Moroccan Journal of Chemistry
ISSN: 2351-812X
http://revues.imist.ma/?journal=morjchem&page=login
H.Rachidi / Mor. J. Chem. 4 N°4 (2016) 920-929

Implementation of HACCP - OPERA approach to the assessment of chemical risks in a sugar factory in Morocco, based on the principles of HACCP - OPERA approach.

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Received 01March 2016, Revised 30Sept 2016, Accepted 19Dec 2016

Abstract

To implement of HACCP-OPERA, we have proposed in a previous work, to demonstrate its reliability and its application in the field and to present the limits of its implementation in an industrial site, a sugar factory in Morocco has launched a study of identification and risk assessment in chemical laboratory quality control of the beets on the basis of this new approach.The results showed that the risks were significant and strong impact on the health of operators such as, the manipulation of acetate of lead, formaldehyde and acetic acid that the risk of severity 156, 148 and 48 respectively, from which we could determine the critical points. Lead acetate for D c = 0, acetic acid D c = 4 and Formaldehyde Dc= 1. These products can cause accidents and diseases, if the exposure was unacceptable and preventive measures were rarely established. HACCP-OPERA has enabled us, to gether, determine the critical limits for each CCP. Corrective measures must be put into action if the monitoring system shows the loss or the trend towards loss of control of a CP. Also, the HACCP-OPERA presented difficulties in implementation, which limited us to identify and assess all chemicals listed on the site.

Keywords: *HACCP-OPERA, chemical risk, safety, factory*

1. Introduction

Some risks are specific to a type of business or sectors. This is the case, for example, chemical risks in SMEs (Small and Medium Enterprises). These chemicals are commonly used in a variety of situations: industrial synthesis, laboratory analysis, surface treatment, stripping, emptying, cleaning ... They can be emitted as dust, fumes, vapors or gases by materials, processes or during their employment [1]. If exposed to chemicals, the health effects can be brutal manifestations (asthma, convulsions ...) or more said ridges (memory disturbances and mood, liver effects ...) [2]. This obviously affects the yield and the quantitative and qualitative aspects of product. Regarding the chemical, the evaluation process is often difficult because of the multiplicity of products and formulations used, despite the information provided by safety data sheets and labeling on the packages. A sugar factory in Morocco launched a professional risk analysis study on the workplace. This study focuses in particular on the identification and assessment of chemical risks in the laboratory quality control beets. Work in this laboratory caterized by the handling and storage of a variety of chemicals, having all categories of danger (fire, explosion, health risk, discomfort, fatigue ...). Our objective is to identify and rank risks associated with handling chemical produced in the laboratory of this candy, identify and estimate the critical points and critical risk exposure limits, propose preventive measures, surveillance and corrective actions, based on the principles of HACCP-OPERA approach we proposed in a previous study [3]. Firstly; to realize the principles of the HACCP-OPERA approach to demonstrate its reliability and ease of its implementation on the ground for chemical risk management. Equaling, presenting the difficulties of its application in the industry. On the other hand; to provide decision support as part of the management, the prevention of chemical risks, including risk communication policy makers, employees in the laboratory and the public power. Also, minimize the adopted standards, the food company, for managing risks related to the product and the operator. Therefore, minimizing training and awareness and economiccosts.

2. Methodology

The identification and assessment of chemical risk to the operator, the laboratory receipt of beet sugar that are conducted by adopting the principles of the HACCP-OPERA approach. This approach is based on the following steps:

- *Team Constitution;*
- *Inventory and description of goods, personnel and the working environment;*
- *Determining the intended use of the products;*
- *Establishment of the list of operations;*
- *Confirmation of the transaction list instantly;*
- *Analysis of hazards and preventive measures;*
- *Hazard Identification*
- *Identification of potential harm;*
- *Identification of preventive measures;*
- *Determination of Critical Control Points (CP) for the control , by the OPERA method:*
- *Assessment of chemical risk:*

This is to assess the severity of the chemicals risk from the equation :

" Severity Risk = [(A / B) + C] * D " of the OPERA method [4] .

