %	Preventive measure	Control type	Frecuency	Responsible	Action	Registry
PROPERTY PERIMETER	Fencing	Low height	Someone could jump	Fence has a spike and there is CCTV system	7	1	1	9	30,00	Higher fence	Surveillance system	3 times per night	Security personnel	Calling the police if there is intrusion detection	Surveillance system records
BUILDING PERIMETER	Illumination	Open area	Someone could access the facility without detection	Keeping the external area properly illuminated	9	5	3	17	56,67	Adequate lighting to assure good visibility of the building perimeter	Visual	Every day	Security personnel	Notifying maintenance personnel if lighting is not working properly	N/A
	Vehicle access	Door closes slowly and it breaks down easily	Someone could access the facility by car or by walking	Access control at the reception (doorbell and surveillance system-CCTV)	5	7	3	15	50,00	Not opening the door to suspicious people and improving door maintenance	Surveillance system	Every entrance	Security personnel and receptionists	Notifying security personnel in case of suspicious activity	Surveillance system records
	Pedestrian access	Possibility of opening the door without ringing the doorbell	Someone could access the facility	Staff training to detect unauthorized people in the facility and keeping a preventive maintenance of the door	4	7	3	14	46,67	Regulation system to not open the door from the outside	Surveillance system	Every entrance	Security personnel and receptionists	Notifying security personnel if someone is opening the door improperly	Surveillance system records
	Parking area	Non authorized car in the internal perimeter	Someone could access the facility	Staff training to identify non authorized cars	2	7	3	12	40,00	Visits parking right in front of reception control, trucks parking of exclusive use, and a distinctive sign to authorized cars	Surveillance system	Every entrance	All personnel	Notifying security personnel if there is a unauthorized car	Surveillance system records
	Emergency doors	Multipurpose doors	Unauthorized people could access the production area	Staff training to detect unauthorized people in the facility	5	9	5	19	63,33	Exclusive use of emergency doors and card access doors	Visual	Every day	All personnel	Notifying security personnel if there is someone without uniform or the mob-cap in the production area	Staff checking in
FACILITY	Personnel access	Lack of control of the access	Unauthorized people could access the production area	Team leaders control the staff during Shift Briefing and notify Human Resources in case of suspicious activity	3	9	6	18	60,00	Lathe access and not showing the company logo on the card	Visual	Every entrance	Human resources	Notifying Human Resources if there is a non identified worker on shift	Staff checking in
	Visits access			Reception provides proper clothes when a visit is registered. No one with a red mob-cap can go by itself at the facility. Staff training to notify in case of non authorized visits	2	9	6	17	56,67	Reception only provides the uniform to employees or authorized visits	Visual	Every entrance	Receptionists	Notifying security personnel if there is someone without uniform in the production area	Visits registration
	Staff control	Bad intentional worker in an unauthorized area	Potential tampering	Different uniform at different areas and mob-cap color code	3	9	6	18	60,00	Card access to different areas and an alarm sound when someone is attempting to enter where is not authorized	Restricted access	Every entrance	Human resources	Notifying the team leader if there is someone in a non authorized area	Staff checking in
	Illumination	Bad intentional worker can perform tampering easily without being seen	Intentional contamination without detection	Keeping an adequate and maintained lighting system	4	9	4	17	56,67	Regular testing of the lighting system of the facility	Reviews	Every month	Maintenance	Notifying the maintenance responsible if there is any trouble with the lighting system	Audits results
	Surveillance system	Bad intentional worker can perform tampering easily without being seen	Intentional contamination without detection	A CCTV system to keep recordings of all areas of the facility	4	9	4	17	56,67	Regular reviewing of the CCTV recordings	Visual	Every month	Control Center	Notifying Human Resources if there is a unidentified worker in any CCTV recording	Surveillance system records
	Locker rooms	Suspicious items going unnoticed	Personal items entering the critical areas	Inspections of the facility areas	5	7	5	17	56,67	Regular checking of personal lockers and having employees wear uniforms without pockets	Inspections	Every month	All personnel	Notifying Human Resources if a suspicious item is detected	Audits results

