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A comparative study of regulations concerning safety in wastewater plants

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Abstract

This paper highlights the growing challenges associated with risk management in wastewater treatment plants, with a focus on the situation in Morocco compared with France. In recent years, the emergence of new environmental issues has increased the complexity of risks, disrupting the assessment of wastewater treatment plants. In Morocco, legislation relating to environmental impact studies stresses the importance of risk management, while the French experience emphasises prior analysis of the risks of failure of treatment plants. Despite the progress made under the National Sanitation Programme, Morocco still lags behind France in terms of network coverage and wastewater treatment. The safety of operational wastewater treatment plants is crucial to protecting the environment and public health. In France, strict standards, advanced technologies, regular maintenance, staff training and incident management proceduresguarantee a high level of safety. In Morocco, further efforts are needed, including harmonisation of regulations, adoption of reliable technologies, specialised staff training, and strengthening of risk prevention practices.

Keywords: Station, Purification, environment, Regulations, Risk.

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1. Introduction

In recent years, the emergence of new issues has been directly correlated with the growth in risks and their complexity. This has led to uncertainty and imbalance in the assessment of wastewater treatment plants [1,2]. In Morocco, law no. 12-03 on environmental impact studies, particularly article 6, sets out in general terms the components of an environmental impact study, thus highlighting the issue of risk control and management. However, experience in France has shown that it is essential to implement a risk analysis of the effects of failure and the measures envisaged to remedy any failures before treatment plants are commissioned [3-5].To this end, several approaches can be deployed to carry out this risk analysis study. These methods present certain disadvantages and obstacles, in particular the mobilisation of a multidisciplinary team, high costs, technical training and control tools [6] [7].

1.1. Objectives of the study

- Carry out a comparative analysis of regulations relating to the improvement and safety of treatment processes and risk management;
- To improve the safety of workers, neighbouring communities and the environment, in order to ensure optimum operation of treatment plants;
- Evaluate similarities, differences and best practices, and make recommendations to strengthen and improve safety at treatment facilities in Morocco. Cadresréglementaires marocain et français.

1.2. Moroccan regulatory framework

Industrial safety at wastewater treatment plants (WWTPs) in Morocco is governed by Law 12-03 on environmental impact assessments. This law requires WWTP operators to carry out an EIA for any project to build or modify a facility. The purpose of the environmental impact assessment is to identify and evaluate the risks to safety, health and the environment, and to propose measures to eliminate or reduce these risks. In addition to Law 12-03, the Moroccan regulatory framework for industrial safety at WWTPs is based on a set of standards and directives, including in particular.

❖ The implementing decrees of Law No. 12-03 relating to environmental impact studies:

− Decree No. 2-04-563 of 5 Kaada 1429 (November 4, 2008) relating to the responsibilities and operation of the national committee and regional committees for environmental impact studies

− Decree No. 2-04-564 of 5 Kaada 1429 (November 4, 2008) establishing the terms of organization and conduct of the public inquiry relating to projects subject to environmental impact studies

❖ Law No. 11-03 relating to the protection and development of the environment

❖ Law No. 13-03 relating to atmospheric control

❖ Law No. 10-95 on water and its implementing texts

− Decree No. 2-04-553 of January 24, 2005, relating to spills, flow, discharges, direct or indirect deposits in surface or groundwater

− Order No. 1607-06 of 29 Joumada II 1427 (July 25, 2006) setting specific limit values for domestic discharges. These specific discharge limit values referred to in Article 12 of Decree No. 2-04-553 of 13 Hija 1425 (January 24, 2005) relating to spills, flow, discharges, direct or indirect deposits in surface or underground water, applicable to wastewater discharges from urban areas

❖ Law and decree of July 27, 1969 relating to the defense and restoration of soils

❖ Law governing classified establishments;

❖ Law No. 28-00 relating to waste management and its elimination and its implementing decree;

❖ Law 12-90 on urbanization and its implementing decree;

❖ Law 78-00 relating to the municipal charter;

❖ The Moroccan standard IMANOR 03.0.22-1 relating to wastewater treatment plants;

❖ The directive from the Ministry of Energy, Mines, Water and the Environment relating to wastewater treatment plants and related works;

❖ Dahir No. 1-72-103 relating to the creation of ONEP;

❖ Dahir n° 1-00-266 of 2 Joumada II 1421 (September 1, 2000) bearing the promulgation of law n° 31-00 modifying Dahir n° 1-72-103 of 18 Safar 1392 (April 3, 1972);

❖ Dahir No. 1-03-194 promulgating Law No. 65-99 relating to the labor code;

❖ Draft framework law no. 55-17 on health and safety at work.2.