In this formula, there are factors A, B, C and D. Factors A and C arise from the product label, the MSDS (Material Safety Data Sheets) and MSDS, where A and C are calculated from the R phrases "risk phrases" that are indicated on the product label and MSDS. An array of values was established by the Cram Burgundy Franche Comte, for each of these R-phrases (see Table A1: rating the R phrases). The factor B depends on the respect or non-compliance with

safety instructions (safety phrases "S" listed on the product label and MSDS). The factor D that discharges from the conditions and work process (see rating of factor D in Annex). Similarly, the OPERA method present the level of risk depending on its severity.

Table A 1:R phrases quotes [4]

Phrase R	quotation A	quotation C	Phrase R	quotation A	quotation C	Phrase R	quotation A	quotation C	Phrase R	quotation A	quotation C
1	10		30	8		14/15	9		39/28	8	
2	6		31	5		15/29	10		40/20		7
3	8		32	7		20/21	5		40/20/21		8
4	8		33	7		20/22	5		40/20/21/22		8
5	6		34	6		20/21/22	6		40/20/22		8
6	10		35	8		21/22	5		40/21		7
7	6		36	5		23/24	7		40/21/22		7
8	4		37	5		23/24/25	8		40/22		6
9	8		38	4		23/25	7		42/43	7	
10	4		39	8		24/25	7		48/20	6	
11	6		40		6	26/27	9		48/20/21	6	
12	8		41	7		26/27/28	10		48/20/21/22	7	
14	8		42	7		26/28	9		48/20/22	6	
15	8		43	7		27/28	9		48/21	6	
16	8		44	5		36/37	6		48/21/22	6	
17	10		45		10	36/37/38	7		48/22	6	
18	8		46		10	36/38	6		48/23	7	
19	6		48	6		37/38	6		48/23/24	7	
20	4		49		10	39/23	8		48/23/24/25	8	
21	4		60		10	39/23/24	8		48/23/25	7	
22	3		61		10	39/23/24/25	9		48/24	7	
23	6		62		8	39/23/25	8		48/24/25	7	
24	6		63		8	39/24	8		48/25	7	
25	6		64		8	39/24/25	8		68/20	7	
26	8		65	3		39/25	8		68/20/21	8	
27	8		66	4		39/26	8		68/20/21/22	8	
28	7		67	4		39/26/27	9		68/20/22	8	
29	6		68	6		39/26/27/28	10		68/21	7	
						39/26/28	9		68/21/22	7	
						39/27	8		68/22	6	
						39/27/28	9				

2.7.2 Identification and assessment of critical points:

CCPs are often difficult to appreciate just by HACCP. The severity of the risks of chemicals evaluated and selected by the OPERA method allow determine and estimate the critical points based on the factor D.

We chose then the level of risk "characterized" (GR> = 25) as the level at which the risk is not acceptable (see Table A2). Indeed, the work team has the option to choose the level of acceptable risk not taking into account the characteristics of the institution and its activities.At this stage of our HACCP-OPERA approach, precautionary statements mention babies on the label or safety data sheet are supposed beings respected, are prerequisites of the process. In this case, B = 2 (see OPERA method above). The listing of the factors A and C depends on the characteristics of the used chemical. In consequence, it is based on the level of risk (GR) and factors A, B and C of a D values (0, 1, 2, 3, 4, or 5) will be considered as the critical point to master. So among the D values previously defined, it equals 25 / [(A / 2) + C] is the critical point to master. It corresponds to:

D (point critique)= 25/ [(A/2) +C].

Table A 2:The level ofrisk according toseverity [4]

Severity of the risk: GR	Risklevel
< 5	Very weak
5 < GR < 15	Low
15 < GR < 25	Average
25 < GR < 35	characterized
35 < GR < 50	Very big
50 < GR < 70	Danger
> 70	Serious or imminent

2.8. Determining the critical exposure limits for each critical point:

So among the D values (critical limit) previously defined, the values of D (critical limit) acceptable with respect to operator safety match : D (critical limit) <25/ [(A / 2) +C]

2.9. Setting up a system for monitoring the risk exposure for each CCP:

The implementation of this system corresponds to the plane, methods and necessary arrangements to make observations or measures to ensure thatcrytick limits are still metand that they are also really mastered.

2.10. Establishment of a corrective action plan:

Corrective actions areactions that should beundertaken immediately when the monitoring system revealsloss or trend towardsloss of control of a point tickcry. Then, in the case where the monitoring system reveals that:D (critical limit) ≥25 /[(A / 2) +C]. Corrective actions must be under taken immediately on the factors of the equation"Severity Risk =[(A / B)+C]*D" of the OPERA method[4].

