Implementation of ISO 55001 in the desalination industry. Case study: desalination plant in southern Tenerife.

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Abstract:
This paper addresses the implementation of the ISO 55001 standard in a seawater desalination plant located in the south of Tenerife. The desalination plant studied uses reverse osmosis technology to produce drinking water, a technological solution that is particularly relevant in regions with scarce water resources such as the Canary Islands. The study delves into the ISO 55001 standard and its practical application in seawater desalination plants through the design of an asset management plan. This includes an audit focused on the most critical equipment, assessing its condition, criticality and the risk associated with it. In this context, the need to apply an asset management model that guarantees efficiency and sustainability is justified. The research results in an asset replacement plan based on technical and economic criteria, with the aim of improving the reliability of the plant and facilitating more strategic long-term management.

Keywords:
ISO 55001, desalination, reverse osmosis, critical equipment, asset management plan.

1. Introduction

According to UNESCO [1], approximately 2 billion people, representing around 26% of the global population, do not have access to sufficient potable water to meet their basic needs. In response to this situation, seawater desalination has emerged as a key technological solution for this situation.

At present, approximately 16,000 desalination plants are in operation worldwide, with a total production capacity ranging between 95 and over 100 million m^3/day [2, 3]. The sector shows a projected compound annual growth rate of 12% until 2033, which reinforces its role as a strategic component of global water security [3]. However, energy consumption remains a critical factor in desalinated water production, accounting for between 40% and 60% of total operational costs [4].

This trend is clearly reflected in Spain, which is recognized as one of the leading countries in desalination in Europe, with more than 460 operational plants. These facilities are mainly located in areas with high water vulnerability, including the Mediterranean coast and the Canary Islands [3, 5].

Within this national framework, the Canary Islands represent a particularly relevant case due to their limited natural water resources. Desalination constitutes a fundamental pillar of water supply in the archipelago, accounting for approximately 79% of all seawater desalinated in Spain. This reflects a strong dependence on this technology to ensure potable water supply and to sustain key economic activities, particularly tourism and agriculture [6, 7]. At present, the Canary Islands operate more than 300 desalination plants distributed across the islands, with a combined production exceeding 480,000 cubic meters per day [6]. However, these facilities operate under demanding conditions, characterized by high energy and maintenance costs, as well as equipment degradation. For this reason, ensuring continuous, safe and efficient operation is essential, particularly in areas such as southern Tenerife where water availability is especially limited [8].

From a technological perspective, RO has become the predominant desalination method due to its high energy efficiency and relatively lower operational costs, especially in large scale plants such as those operating in the Canary Islands [9, 10].

Given the technical complexity, high capital investment and strict maintenance requirements associated with these infrastructures, it is necessary to adopt management approaches that ensure efficiency, sustainability and operational continuity. In this context, standardization through international frameworks has become an essential tool for improving industrial processes.

Today, ISO standards provide a fundamental framework for industrial management, supporting continuous improvement, operational optimization and the reduction of environmental impact in capital intensive sectors such as desalination [11]. A norm ISO is defined as "an item, object or entity that has actual or potential value for an organization. This value may be tangible or intangible, financial or non financial" [12].

Within this framework, the ISO 55000 family of standards plays a key role in asset management, as illustrated in Figure 1. ISO 55000 establishes the principles and terminology required for asset management within organizations, with the objective of maximizing value. ISO 55001 defines the requirements for implementing an asset management system, including its design, operation and continuous improvement. ISO 55002 provides practical guidance to support the implementation and maintenance of such systems [11].

Figure. 1. *ISO 55000 family of standards.*

The application of these standards allows organizations to align asset management with their strategic objectives, optimize asset life cycles and improve decision making, while strengthening both economic and operational sustainability [5, 12].

The rapid growth of the desalination industry and its strategic importance in regions such as the Canary Islands highlight the need for structured and sustainable infrastructure management. In this context, the ISO 55000 series provide guidance for decision making and helps organisations extend the service life of assets in capital intensive sectors such as energy, mining, transport and water management. Its practical value can be observed in infrastructures such as the Fonsalía Seawater Desalination Plant, operated by FCC Aqualia in Tenerife. This facility has a production capacity of approximately 4,000 m^3/day using RO and represents a strategic installation where advanced asset management practices are applied. In addition, international experiences of ISO 55001 implementation in desalination plants provide useful references for improving efficiency and sustainability in high demand environments [13,14].