UTILITIES	HVAC systems	Possibility of introducing a contamination agent to the product	Food and employees damage	Keeping HVAC systems locked	1	8	9	18	60,00	Having main air intakes in a fenced area	Reviews	Every month	Maintenance	Notifying Quality Department if there is any suspicious change on the ventilation system	Audits results
	Refrigeration	Possibility of food damaging	Intentional contamination	Limiting access to refrigeration controls	1	8	9	18	60,00	Keeping records of the cameras temperatures	Reviews	Every month	Maintenance	Notifying Quality Department if there are any changes of temperatures	Audits results
	Water systems	Water contamination	Intentional contamination	Keeping water storage restricted to authorized personnel	1	9	9	19	63,33	Regular testing of the water in the facility	Reviews	Every month	Maintenance	Cutting off the water supply if the water testing shows any sign of contamination	Audits results
	Electrical and IT systems	Possibility of hacking the computer system	Outsiders gaining access to information stored on the system	Installing an antivirus software and a firewall	1	3	3	7	23,33	Keeping access to the system to a limited number of authorized employees	Reviews	Every month	IT	Improving the security and protection of the system	Audits results
LOGISTICS AND STORAGE	External storage	Possible access to external storage	Potential tampering	Keeping external storage restricted to authorized personnel	7	9	9	25	83,33	Keeping external storage locked	Storage locking	Every day	Warehouse	Notifying security personnel if an unauthorized person is detected	Temperature controls
	Access control	Possibility of entering the facility through the dock	Potential tampering	Staff training to detect unauthorized people in the facility	8	1	1	10	33,33	Keeping dock doors controlled and closed when not in use	Visual	Every day	Logistics	Notifying security personnel if an unauthorized person is detected	Surveillance system records
	Suppliers	Not trustworthy suppliers	Purchasing contaminated food from a supplier	Verification measures to assure a reliable source of purchase and ensure that every shipment comes from approved suppliers	5	9	9	23	76,67	Audits of the suppliers facilities and scheduled deliveries	Inspections	Every entrance of product	Warehouse	Stop purchasing from any supplier who has not adequate food security measures and notify the warehouse responsible in case of any arrival of an unknown supplier	Audits results
	Incoming shipment	Incoming shipments not secured with tamper-evident seals	Material could be contaminated during shipping	All trucks and trailers with supplies are sealed until use	3	9	9	21	70,00	Incoming shipments with no tamper-evident seal are not accepted	Visual	Every incoming shipment	Logistics	Rejection of shipments without secured seals	Temperature controls
	Outgoing shipment	Outgoing shipments not secured with tamper-evident seals	Finished products could be contaminated without detection	All trucks and trailers with supplies are sealed until use	3	9	9	21	70,00	Outgoing shipments with no tamper-evident seals are not delivered	Visual	Every outgoing shipment	Logistics	Return of shipments without secured seals	Temperature controls
	Returned products	Tampering of returned products	Intentional contamination	Staff training to detect someone in an unauthorized area	7	9	9	25	83,33	Keeping products suitable for reuse protected and controlled	Visual	Every entrance of returned product	Logistics	Rejection of suspicious products	Stock inventory