2.11. Application verification procedures:

Verification of compliance with the application procedures of the HACCP-OPERA approach can be conducted periodically, including respect of the critical points and crytick limits.

2.12. Registration: the single document

The employer mayuseall types of mediato transcribethe results of therisk assessment.The document can bedigitalorin writing, the employer has the choicemeansthatitappearsbest suitedto its needs.

2.13. Appendix: Examples of rating factor D

D = 0: absence of any operator in the environment.

D = 1: physical separation between the operator and the former operation: ventilated and closed Sorbonne.

waterproof machine without product loss Any device allowing the total lack of contact with the product ...

D = 2: human presence in the environment, not in the operating room, low pressure type ventilation

Cabin ventilated paint, largely operator outside. Sorbonne ventilated but not closed. Evaporations lower third of the VME. inert gas likely to fall by 1 point the oxygen concentration (now 5%) ...

D = 3: operator in the operating environment, local-type ventilation collection at source, open cab sprays. PE greater than 20 ° C to room temperature. Operating temperature between 50 and 70 ° C. Atmospheric concentration (lower?) reaches the VME. Inert gas likely to fall by 2 points the oxygen concentration (now 10%) ...

D = 4: operator fully in process atmosphere, general ventilation only. Sprays. PE above room temperature only 10 ° C. Operating temperature between 70 ° C and 90 ° C. Atmospheric concentration reaches 2 WEL or TLV. Inert gas likely to fall by 3 points the oxygen concentration (now 15%) ...

D = 5: operator fully in process atmosphere nonexistent ventilation. Pulverized product in the open. PE less than or equal to room temperature. Temperature greater than or equal operating at 90 ° C. Atmospheric concentration reaches 10 VME or VLE. Inert gas likely to fall by 4 points or more in oxygen concentration (pre-sent 20%).

3. Results

The inventory of chemicals in the laboratory candy enabled us to identify chemicals labeled, unlabelled chemicals and other including labels, safety data sheets and MSDS (Material Safety Data Sheets) are lost or discarded. These chemicals are used in reactions to assess the quality of chard, kale; sugar content and impurities, the criteria on which the farmer is paid. The team identified chemicals labeled in this laboratory: lead acetate, acetic acid, copper sulfate and formaldehyde. She checked the available nibles information on labels and safety data sheets. These data were used to determine their hazards, their damage and preventive actions required. Indeed, dipaid data collected during the inventory were used, also, to establish safety plugs to workstations. The priority risks are identified and assessed by the OPERA method from the equation "Severity Risk = [(A / B) + C] * D". Where A, B and C derive from the product label, MSDS (Material Safety Data Sheets) and toxicology records and D stems from the work process. This allowed us to identify chemicals of priority risks, critical points D (critical point), where a health hazard can be avoided, eliminated or reduced to an acceptable level by appropriate control action, determine D critical limits (critical limit) to separate the acceptability of non-acceptability of the level of risk in relation to operator safety. The classification of risk allowed us also to establish the surveillance and corrective action for each critical point. We give below a sample calculation for the identification and assessment of priority risks, critical points, critical limits and corrective actions of the chemical risk in this laboratory OPERA HACCP method. The results of the risk assessment of other chemicals are shown in Table 3. We take as an example the lead acetate, the product label contains the following intraining: the risk phrases R33, R48 / 22, R40, R61 and R62. So the risk of severity of this product is

GR = (A / B + C) D = 156, Where:

* A = R33 + R48 / 22 , where A = 15 (see table 1 "rating of R-phrases" in the appendix);

* C = R40 + R61 + R62, where C = 24 (see table 1 "rating of R-phrases" in anix) [4];

* The operators of this laboratory does not meet the safety instructions (they do not wear personal protective equipment: masks, gloves ...), which gives B = 1;

* The operator is fully operative in the atmosphere, only general ventilation, which gives

D = 4 (see examples quotation D attached).