1.3. French regulatory framework

In France, industrial safety in Wastewater Treatment Plants (STEP) is regulated by a set of international standards and directives. Among the main applicable standards and directives, we find:

❖ Council Directive 96/82/EC of December 9, 1996 relating to the protection of the environment, particularly water, against the risks of pollution by major accidents involving dangerous substances;

❖ European directive 2015/1598: relating to the safety of urban wastewater treatment installations;

❖ The ISO 14001 standard: “Environmental management system – Requirements and guidelines for use”

❖ The ISO 45001 standard: “Occupational health and safety management system – Requirements and guidelines for use”

❖ The ISO 31000 standard: “Risk management system”

France benefits from exhaustive regulations regarding industrial safety in wastewater treatment plants. This regulation arises from various texts of law, orders and decrees, among which the main ones are the following:

❖ The law of July 30, 2003: prevention of industrial risks, which provides in particular that installations classified for environmental protection (ICPE) must comply with reinforced safety rules;

❖ The decree of May 11, 2006: relating to the prevention of industrial risks, which sets the technical requirements applicable to ICPE;

❖ The decree of January 21, 2015: relating to installations classified for environmental protection subject to authorization, which specifies the conditions of authorization of ICPEs;

❖ The decree of July 21, 2015: relating to the monitoring of local authority sanitation systems requires wastewater treatment plants with a nominal capacity greater than 200 population equivalents (PE) to carry out “a risk analysis” before they are put into service. of failure (ARD)”;

❖ Draft decree (May 2019 version) modifying the decree of July 21, 2015: modified relating to collective sanitation systems and non-collective sanitation installations receiving a gross load of organic pollution less than or equal to 1.2 Kg/d of BOD5.

2. Analysis methods and tools

2.1. FMEA method: Analysis of Failure Modes and their Criticality Effects

Failure Mode, Effects and Criticality Analysis (FMEA) is a quality tool used to perform preventative analyzes aimed at identifying and addressing potential causes of faults and failures before they occur . This method is based on a rigorous working approach which is very effective thanks to the centralization of information and data.The principle of the FMEA method lies in the compilation of all potential causes of each failure mode. Then, it is essential to assess the criticality of these modes of dysfunction. The review is obtained through a triple rating:

- The Severity (G) of the effect of the defect or failure.
- Occurrence (O), which represents the frequency of appearance of the cause.
- Detection (D), which measures the probability of non-detection of the cause.

Thus, the Criticality index (C) is calculated according to the following formula:

Criticality (C) = Severity (G) x Occurrence (O) x Detection (D)

The higher the Criticality, the more significant the failure is considered [8].

2.2. Hazard Operabilitystudies

Hazard OperabilityStudies (HAZOP) is a systematic approach to identifying potential issues that may arise when reviewing the safety of designs, as well as within the context of existing processes and operations within the chemical, pharmaceutical, oil, gas and nuclear [15]. The fundamental principle of the HAZOP method is the use of "guide words" to undertake a systematic search for potential deviations from the design intent. To facilitate this analysis, the system is subdivided into parts (also called "nodes" or subsystems), so that the design intent can be defined appropriately for each of them. The choice of game size depends on the complexity of the system as well as the severity of the risks encouraged.To carry out a HAZOP study, it is imperative to follow the steps indicated in the figure 1[21].