WAREHOUSE	Raw material storage	Possibility of entering the palletized area without authorization	Contamination of raw material	Staff training to detect someone in an unauthorized area	6	9	9	24	80,00	Keeping raw material locked or under supervision	Storage locking	Every day	Warehouse	Getting rid of any product with signs of manipulation	Surveillance system records
	Chemical storage	Possibility of using chemical products to contaminate food	Intentional contamination	Keeping an inventory of chemical storage	5	9	9	23	76,67	Keeping chemical storage locked	Storage locking	Every week	Warehouse	Investigate any discrepancies detected on the inventory	Stock inventory
	Other storage areas	Contamination of ingredients, finished products or other food contact materials	Intentional contamination	Staff training to detect manipulation clues	7	9	9	25	83,33	Routine and random unscheduled checks of all storage areas	Inspections	Every week	Quality Assurance	Avoiding the delivery of any contaminated food	Surveillance system records
PRODUCTION	Knives and dangerous tools	Someone could put a small piece into the food or dangerous tools on the trolley that is going in the plane	Consumers of that food could get hurt	Keeping a knife inventory and dangerous tools locked	5	9	9	23	76,67	Passing food through a metal detector	Visual	Every day	Team leader	Checking the surveillance system to identify who did it	Surveillance system records
	Food manipulation	Incorrect hygiene of manipulators	Microbiological contamination	Staff training to accomplish adequate hygiene measures	8	9	9	26	86,67	Disinfectant soaps in and out the production area and constant supervision of the team leader to prove hand washing of manipulators	Microbiological tests	Every day	Quality Assurance	Getting fired employees that do not follow hygiene procedures	Laboratory tests results and surveillance system records
	Food temperature	Products cooked or handled without proper temperature	Some microorganisms can survive	Keeping a registry of the temperatures and staff training to detect suspicious manipulation	8	9	9	26	86,67	Cooking food with automatic equipment with temperature control to ensure the lack of microorganisms	Registries and daily patrols	Every day	Kitchen	Discarding any food improperly cooked and being aware of who are the employees of the kitchen	Temperature controls
	Cooking and packaging	Someone could alter the food during making and packing of the flight menu	Intentional contamination	Staff training to detect suspicious activities	8	9	9	26	86,67	Cameras on the most critical areas	Visual	Every day	Quality Assurance	Checking the surveillance system to identify who did it	Surveillance system records

Eventually, we will implement an action plan to evaluate which corrective measures are needed to every process step previously analyzed in the mitigation strategies, and define its status (whether it is already planned to do or not possible) and its priority, depending on the urgency, as shown in Table 6.

Table 6. Action plan

Measure or Process Step	Action Step	Status	Priority
2c. Are emergency exit doors self-locking from the outside, with alarms that activate when the doors are opened?	It would be necessary to install self-locking doors and alarms that will sound when emergency exit doors are opened.	In Progress	High
2d. Are operational entrances, such as the loading dock doors, secured when not in use?	The loading dock doors should be secured when not in use.	New	
2f. Are products and ingredients that are stored outside the secured building protected by fences, tamper-evident seals, and/or locks?	The use of locks in the external freezers containing products and ingredients would be needed to prevent its access and intentional manipulation.	Planning	Medium
4d. Does your facility have established emergency procedures, including procedures for responding to an intentional contamination?	The facility should have a standard operating procedure for emergencies, including potential acts of intentional contamination. Employees should be trained on the emergency procedures and the facility should conduct testing of the procedures periodically.	Planning	Low
4i. Are procedures in place to check maintenance closets, personal lockers, and storage areas for suspicious items or packages?	Regular checking of personal lockers should be done to reduce the risk that suspicious items or packages will go unnoticed.	Planning	Medium
5b. Are controls for refrigeration, including the main storage areas for combustible materials like ammonia, secured by lock to prevent access by unauthorized persons?	Refrigeration controls should be secured by a lock.	New	
5e. Are cleaning/sanitization chemical dispensing systems secured from unauthorized access?	Storage areas and primary distribution systems for sanitation chemicals should be kept in a locked area that is restricted to authorized individuals.	In Progress	Medium
8a. When choosing suppliers for your packaging materials, labels, ingredients, and raw materials, do you consider whether they have developed a Food Defense Plan?	Company policy should require all suppliers to have a Food Defense Plan and to implement food defense measures at their facilities.	Gap Impractical	Low
14b. Is an access record maintained to indicate who has entered raw material or ingredient storage areas?	Employees that enter storage areas should be required to enter their name, date and time on a registry kept near the entrance.	Gap Impractical	Low
16b. Are more comprehensive background checks conducted on employees who will be working in sensitive operations?	A more comprehensive background and reference checks should be conducted for employees working in sensitive operations.	Planning	Low
16d. Do all employees receive training on security procedures and food defense awareness as part of their orientation training?	A training on FDA's FIRST food defense materials should be implanted to train employees to report suspicious activities or unusual observations. In addition, all facility managers and supervisors should take FDA's ALERT food defense awareness training.	Planning	Medium
17b. Have supervisors, management, and key personnel received additional food defense training geared towards management?	Key employees should be trained on the facility's food defense plan. Supervisors and managers should also be required to take the training on an annual basis.	Planning	Medium

7. Economic impact and valuation

In this section of the document, we will evaluate the risk and the probability of a food terrorism attack that could happen in the airline catering, with the consequent impact and losses of economic value.