For that reason, this study presents the design of an implementation plan for ISO 55001 2024 for the management of tangible assets at the Fonsalía desalination plant in Tenerife. Through a methodology based on criticality and risk assessment, key equipment required for system operation was identified, allowing the development of a replacement plan based on technical and economic criteria. The results show that, although the facility demonstrates a high level of maturity in planning and maintenance, there are still significant gaps in document control and asset life estimation. In conclusion, this study provides a strategic basis for future international certification and highlights the importance of asset management as a key tool for continuous improvement and investment decision making in the desalination sector.

2. Materials and methods

Having established the foundations that justify the design of an implementation plan for ISO 55001:2024 concerning the management of tangible assets at a seawater desalination plant located in Fonsalía, in the south of the island of Tenerife, a roadmap for its implementation is proposed. To achieve the objectives of this study, a methodology comprising a sequence of stages is adopted, as illustrated in Figure 2.

2.1. Description of the installation

The seawater desalination plant EDAM Fonsalía is in Guía de Isora, Tenerife, as shown in Figure 3. The facility is situated a few meters from the coastline, which facilitates seawater intake and reduces operational energy costs [5].

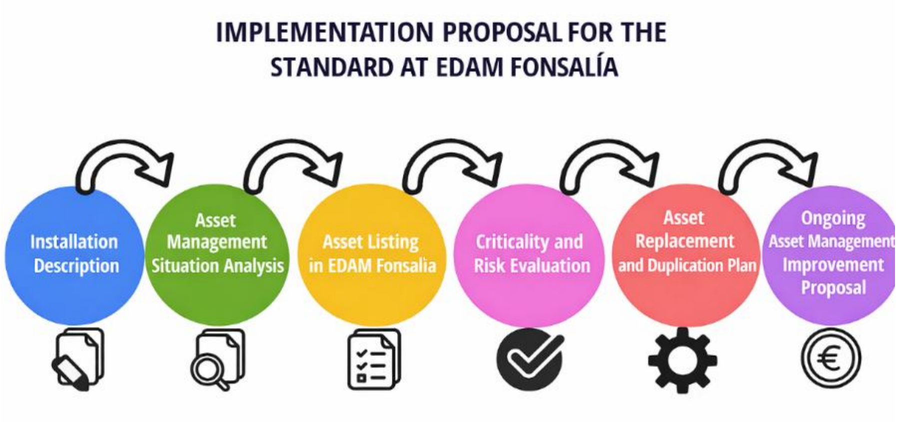

Figure. 2. *Proposal for the implementation of the standard*.

The desalination process implemented is based RO technology, one of the most energy-efficient technologies for sea water desalination. Sea water is abstracted through eight wells (six currently in operation). These wells are equipped with submersible pumps that convey the water to three sand filters with the facility, followed by three cartridge filters. Subsequently, system pressure is increased by means of three high-pressure pumps up to 60 bar, after which the seawater is fed into three racks, each containing 336 membranes. In this stage, approximately 40% of the feed water is recovered as permeate, while the remaining 60% is discharged as brine. The treated water is directed to calcite bed tanks, whereas the high-pressure brine is routed through energy recovery devices and discharged back into the sea upon completion of the process [5]. A simplified schematic summarizing the RO desalination process at EDAM Fosalía is presented in Figure 4.

Regarding facility management, FFC Aqualia S.A. aligns its strategy with the implementation of a physical asset management system in accordance with ISO 55001:2024 certification. This approach aims to optimize the service life of assets within the facility and improve resource-use efficiency through medium to long term equipment replacement planning.