Table 3**: Evaluation of** riskchemicalproducts usedin the laboratory ofcandy

Chemical products	Phrases R	A	B	C	D	GR= (A/B+C) D	D p.c = [25/(A/2+C)]	D l.c< [25/ (A/B+C)]
lead acetate	R33, R48/22, R40, R61, R62	A=R33+R48/22 A=15	B=1	C=R40+R61+R62 C =24	D=4	GR=156 > 25 priorityrisk	D p.c. =25/ (15/2+24) D p.c. =25/31.5=0.79 ; D p.c.=0 CCP	D l.c. <25/ (15/2+24) D l.c. <25/31.5 D l.c. <0
Aceticacid	R11, R25	A=R11+R25 A=12	B=1	C=0	D=4	GR=48 > 25 priorityrisk	D p.c. =25/ (12/2+0) D p.c. =25/6 =4.16 D p.c. =4 CCP	D l.c. <25/ (12/2+0) D l.c. <25/6=4.16 D l.c. <4
Copper sulfate	R22	A=R22, alors A=3	B=1	C=0	D=4	GR=12< 25 non-priorityrisk	Non CCP	
Formaldehyde	R23, R24, R25, R34, R43, R40	A=R23+R24+R25+R34+R43, A=31	B=1	C=R40 C =6	D=4	GR=148 > 25 priorityrisk	D p.c. =25/ (31/2+6) D p.c. =1.16, D p.c. =1 CCP	D l.c. <25/ (31/2+6) D l.c. <1.16 D l.c. <1

In our case, the operator fully in the operating room, general ventilation only, according to the rating of the factor D, proposed by the OPERA method, D = 4 (see examples quotation D attached). D (critical limits): D l.c. D (critical point): D p.c. Severity of the risk: GR.

Therefore, lead acetate GR = 156 which presents an imminent risk. The GR (lead acetate) is greater than 25. This is a priority risk, for which a critical point can be undone, since we have seen the level of risk "characterized" (Severity Risk = 25 for example) as the level at which the risk is not accepted (see table 2) [4]. According to the formula "D (critical point) = 25 / [(A / 2) + C]" the corresponding critical point: D (critical point) = 25 / [(15/2) +24]. Finally, D (critical point) = 0.79. The values of the factors A, B, C, and D were determined by the authors of the method on the basis of their experience. There is no need to change them, because they are correlated to the relevance of the tool [4]. Indeed, one of the D values (0, 1, 2, 3, 4 or 5) will be considered to master the critical point (see "scoring factor D" in anix). In this case, we can choose more preventive work conditions, then the D (critical point) = 0 (less than D (critical point) = 0.79) is the critical point to master for the handling of lead acetate (see examples of D quotation attached). In this example and after the phrase "D (critical limit) <D (critical point) = 25 / [(A / 2) + C]." The value of the exposure limit to the risk of lead acetate would be: D (critical limit) <0 (see examples quotation D attached). Where if the surveillance reveals that the critical limits are not well respected, D (critical limit) ≥ 0, corrective action must be taken. These actions are predetermined by the multidisciplinary team (see Table 4 in the Appendix).

Table 4: Preventive measures, monitoring and corrective chemical risk in the laboratory of candy.