2.3. APR method: Preliminary Risk Analysis

Preliminary Risk Analysis (PRA) is a very general application method widely used for the identification of risks at a preliminary stage of the design of an installation or project. Consequently, this method generally does not require in-depth and detailed knowledge of the installation under examination (Table 1).The Preliminary Risk Analysis (PRA) first requires the identification of potentially dangerous elements within the installation. These dangerous components typically include:

- Substances or preparations of a dangerous nature, whether they appear in the form of raw materials, finished products, or utilities, among others.
- Equipment presenting a risk, such as storage areas, reception-dispatch areas, reactors, as well as utility infrastructure such as boilers.
- Procedures associated with the process that may result in inherent danger.

The working group can then follow a systematic approach according to the following steps:

1) Select the system or function to be studied based on the functional description previously produced.
2) Choose equipment or product for this system or function (column 2).
3) For this equipment, consider a first risk situation (column 3).
4) For this risk situation, consider all possible causes and consequences (columns 4 and 5).
5) For a given sequence of cause-risk situation-consequences, then identify the existing safety devices on the installation (column 6).
6) If the risk thus assessed is deemed unacceptable, formulate proposals for improvements in column 7. The last column (column 8) is reserved for possible comments. It is of particular importance to highlight the hypotheses formulated during the analysis or the people who need to take additional actions.
7) Then consider a new sequence of cause-risk situation-consequences for the same risk situation and return to point 5).
8) Once all the sequences have been studied, consider a new risk situation for the same equipment and return to point 4).
9) When all risk situations have been examined for the equipment considered, choose new equipment and return to point 3) above.
10) If applicable, once all equipment has been examined, select a new system or function and return to point 2).

2.4. Fault Tree Method

Fault tree analysis is based on a deductive process. It is used by developers and engineers to identify the root cause or human errors that may occur in various types of software, technical installations or hardware. This method typically starts from a single point, the high-level adverse event, and then grows in a tree format, forming a top-down structure of blocks and symbols to illustrate relationships between events. (like mechanical components).More specifically, in the context of fault tree analysis, the term "fault" means the occurrence of an undesired state for a component or system.Additionally, the term "Misconduct" encompasses three key types:

- Primary fault: A failure of a component that cannot be defined at a lower level of the system;
- Secondary fault: A component failure that can be defined at a lower level, but with limited detail;
- Control fault: A condition that is caused by an upstream failure.

2.5. Environmental impact study

- Environmental Impact Study in France using the “Default Risk Analysis (ARD)” method:Failure Risk Analysis (ARD) constitutes a crucial method for identifying and evaluating the risks inherent in the failure of various elements such as systems, processes, products or equipment. It is of capital importance in preventing accidents, securing property and individuals, and applies to a multitude of areas, including quality, safety, health, the environment and productivity.This analysis segments risks into different classes, assessed according to the frequency and severity of potential incidents: R1 (significant risk), R2 (tolerable risk) and R3 (intolerable risk). It also allows precise prioritization of risks and issues appropriate recommendations.The Default Risk Analysis (ARD) process is deployed in several stages:

➔Risk identification: This phase aims to list all the failure risks, whether technical, human, organizational or environmental. Various techniques can be used, including Failure Mode and Criticality Effects Analysis (FMEA).

➔ Risk assessment: This step involves assessing the severity of failure risks, taking into account two main criteria: severity and probability. Severity measures the negative impact that a failure could have on aspects such as quality, safety, health, environment and productivity.

Probability quantifies the chance that such an event will happen again.

➔ Definition of prevention measures: This phase consists of implementing measures aimed at reducing the risk of failure, based on the results of the risk assessment. These measures may be of a technical, human, environmental nature and may involve modifications to the system or process, the implementation of safety procedures and the establishment of monitoring systems to eliminate the causes of failure, or reduce their probability or their seriousness (Table 2).