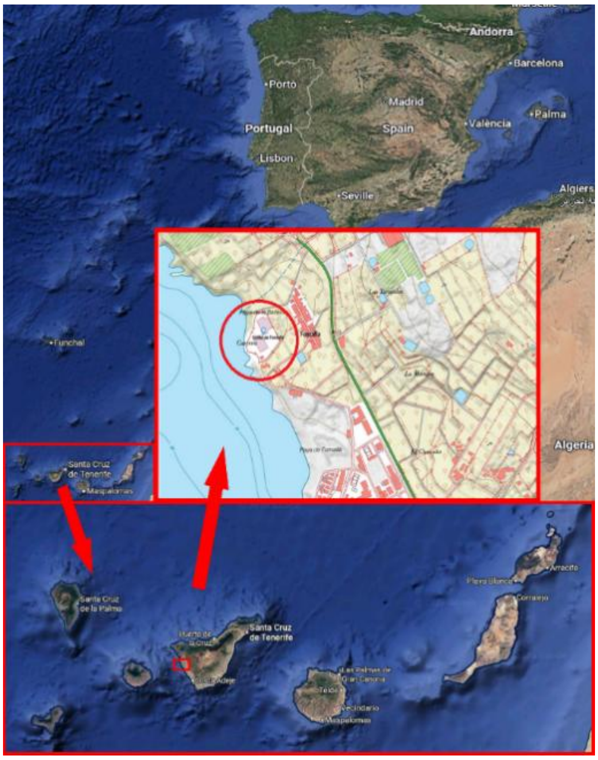

Figure. 3. *Geographical location of EDAM Fonsalia, Tenerife (Spain).*

2.2. Asset management situation analysis

As recommended by Gutiérrez et al. [15], the development of an initial assessment of the asset management system represents a recommended step for the evaluation of its alignment with the requirements established in ISO 55001. This preliminary diagnosis enables the identification of existing gaps and the definition of corrective actions required to achieve compliance with the standard. These criteria, together with their practical application, are presented in the results included in this study.

For this diagnosis, and in accordance with ISO 55002:2020, a set of items is proposed in order to determine the maturity level of the asset management system within the organization. These items are structured according to the key elements defined in the standard. To evaluate the level of compliance for each item, a numerical scale from 1 to 3 is applied, defined as follows:

1. Not fulfilled or absence of evidence

2. Partially fulfilled

3. Fully fulfilled

Based on the evaluation of each item, an overall conformity percentage for each section is calculated within a range from 0% to 100%. This approach enables the identification of priority areas where efforts require focus in relation to the implementation of the norm.