The impact of a bioterrorist attack depends on several factors: the specific agent or toxin, the method and efficiency of dispersal, the population exposed, the level of immunity in the population, the availability of effective post exposure treatments and the potential for secondary transmission. [12]

To calculate the impact of a bioterrorist attack, we will consider a few risk scenarios based on different probabilities and costs. Then we will be able to obtain different benefits of the plan based on every scenario. All the results will be illustrated in graphics to compare every studied situation.

On the one hand, we will consider a minimum probability of happening, due to the historical data of this kind of events in our country. It is estimated that airplane terrorist attacks take place in 1 of 1.000.000 flights. The number of attacks including food terrorism is even smaller.

On the other hand, we will consider the costs of the compensation to the victims, depending on the quantity of affected people; and the loss of the airline companies as clients, due to the loss of confidence and reputation.

The benefit of the implementation of the Food Defense plan will be the equivalent of multiplying the costs generated by a terrorist act because of the probability of happening before and after the plan:

$$\text{Plan Benefits} = \text{Attack costs} \times (\text{Attack probability} - \text{Reduced probability})$$

SCENARIO A

INDEMNIFICATION COSTS		INACTIVITY COSTS	
Airplane capacity	293 passengers	Single menu price	15 €/menu
Affected passengers	285 passengers	Airplane capacity	293 passengers
Affected flights	20 flights	Number of flights	20 flights/month
Victims indemnification	250.000 €	Lost airline companies	5
$285 \times 20 \times 250.000 = \mathbf{1.425.000.000 \text{ €}}$		$15 \times 293 \times 20 \times 5 = \mathbf{439.500 \text{ €/month}}$	

It is assumed that after applying the plan, the probability of the attack would be reduced in a **90%**.

The following graphics of every scenario show that the benefit of the plan would be affected considering different attack probabilities: $\frac{1}{1.000}$, $\frac{1}{10.000}$, $\frac{1}{100.000}$ and $\frac{1}{1.000.000}$. The benefit would increase if the probability is higher and viceversa.

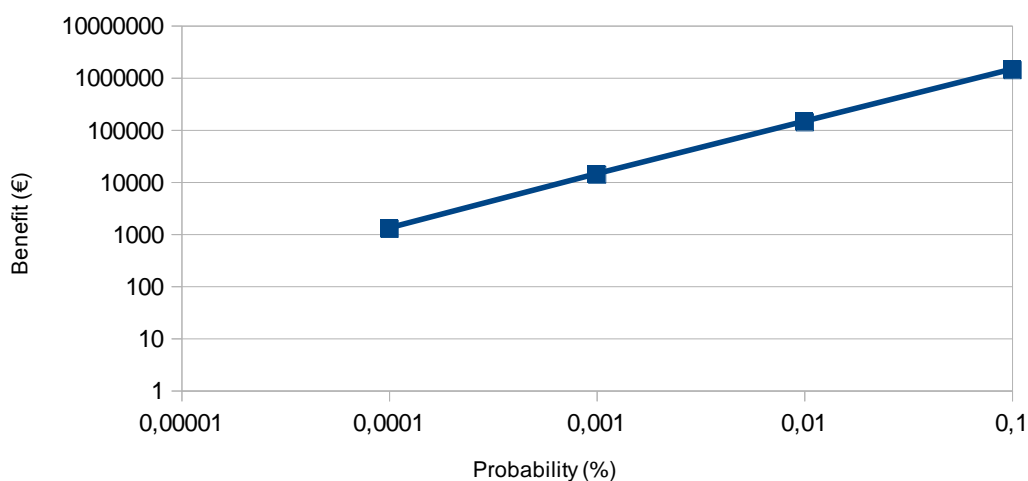
SCENARIO A

Figure 3. Plan benefits of scenario A

SCENARIO B

INDEMNIFICATION COSTS	
Airplane capacity	220 passengers
Affected passengers	200 passengers
Affected flights	10 flights
Victims indemnification	250.000 €
$200 \times 6 \times 250.000 = \mathbf{500.000.000 \text{ €}}$	

INACTIVITY COSTS	
Single menu price	10 €/menu
Airplane capacity	220 passengers
Number of flights	24 flights/month
Lost airline companies	4
$10 \times 220 \times 24 \times 4 = \mathbf{211.200 \text{ €/month}}$	

It is assumed that after applying the plan, the probability of the attack would be reduced in a **80%**.