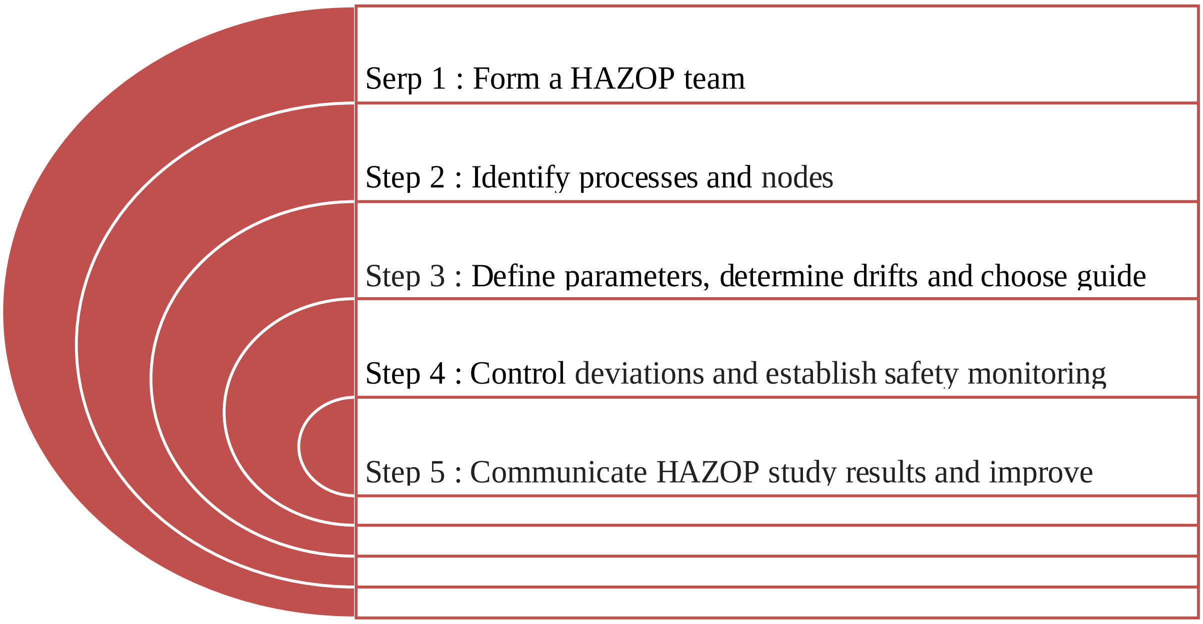

Figure 1 : The stages of the HAZOP study

Table 1: Example of a Preliminary Risk Analysis table

Function or System:									Date :	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
N°	Product or equipment	Danger situation	Causes	Conséquences	G_0*	Existing safety measures	P*	G*	Proposal for improvement	Observations

* G0 : A priori severity P : Probability G : Gravity

Table 2: Environmental Impact Study of the BOUARFA-Morocco STEP

Environment: Human

Element: Hygiene and population health

Source of impact: Construction phase, operation phase.

Description of impact

Construction phase

• The use of pitsor the direct discharge of this water into the natural environment presents a risk of leading to the deterioration of public hygiene.

• Abandonment of scrap and construction waste on site at the end of the work

Operationphase:

• The proliferation of mosquitoes and rodents at the WWTP could present a health risk for populations.

• Uncontrolled reuse of treated wastewater.

• Handling wastewater works presents a healthrisk for workers

Impact assessment : Negative

Sensitivity	High	Medium	Low
Intensity	High	Medium	Low
Scope	National	Regional	Local
Duration of impact	Long	Medium	Short
Significance	Major	Medium	Low

Reduction measures :

Construction phase

• Ensure the collection and disposal of waste of all kinds in the work area to the appropriate locations.

Operation phase

• Ensure good collection of solidwaste management, by the services concerned, to limit malfunctions in the sanitation network

• Implement a disinfestation program at the WWTP, especially during hot periods.

• Develop a control and monitoring plan for the quality of treated wastewater and monitor their use

• Wear personnel protection accessories against contact with equipments oiled by wastewater (gloves, boots, etc.)