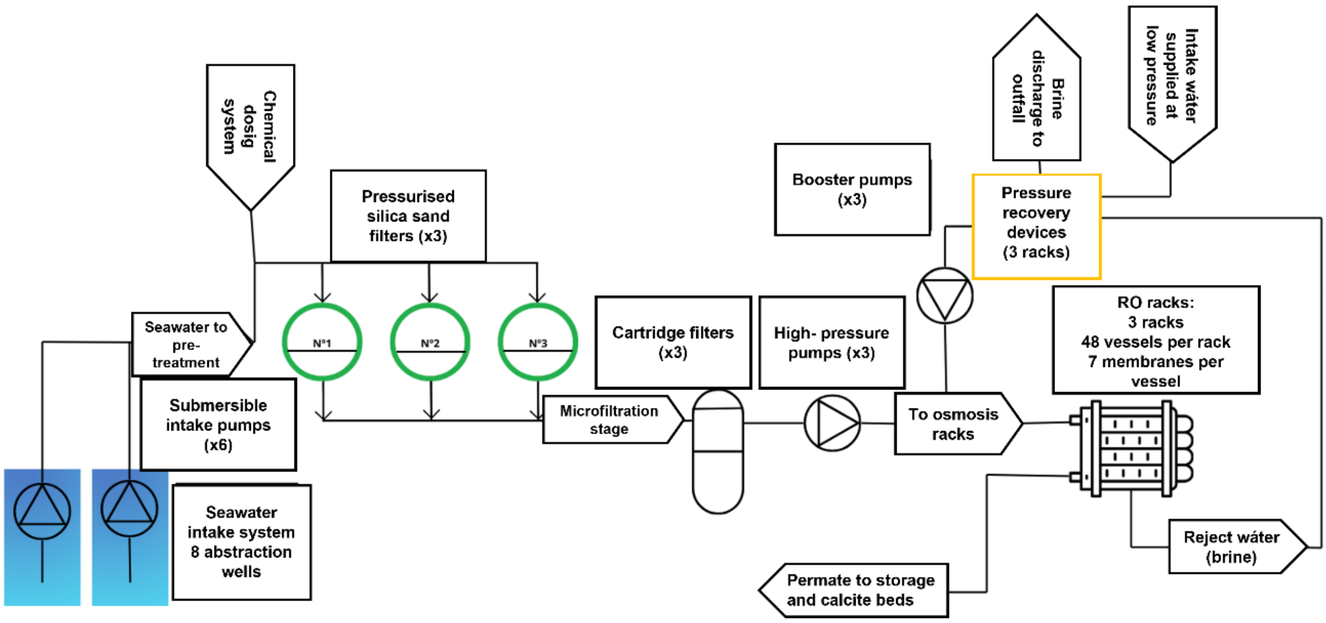

Figure. 4. *Simplified Schematic of the desalination process at EDAM Fonsalía.*

2.3. Asset listing in EDAM FONSALIA

The equipment inventory of EDAM Fonsalía is obtained through the public sector procurement platform, which provides a detailed register of both mechanical and electrical assets. The facility comprises a total of 213 mechanical assets, representing 82% of the overall equipment, while electrical assets account for 46 units, corresponding to the remaining 18%, as presented in Figure 5.

Given that the asset inventory includes a wide range of components, such as valves and auxiliary equipment, the analysis focuses on the most relevant assets. These correspond to those whose failure may produce a significant impact on the operational performance of the plant.

2.4. Criticality and risk assessment

The definition of criticality and risk levels for the equipment enables the establishment of priorities for maintenance activities throughout the asset life cycle, with the objective of minimizing disruptions in the production process. This analysis applies exclusively to the equipment associated with water treatment and post-treatment processes in the EDAM Fonsalía desalination plant, excluding assets related to technological systems or those not directly involved in the process.

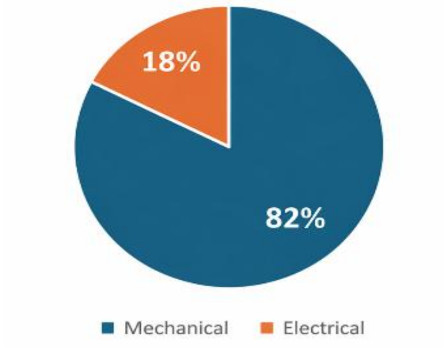

Figure. 5. *Percentage distribution of mechanical and electrical equipment in EDAM Fonsalía.*

For the evaluation of criticality, the equipment is classified into three categories based on [15]:

1. High criticality equipment Class A, where failure produces a significant impact on production capacity and may affect performance and safety, with the potential to interrupt operations
2. Medium criticality equipment Class B, where failure may affect production performance to a certain extent without causing a complete interruption
3. Low criticality equipment Class C, where failure produces a limited impact on production and generally corresponds to auxiliary systems or elements with minor influence on plant performance

The qualitative risk assessment follows the criteria defined in Table 1, based on the consequences associated with asset criticality and their condition. Five risk levels are established to support risk categorization and prioritization.

Table 1. *Proposed risk classification.*

Risk level	Abbreviation
Negligible	N
Low	L
Medium	M
High	H
Very High	VA

Although a risk matrix is defined in the study, the desalination plant applies spreadsheet-based tools for the evaluation of equipment criticality and condition. For this purpose, a set of criteria is defined to assess criticality, and a weighting factor is assigned to each criterion. The parameters considered are:

C1: Maintenance requirement of the equipment - (15%)

C2: Production capacity of the equipment - (35%)

C3: impact on water quality - (35%)

C4: Environmental and reputational impact - (15%)

For the assessment of equipment condition, the following parameters and weightings are defined:

C1a: Internal condition of the equipment - (10%)

C1b: External condition of the equipment - (10%)

C2a: Mechanical performance - (13%)

C2b: Energy performance - (12%)

C2: Overall performance - (25%)

C3: Environmental performance - (10%)

C4: Healty and safety performance - (10%)

C5: Maintenance - (15%)

C6: life cycle - (20%)

The selected weightings for both criticality and condition assessment present a subjective component, as they are based on the experience of the maintenance management team at EDAM Fonsalía. However, this approach aligns with methodologies previously applied in other desalination plants operated by the company. Table 2 includes the evaluation criteria and scoring system adopted, ensuring consistency in the assessment and classification model. The evaluation of equipment condition follows the weighting system defined in Table 3.