Chemical products	Domage	D p.c	Preventivemeasures	Surveillance measures	Corrective actions
lead acetate	* Danger of cumulative effect * Possibility of irreversible effects; * Possible risk of impaired fertility; * Pregnancy risk of harm to the child; * Risk of serious damage to health by prolonged exposure if swallowed; * Acute and subacute events: - anemia - Acute encephalopathy * Chronic manifestations; * Peripheral neuropathy and / or amyotrophic lateral sclerosis syndrome does not get worse after stopping exposure [8] [9].	CCP	* Wear PPE: gloves, mask, goggles; * Work under the hood; * Avoid exposure, obtain instructions Specialtion used before; * Remove the product and / or its container as hazardous product, avoiding release into the environ-ment; * Periodic checking the health of employees;	* Periodic monitoring of the effectiveness, maintenance and port PPE (mask, gloves, goggles ...) * Periodic checks of ventilation systems must be made: airflow, air speed, state of the elements of the installation, filter ...;	* medical intervention. * In case of accident or illness seek medical advice immediately (if possible show the label) * Distance operator by containment operations by automating processes, for source capture vapors or dusts; * Replacement of dangerous by less dangerous.
Aceticacid	* Easily flammable; * Toxic by ingestion, inhalation, skin or eye projection: injuries and burns like very painful neurosis, bronchoalveolitis which, according to the extent of damage, may lead to a fatal fibrosis [9].	CCP	* Wear PPE: gloves, mask, goggles; * Keep container tightly closed; * Avoid contact with the skin ; * Keep away from any flame, do not smoking; * Periodic checking the health of employees;	* Verification of the implementation of safety guidelines, written procedures ..	
Copper sulfate	* Harmful in contact with skin; by ingestion of 15 g of copper sulfate: -intoxications with severe vomiting and dysenteryment that cause collapse; abnormal liver function, anemia Hemolytic and anuria with acute renal failure are complications of this systematic poisoning, coloring blue-green stool and vomit-ments can guide the diagnosis [11].	NON CCP	* Wear gloves and eye protection and face protection; * Periodic check-ing the health of employees; * Periodic checkment efficiency between Tien and use of PPE (masks, gloves, read-net ...) * Apply safety instructions, written procedures		
Formaldehyde	* Toxic by inhalation; * Toxic if swallowed; * Sensitizing on contact with the skin; * Skin ulcers; * Dermatitis eczema Subaiguous or chronic; * Rhinitis, asthma or wheezing dyspnea confirmed by test or function tests recipro-divant after further exposure; * Burns; * Possibility of irreversible effects [8] [9].	CCP	* Use only in well-ventilated areas ; * Ensure general and local exhaust ventilation efficient; * Periodic checking the health status of employees .	* Periodic monitoring of the effectiveness, maintenance and port PPE (mask, gloves, goggles ...) * Periodic checks of ventilation systems must be made: airflow, air speed, state of the elements of the installation, filter ...; * Verification of the implementation of safety guidelines, written procedures ...	* medical intervention. * In case of accident or illness seek medical advice immediately (if possible show the label) * Distance operator by containment operations by automating processes, for source capture vapors or dusts; * Replacement of dangerous by less dangerous.

4. Discussion

Integrated risk management helps identify opportunities to remove threats and especially to measure their performance levels. It helps, too, improving productivity, resource optimization, risk reduction and finally, the principle of coherence. When a company manages its performance by displaying an overview and based on separate and independent systems, inconsistency moved [5]. The HACCP-OPERA approach proposed by our team, based on the synergy of HACCP principles [6] [7] and the OPERA method, which are habirently implemented independently. It formalizes a new simplified method of analysis of chemical risk to the operator in the industry, especially the food. HACCP entant a permanent treasury system avoids many nonconformities, determine the critical limits of risk exposure and surveil lance measures that are not defined by the OPERA method. OPERA to estimate the severity and prioritize risks to the position of labor, to identify and assess critical points. These are often difficult to assess by HACCP. To develop a prevention and protection system in the laboratory quality control of this candy, well suited to the actual conditions of work, we had to analyze the chemical risk in this laboratory by the process HACCP- OPERA.

The application of this method allowed us to show that the chemical risk is important in this laboratory because of the multiplicity of chemicals used and / or stored, the absence of collective and individual prevention measures, the wrong perception professional risks for operators and non knowledge of regulations guaranteeing the prevention of occupational risks. This is due mainly to the lack of awareness thrust on the damage caused by these risks, the preventive and corrective actions. The chemical risk is accentuated in this laboratory by manipulating some unlabeled chemicals that are not addressed by the HACCP-OPERA method, which made the analysis of chemical risks less accurate and complete. The use of certain chemicals labeled identified the risk of severity of these products, such as lead acetate (**GR = 156**), Formaldehyde (**GR = 148**) and acetic acid (**GR = 48**). These risk levels are above 25, as we considered the level of risk "characterized" (Severity Risk = 25) such as the level at which the risk is not accepted (see Table 2) [4]. These are, then, the priority risks (see Table 3). The classification of these risks, allowed us subsequently, to determine critical points based on the formula "D (critical point) = 25 / [(A / 2) + C]." For lead acetate (**D (critical point) = 0**), Formaldehyde (**D (critical point) = 1**) and acetic acid (**D (critical point) = 4**) (D values (critical point) D correspond to the values in Appendix "D rating factor"). Whereas copper sulphate has medium risk (**GR = 16 <25**) (see Table 3), it is not a priority risk, it required simple preventive actions (see Table 4). Indeed, lead acetate is an imminent risk, which may result in potential damage, in most cases irreversible (see Table 4). Formaldehyde has also a strong impact effect on health, irreversible effects [8] [9] (see Table 4). Acetic acid has a very high risk and can lead to a deadly fibrosis [9] (see Table 4). So the risk of high impact required precise and permanent control measures, giving priority to information, awareness, guidance and control (see Table 4). Eventually, the lack of individual prevention equipment, the large number of operators in this laboratory which is 13 persons and the extension of working time for the companion (12 hours), increase exposure to these risks. However, the HACCP-OPERA method does not allow us to take into account the duration of exposure, the quantities of products implemented and the number of operators at risk. In the literature, the Weighted Average Exposure to Lead acetate is AEV [average exposure value]= 0.10 mg / m³ [9] [10]. The Exposure Limit Value acetic acid is TLV [limit value exposition] = 10 ppm, 25 mg / m³ [9] [10] and for Formaldehyde, it is TLV = 2 ppm, 3 mg / m³ [9]. In the absence of air sampling devices in this business, we determined the critical limits of exposure to risk by adopting the equation "D (critical limit) <25 / (A / B + C)." The latter is simple, does not require the use of organic or metrological methods. The application of this approach has given us the following critical limits: for lead acetate (**D (critical limit) <0**), acetic acid (**D (critical limit) <4**) and Formaldehyde (**D (critical limit) <1**) (D values (critical limit) correspond to the values of D "rating factor D" in the Annex) (see table 3). These limits for separating acceptable working conditions of