Residual impact: None

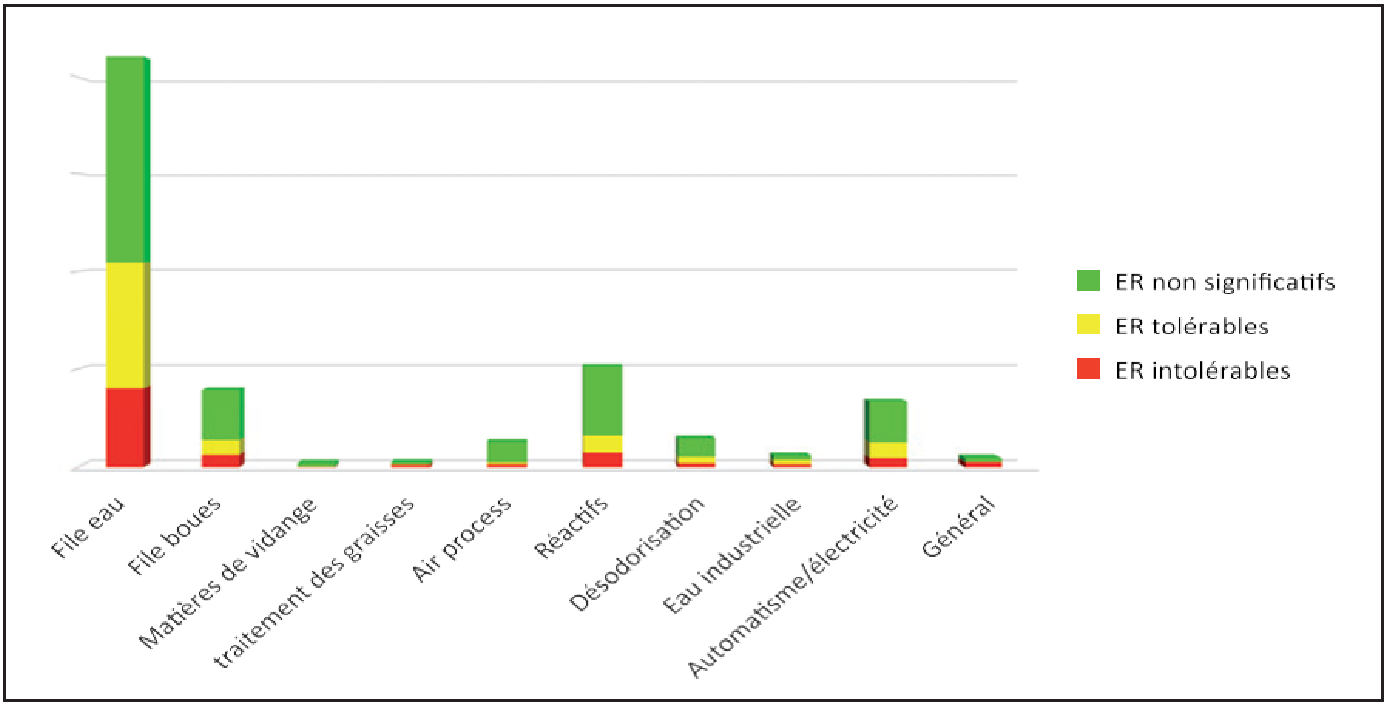

Figure 2: Analysis of failure risks in France.