SCENARIO B

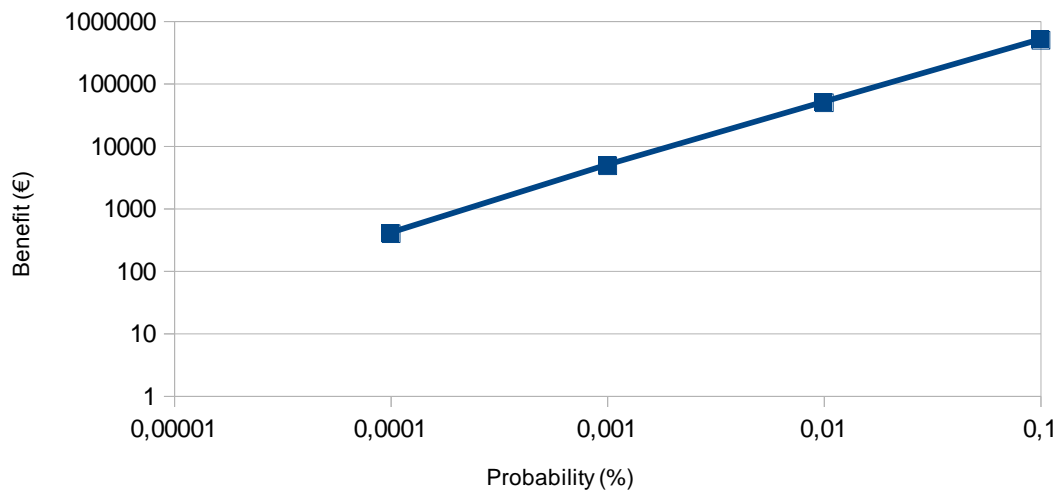


Figure 4. Plan benefits of scenario B

SCENARIO C

INDEMNIFICATION COSTS		INACTIVITY COSTS	
Airplane capacity	132 passengers	Single menu price	5 €/menu
Affected passengers	100 passengers	Airplane capacity	132 passengers
Affected flights	5 flights	Number of flights	12 flights/month
Victims indemnification	250.000 €	Lost airline companies	3
$100 \times 3 \times 250.000 = \mathbf{125.000.000 \text{ €}}$		$5 \times 132 \times 12 \times 3 = \mathbf{23.760 \text{ €/month}}$	

It is assumed that after applying the plan, the probability of the attack would be reduced in a **70%**.