Once these criteria are established, the calculation of total asset criticality and the evaluation of equipment condition are performed.

Table 2. *Criteria for criticality assessment* ***(****adapted from FCC Aqualia).*

Equipment criticality criteria			
Score	**Rating**	**C1: Maintenance requirements**	**Comments**
1	Low	No preventive or predictive maintenance required (RUN TO FAILURE)	Asset condition and associated risk are not evaluated
2	Medium	Preventive maintenance required	
3	High	Preventive and predictive maintenance required	
Score	**Rating**	**C2: Production capacity**	**Comments**
1	Low	Equipment duplicity available (redundancy). Minimum spare parts stock ensured. Shutdowns do not interrupt service.	
2	Medium	Shutdowns up to 48 hours with total service interruption. Longer shutdowns with production reduced up to 50%.	
3	High	Shutdowns exceeding 48 hours causing total service interruption.	
Score	**Rating**	**C3: Water quality impact**	**Comments**
1	Low	Failure produces a non-conformity/ impact on quality water, although water remains suitable for consumption without restrictions.	
2	Medium	Failure produces a non-conformity/ impact on quality water, although water may still be suitable requiring partial consumption restrictions.	
3	High	Failure produces a non-conformity/ impact on quality water, which means a total restriction on water consumption.	
Score	**Rating**	**C4: Environmental, safety, and reputational impact.**	**Comments**
1	Low	In case of failure, - Not perceived by customers, - Not generate environmental impact, safety incidents, or reputational, - Not safety and healthy incidents, - Not reputational issues.	
2	Medium	In case of failure, - May be detected by customers without generating complaints, - Minor environmental or health risks to worker, which can be managed under the Contract, - Reputational impact is moderate	
3	High	In case of failure, - Failure is always detected by customers and generates complaints, - Significant environmental, and/or healthy and safety impact occur, requiring external response, - Reputational impact is severe.	

Table 3. *Criteria for equipment condition assessment (adapted from FCC Aqualia).*

Asset condition criteria			
Score	**Rating**	**C1a: Internal and external condition of the equipment**	**Comments**
1	Good	No wear, visible damage, corrosion, or leakage. Predictive maintenance indicators such as temperature, noise, and vibration remain within optimal range.	
2	Moderate	Presence of wear, localized damage, or occasional leakage. Predictive maintenance indicators show deviations requiring improvement.	
3	Poor	Significant wear, recurring dame or leakage. Predictive maintenance indicators outside acceptable limits	
Score	**Rating**	**C2a: Mechanical performance of the equipment**	**Comments**
1	Good	Number of breakdown stoppages per year: <= 1	
2	Moderate	Number of breakdown stoppages per year: > 1 y <= 3	
3	Poor	Number of breakdown stoppages per year: > 3	
Score	**Rating**	**C2b: Energy performance of the equipment**	**Comments**
1	Good	Rto. >= 90%	If C2b is not available, C2a is assigned double wight
2	Moderate	Rto. 80-90%	
3	Poor	Rto. <= 80%	
Score	**Rating**	**C3: Environmental performance**	**Comments**
1	Good	Full compliance with environmental regulation and control requirements	
2	Moderate	Isolated NC detected, without environmental impact	
3	Poor	Isolated NC detected, with environmental impact	
Score	**Rating**	**C4: health and safety performance**	**Comments**
1	Good	Full compliance with safety and health regulations. No incidents detected	
2	Moderate	NC detected / Incident during operation and/or maintenance processes, causing no harm to workers.	
3	Poor	NC detected / Incident during operation and/or maintenance processes, causing harm to workers. Fire or explosion events detected.	
Score	**Rating**	**C5: Maintenance**	**Comments**
1	Good	Corrective / preventive maintenance (%): < 5%	The criterion shall be calculated in hours; otherwise, it will be measured by number of work orders.
2	Moderate	Corrective / preventive maintenance (%): >= 5 y < 10%	
3	Poor	Corrective / preventive maintenance (%): > 10%	
Score	**Rating**	**C6: Life cycle**	**Comments**
1	Good	(Current Date – Installation Date) / Equipment Service Life (%): > 60%	
2	Moderate	(Current Date – Installation Date) / Equipment Service Life (%): 40 a 60%	
3	Poor	(Current Date – Installation Date) / Equipment Service Life (%): < 40%	