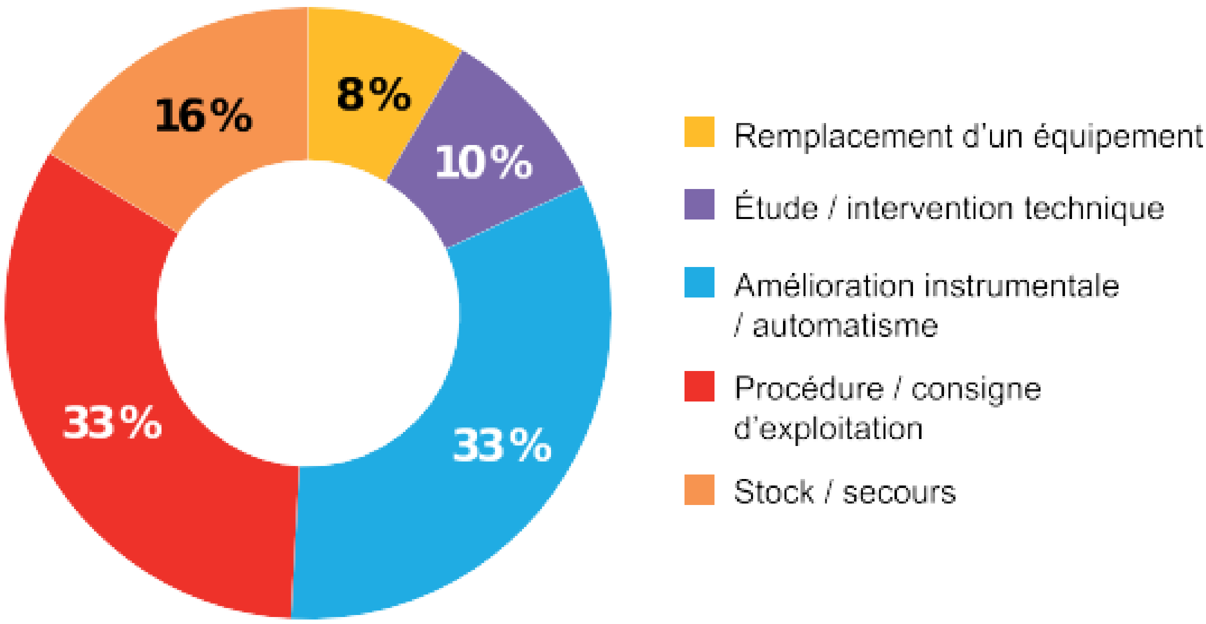

Figure 3: Recommendations from the Failure Risk Analysis.