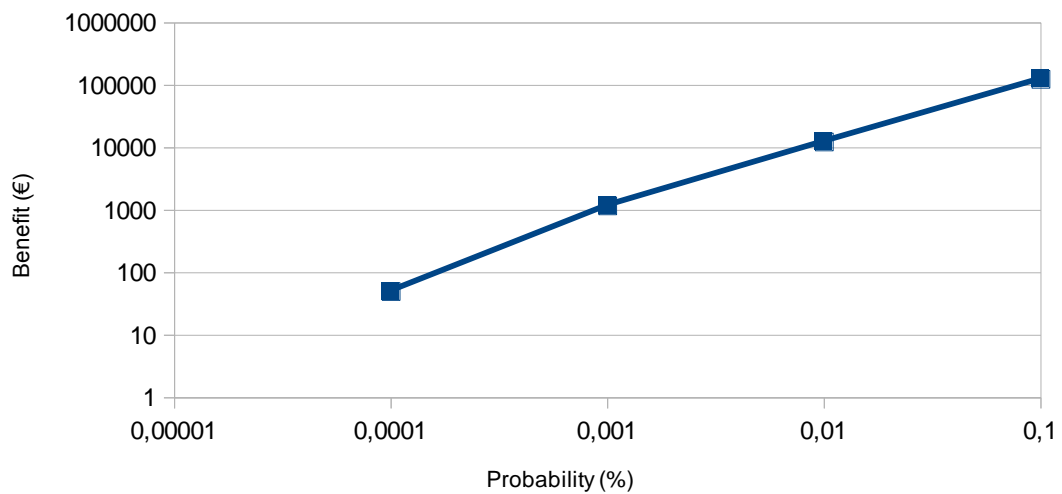
SCENARIO C

Figure 5. Plan benefits of scenario C

As we can see in these graphics, the Food Defense Plan would be leasable if there is a high probability of a bioterrorist attack.



Although the probability of the attack is so low, there is still a chance that an act like this may happen, and the big significance of the attack costs is one of the reasons why it is important to have a good insurance to cover this probability.

When choosing an insurance for the company, the terrorism is covered by paying an additional premium. The sum insured may include material damages and business interruption. The premium charged varies depending on the risk and the sum insured. [13]

There are several insurance companies with no cover of death by a terrorism act. In Spain, in 1954 the Insurance Compensation Consortium was created with the aim of compensate the victims of acts derived from terrorism that have contracted some type of insurance of life or accident policy.

Conclusions

It is very easy to damage the activity of an agri-food company and cause economic damage. There are several groups or types of people that may consider intentional contamination of food to further their cause, but internal staff are the most dangerous because they know well the facilities and have already access to them.

To avoid the typical incidents that can occur like an intrusion, it is essential to assure some basic control measures like not leaving visitors alone in the facility and have restricted access to critical areas, controlling all the staff working in the building and keeping all access points locked.

Even so, the lack of awareness to inform of strange circumstances (opened product bags, opened doors, strange staff...) and not giving true importance to deliberate acts that could happen, are possible shortcomings that can interfere with the process. That is why the best way of prevention and detection of sabotage signs is staff training.

As shows the economic valuation, there is a significant increase of the plan benefit as the probability increases, reaching profits of up to 1 million euros. However, in this case it is a medium-sized catering that serves a few airlines, and at the low probability is added the lesser impact that an attack would have when considering few affected flights.

Even so, as previously mentioned, the Food Defense plan implementation provides a better image versus the competition and a higher probability of being chosen by the airline companies due to the improvement of the security measures. This could mean a higher number of customers and therefore a better business. In conclusion, the implementation of the Food Defense Plan could indirectly lead to an economic benefit.

A great way to prove the Food Defense system is doing its job is to conduct a food terrorism simulation in the facility to evaluate the weak points of the protection and prevention measures along with the consequences that it entails.

It is recommended to create security from the beginning (prevention), to do inspections and tests based on risks (intervention) and have a quick reaction and effective communication (answer).



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Annexes

Annex A. Risk assessment key

A C C E S S I B I L I T Y		Punctuation
Easily accessible	The target is outside the building and there is no perimeter fence.	9-10
Accessible	The target is inside the building, but in an uninsured part of the establishment.	7-8
Partially accessible	The target is inside the building, in a relatively unprotected, but highly active part of the establishment.	5-6
Hard to access	The target is inside the building, in a protected part of the establishment.	3-4
Not accessible	There are physical barriers, alarms and surveillance to avoid reaching the goal.	1-2

C R I T I C A L I T Y		Punctuation
Very critical	With a significant loss of human lives or more than 90% of the company's economic value.	9-10
Critical	With loss of human lives or losses between 61% and 90% of the company's economic value.	7-8