2.4.1. Calculation of asset criticality and condition

This study adopts an alternative approach for asset risk calculation, based on the relationship between asset criticality and a representative value of its current condition, with the aim of reducing evaluator subjectivity. The equation applied for risk calculation is:

$$\boldsymbol{Risk = criticality \cdot asset\ condition} \tag{1}$$

The criticality of each asset is calculated as the weighted sum of the defined criteria, resulting in a value between 1 and 3, where 1 represents non-critical assets and 3 represents highly critical assets:

$$\boldsymbol{Criticality = C1 \cdot 0,15 + C2 \cdot 0,35 + C3 \cdot 0,35 + C4 \cdot 0,15} \tag{2}$$

Similarly, the condition of the assets is calculated as an arithmetic sum, where 1 indicates excellent condition and 3 indicates poor condition. These values are determined based on historical data analysis and predictive maintenance activities:

$$\boldsymbol{Asset\ condition = C1a \cdot 0,10 + C1b \cdot 0,10 + C2 \cdot 0,25 + C3 \cdot 0,10 + C4 \cdot 0,10 + C5 \cdot 0,15 + C6 \cdot 0,20} \tag{3}$$

The development of the asset replacement and duplication plan, together with the ongoing asset management improvement proposal, is presented in the results section.

3. Results

The following section presents the results obtained after the application of the proposed methodology for the implementation of ISO 55001:2024 in EDAM Fonsalía.

3.1. Asset criticality and condition assessment

Figure 6 shows that critical equipment represents 10% of the total assets within the facility. This distribution reflects the classification of equipment in EDAM Fonsalía according to their level of criticality, indicating that these assets perform a key role in plant operation. Their failure may generate significant consequences in terms of operational performance, safety, environmental impact, and regulatory compliance. This result is particularly relevant within the framework of asset management aligned with ISO 55001:2024, as it enables the allocation of technical and economic resources toward those assets whose availability and reliability are essential for achieving organizational objectives.

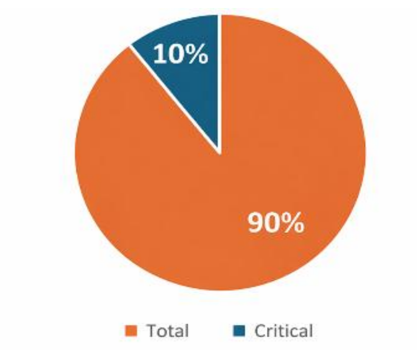

Figure. 6. *Percentage of critical equipment in EDAM Fonsalía.*

The identification of this 10% of critical assets supports the prioritization of preventive maintenance activities, failure analysis, and asset renewal or technological upgrade strategies. This contributes to improved decision-making processes and a reduction in operational risk.

Following the identification of highly critical equipment, the evaluation of asset condition is performed using the parameters defined in the theoretical framework of this study. This assessment is based on the analysis of maintenance records, including both preventive and predictive activities provided by the organization. Table 4 presents the assets with the highest criticality levels, together with their condition assessment and associated risk.

The integration of criticality, condition, and risk data provides a structured and comprehensive understanding of which assets require priority intervention. This analysis does not only identify the most relevant assets but also evaluates their current condition and the potential consequences of failure, enabling more effective resource allocation and avoiding unnecessary interventions. In practical terms, Table 4 constitutes a key tool for maintenance planning. Assets with high criticality combined with signs of degradation or elevated risk levels require prioritization.