those unacceptable in relation to operator safety. We proposed, thereafter, surveillance measures to ensure that the critical limits are consistently met and that they are also really mastered. They can quickly detect any deviation from the target values in order to take corrective measures already established by the team. In addition, we noted the importance of verifying the proper application of the procedures of the HACCP-OPERA approach (see table 4).

The company has a consolidated statistics on industrial accidents and their analyzes of all workplaces, whose laboratory is part. However, we noticed a lack of data on occupational diseases. Therefore, we propose to consolidate on a single support professional risk analysis of the data (accidents, incidents and diseases) to which workers are exposed. This allows to have a means of proof of the control exercised. The evaluation should be conducted by management that consult and / or will involve all present on the workplace: employers, management, CHS (Hygiene and Security Committee) staff representative bodies and workers. These have the knowledge and experience of their own situation of work and the risks it entails. Similarly, many accidents are caused because they are qualified human error, but they are mostly the result of ignorance of the risks. Knowledge of the risks is a prerequisite for behavior and reasoned responses. Therefore, training in safety and health at work well done can facilitate-Functioning system into a truly integrated component of the management of the inter-taking. The plan training covers training to the specific risks to the trade, to the function and interfaces with business generally coexist. The application of the HACCP-OPERA approach in the laboratory of this candy has identified and evaluated in a simplified manner the chemical risk. Although some chemicals do not have the necessary information to classify and evaluate the measures proposed for chemical risk management in the laboratory can be used, likewise, for the prevention of risks of non labeled products. Also, the application of this new approach in a food company has been facilitated due to the knowledge of the HACCP principles by operators and managers. What motivated managers to think about the development of a quality plan based on HACCP principles and the integration of HACCP-OPERA approach in this plan. This can promote thereafter the establishment of a quality system, safety and health, minimizing the multiplicity of approaches to managing risks related to the product and the operator and manage well human and financial resources of the company. The application of HACCP-OPERA did not require the use of metrological evaluation methods or bio-metrology, but it is preferable to rely on these techniques for risk management products whose properties are unknown.

5. Conclusion

The application of the HACCP-OPERA method allowed to conduct a simplified identification, assessment and management of chemical risk to the operator in the laboratory quality control beets. It helped, too, a better use of resources and savings for the refinery and a reaction to the problems of safety of operators and therefore products. Applying this approach enabled participation an interesting employees and managers to understand and to guarantee safety, giving them an extra motivation for the development of a quality plan security in this business. Although HACCP-OPERA method does not assess any chemical hazards in the laboratory due to a lack of information necessary for its implementation. But it has provided a good vision on safety and health in this business.

So the HACCP-OPERA approach involves the processing of relevant data in the form of a company profile. These data support the development of a strategy, to the extent that the various stakeholders reached an agreement on the objectives, priorities, policies, the role of different departments / agencies and the responsibilities of industry. In particular, the main problems related to the control and prevention of risks can be demonstrated in order to apply effective strategies for solving these problems.

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