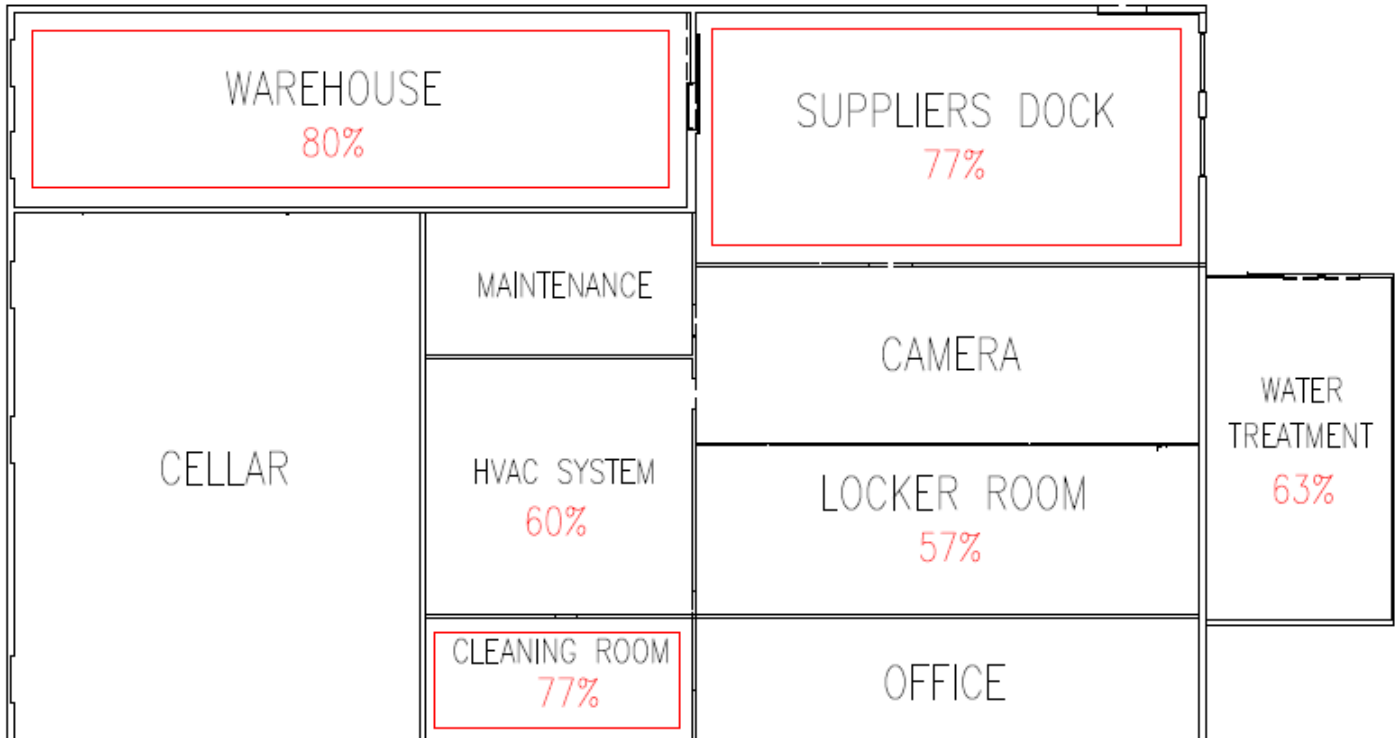


Slightly critical	Without loss of human lives although there is severe intoxication or losses between 31% and 60% of the company's economic value.	5-6
Barely critical	Without loss of human lives. Losses between 10% and 30% of the company's economic value.	3-4
Not critical	Without loss of human lives. Losses less than 10% of the company's economic value.	1-2

V U L N E R A B I L I T Y		Punctuation
Very vulnerable	The product is openly exposed and there is enough time to allow the introduction of the polluting agent without being seen. A uniform mixture disperses the agent.	9-10
Vulnerable	The product has a certain degree of open exposure and there is almost enough time to introduce the polluting agent without being seen. The product will be mixed.	7-8
Slightly vulnerable	The product has limited exposure points and limited periods when contaminants can be added without being seen. The agent may not be well mixed.	5-6
Barely vulnerable	The product has limited exposure points but is almost always under observation while is in the production phase. There is little or no mixing for disperse the agent.	3-4
Not vulnerable	The product is in sealed containers and ducts that do not have exposure points or is under full and controlled observation. The product is solid or very difficult to mix.	1-2

Annex B. Localization and significance of the critical areas

BASEMENT



GROUND FLOOR