Table 4. *Summary of critical assets, condition, and risk of the EDAM Fonsalía.*

List of critical assets	Asset criticality	Asset condition	Asset risk
Multistage submersible Pumps #1 (Seawater intake from wells)	2,7 Class A	2,25	**6,075 VH**
Multistage submersible Pumps #2 (Seawater intake from wells)	2,7 Class A	2,25	**6,075 VH**
Multistage submersible Pumps #3 (Seawater intake from wells)	2,7 Class A	1,95	**5,265 H**
Multistage submersible Pumps #4 (Seawater intake from wells)	2,7 Class A	2,15	**5,805 H**
Multistage submersible Pumps #5 (Seawater intake from wells)	2,7 Class A	1,85	**4,995 H**
Multistage submersible Pumps #6 (Seawater intake from wells)	2,7 Class A	2,05	**5,535 H**
Booster Pump #1	2,7 Class A	1,95	**5,265 H**
Booster Pump #2	2,7 Class A	1,65	**4,455 H**
Booster Pump #3	2,7 Class A	1,65	**4,455 H**
Closed Pressure Filters #1 (Sand filters)	2,65 Class B	1,95	**5,1675 H**
Closed Pressure Filters #2 (Sand filters)	2,65 Class B	1,95	**5,1675 H**
Closed Pressure Filters #3 (Sand filters)	2,65 Class B	2,15	**5,6975 VH**
High Pressure Pump #1	2,7 Class A	2,25	**6,75 VH**
High Pressure Pump #2	2,7 Class A	2,25	**6,75 VH**
High Pressure Pump #3	2,7 Class A	2,05	**6,15 VH**
ERI´S(Pressure recovery divice) #1	2,7 Class A	2,15	**6,45 VH**
ERI´S (Pressure recovery divice) #2	2,7 Class A	2,05	**6,15 VH**
ERI´S (Pressure recovery divice) #3	2,7 Class A	1,75	**5,25 H**
Product Water Pump #1	2,7 Class A	1,85	**5,55 VH**
Product Water Pump #2	2,7 Class A	1,95	**4,1925 H**
Product Water Pump #3	2,7 Class A	1,95	**4,1925 H**
Dry Power Transformers #1	2,3 Class B	1,85	**4,255 H**
Dry Power Transformers #2	2,3 Class B	2	**4,6 H**
Dry Power Transformers #3	2,3 Class B	2,15	**4,945 H**
Generator Set 560/448	1,95 Class B	2,15	**4,1925 H**
Variable Frequency Drives	2,3 Class B	2	**4,6 VH**
Variable Frequency Drives	2,3 Class B	1,775	**4,0825 H**
Variable Frequency Drives	2,3 Class B	1,575	**3,6225 M**

Based on these results, the maintenance plan is designed to prioritize asset replacement in a structured manner, based on criteria of criticality, risk, and current condition. The objective is to ensure plant reliability, optimize costs, and reduce the probability of unexpected failures, thereby supporting efficient and sustainable operation over the medium to long term.

The investment plan is defined over a five-year period, during which financial resources are strategically allocated according to the prioritization of assets with higher risk levels. In this context, highly critical assets may require the incorporation of redundant system to ensure continuous operation of the desalination plant, given its strategic role in water supply to nearby locations. This measure involves the planned acquisition of additional equipment capable of replacing critical assets in the event of failure.

Table 5. *Proposed equipment replacement over a five-year period.*

Equipment	Description	Initial Value	Current asset value	Replacement cost over 5 years	Useful life	Years to replacement	Annual Maint. cost	Annual reserve fund
Multistage submersible Pumps #1 (Seawater intake from wells)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	2	2.251,57 €	27.702,21 €
Multistage submersible Pumps #2 (Seawater intake from wells)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	2	2.251,57 €	27.702,21 €
Multistage submersible Pumps #3 (Seawater intake from wells)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	3	2.251,57 €	18.468,14 €
Multistage submersible Pumps #4 (Seawater intake from wells)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	4	2.251,57 €	13.851,11 €
Multistage submersible Pumps #6 (Seawater intake from wells)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	5	2.251,57 €	11.080,89 €
Multistage submersible Pumps (Standby)	Q=440 m^3/h TDH=70 mH_2O	49.450,00 €	44.018,89 €	55.404,43 €	10	5	2.251,57 €	11.080,89 €
High Pressure Pump #1	Q=198 m^3/h TDH=594,4 mH_2O	159.823,00 €	142.269,60 €	179.067,78 €	10	1	7.277,09 €	179.067,78 €
High Pressure Pump #2	Q=198 m^3/h TDH=594,4 mH_2O	159.823,00 €	142.269,60 €	179.067,78 €	10	2	7.277,09 €	89.533,89 €
High Pressure Pump #3	Q=198 m^3/h TDH=594,4 mH_2O	159.823,00 €	142.269,60 €	179.067,78 €	10	3	7.277,09 €	59.689,26 €
High Pressure Pump (Standby)	Q=198 m^3/h TDH=594,4 mH_2O	159.823,00 €	142.269,60 €	179.067,78 €	10	5	7.277,09 €	35.813,56 €
ERI´S (Pressure recovery device) x3	Px260 or equivalent	81.834,00 €	72.846,15 €	91.687,88 €	10	1	3.726,08 €	91.687,88 €
ERI´S (Pressure recovery device) x3	Px260 or equivalent	81.834,00 €	72.846,15 €	91.687,88 €	10	2	3.726,08 €	45.843,94 €
ERI´S (Pressure recovery device) x3	Px260 or equivalent	81.834,00 €	72.846,15 €	91.687,88 €	10	4	3.726,08 €	22.921,97 €