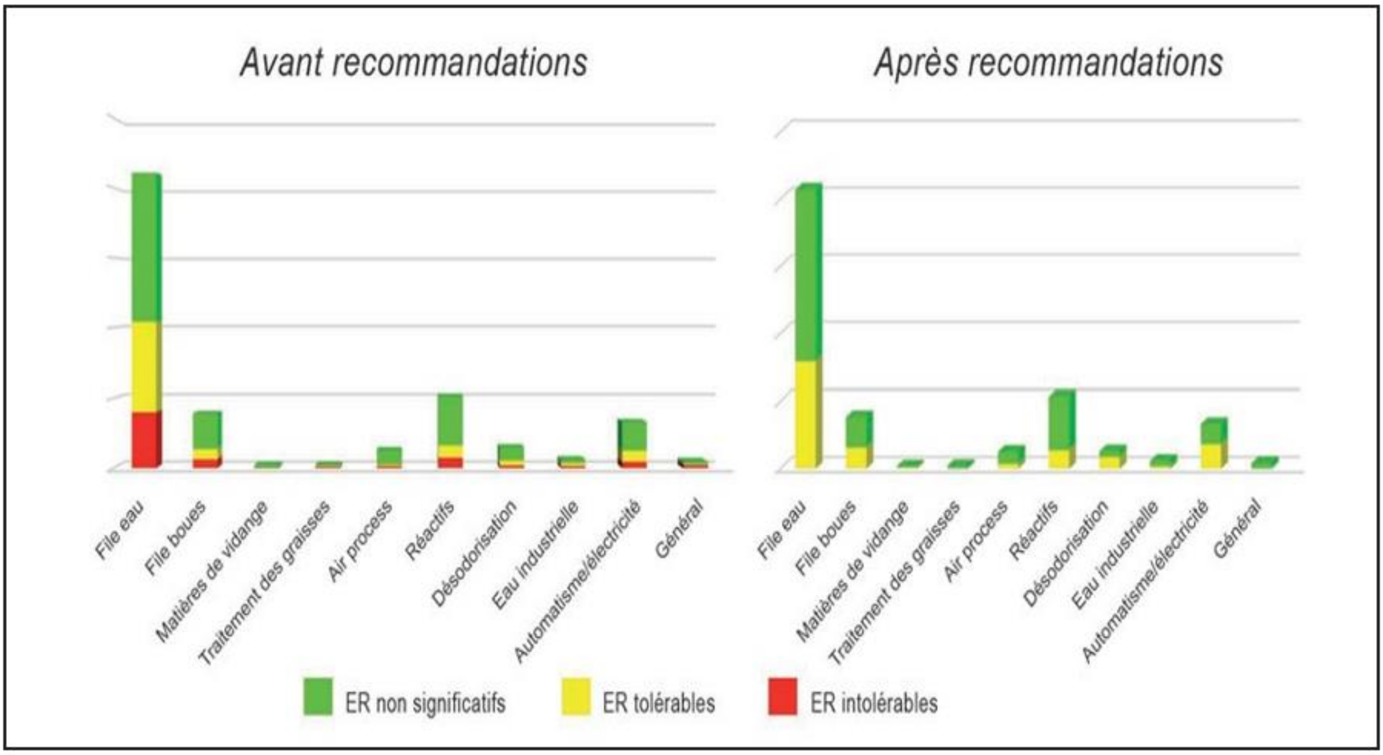

Figure 4: Evolution of industrial risk before/after taking into account the recommendations

➔ Monitoring and updating: ARD is a dynamic process which requires regular updating to integrate any changes occurring in the system or equipment concerned.

2.6. Most frequently malfunctions

This analysis aimed to identify the most frequently observed malfunctions in the process, with the aim of drawing relevant lessons for the design of future installations and the optimal operation of existing installations. In our example, this method was applied to examine in detail the procedures and events most likely to generate these malfunctions (figure 2).According to the figure 2 presented, it is observed that the "water" section is the one which lists the greatest number of events likely to lead to non-compliant discharges. Consequently, failures in these facilities often have an impact on the environment, resulting in releases that do not meet established standards. The "sludge" section is also represented, although it is not always doubled. Thus, in the event of a failure leading to the accumulation of sludge, there is a risk of non-compliant discharges. In addition, other processes require specific monitoring:

● "Reagents", because of their potential effects on the safety and health of personnel;

● "Automation and electricity", because the loss of energy, power or control inevitably leads to a disruption or unavailability of the treatment, which results in non-compliant discharges.

- Recommendations following the Failure Risk Analysis carried out:

The recommendations for not only technical but also organizational improvements were classified according to the following categories (figure 3):

According to the figure above, we observe that:

● 33% of recommendations are linked to organizational improvements.

● 33% concern improvements to instrumentation and automation.

● 33% are miscellaneous recommendations.

Thus, it appears that most of the recommendations aimed at improving the safety of wastewater treatment plants seem relatively accessible and will not require major investments. The final industrial risk assessment, taking into account these recommendations, also demonstrates that they can significantly reduce the level of risk, as illustrated in Figure 4 below. In conclusion, this type of study offers the possibility of establishing a precise diagnosis of our installations with a view to optimizing our operations and managing risks. This is accomplished through methodical identification of areas requiring improvement, as well as the formulation of response plans specific to each risk, presented in a summary manner and intended for operators.

3. Conclusions and perspectives

The operational safety of WWTPs is crucial for the preservation of the environment and public health. These complex installations, dedicated to the treatment of domestic and industrial wastewater, require optimal operation to guarantee the effectiveness of the treatment and the protection of receiving environments. In Morocco, the National Sanitation Program (PNA), initiated in 2005, has significantly improved the coverage of the sanitation network and the rate of wastewater treatment. However, in 2023, the rate of connection to the network and wastewater treatment remains lower than that of France. In France, with a highly developed sanitation network, the network connection and wastewater treatment rates are very high, highlighting a high level of operational security. The operational safety of STEPs is ensured by rigorous technical and organizational measures, including compliance with standards and regulations, the use of appropriate technologies, regular maintenance of equipment, staff training, and the implementation of safety procedures. management of incidents and accidents. Compared to France, Morocco has a less developed sanitation network and lower wastewater treatment rates, making the operational safety of WWTPs a more crucial issue. The main distinctions between the operational safety of WWTPs in Morocco and France lie in standards and regulations, treatment technologies, upkeep and maintenance, staff training, as well as incident management procedures. To strengthen the operational security of WWTPs in Morocco, measures such as harmonization of regulations, certification in accordance with international standards, incentives for the adoption of more reliable treatment technologies, the creation of specialized training centers, and the Strengthening risk prevention and control practices are recommended. The development of a WWTP monitoring system is also recommended to detect potential failures. These initiatives would help reduce the risks of incidents and accidents within WWTPs, thus preserving the environment and public health.

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