TDH: Total Dynamic Head;
Q: Flow rate

Among the priority equipment are multistage submersible pumps, due to their continuous wear in a saline environment, as well as the three high pressure pumps, which are key components in the RO process and whose degradation directly affects energy performance. Likewise, the progressive replacement of isobaric chamber and the incorporation of standby units are considered due to their high criticality and economic value, in order to ensure operational continuity.

Given the lack of reliable data on the actual useful life of assets, which may vary considerably depending on operating conditions and use, a reference life cycle of 10 years is adopted as a common framework to facilitate comparison among assets. For estimating replacement cost over a five-year period, an additional cost associated with inflation is incorporated, assuming an average annual inflation rate of 2,3% according to data from the INE [16].

Additionally, the annual calculation of a reserve fund for equipment replacement is proposed, consisting of progressively part of replacement cost to minimize the economic impact of these investments over time. Altogether, this methodological approach allows improved planning of future investments, focusing on the renewal of assets with the highest cost/risk relationship while optimizing the use of available resources.

The equipment included in this investment plan is detailed in Table 5. Financial efforts have been focused on this set of critical assets due to their importance for the overall operation and efficiency of the facility.

As shown in Tables 4 and 5, there is a clear relationship between criticality, risk level, and replacement planning. Equipment directly involved in a key process stage, such as multistage submersible pumps, high pressure pumps, and ERI's, present elevated risk levels reaching MA categories, and these are precisely the assets prioritized for replacement during the first years of the plan. This demonstrates consistency between technical risk analysis and investment decision/making, in contrast, auxiliary equipment presents moderate risk levels, allowing the establishment of a clear technical hierarchy to guide investment prioritization toward the most critical elements.

In this context, the results obtained are aligned with the principles established by ISO 55001:2024 [12], which states that "the organization shall evaluate asset performance and asset management, and the effectiveness of the asset management system and its contribution to achieving organizational objectives", promoting a continuous improvement approach.

In line with this principle, a set of performance indicators is proposed that could be used in a future implementation of the asset management system according to the standard. Although these indicators were not evaluated or applied during this study, their inclusion complements this work as a basis for future developments. Prosed operational indicators include mean time to repair, mean time between failures, and failure related availability, while financial indicators would include maintenance cost per asset, percentage of maintenance budget used, and maintenance cost relative to asset replacement valuer.

4. Conclusion

The ISO 55001:2024 standard proved to be an essential tool in designing an asset management system for EDAM Fonsalía, laying the groundwork for a system intended to play a crucial role in long-term decision-making at the desalination plant.

Throughout the study, it was demonstrated that, despite not being certified under ISO 55001:2024, EDAM Fonsalía exhibits an advanced level of maturity in asset planning and maintenance, systematically applying many of the most relevant asset management measures.

The organization allocates resources effectively to asset management. However, there are deficiencies in the control of documentation regarding the condition, criticality, and risk of assets, which significantly hinders the estimation of the useful life of assets within the facility.

By assessing the condition, criticality, and risk of the assets, it was possible to identify the most critical equipment, whose failure could cause an operational shutdown of the desalination plant. This information allowed the organization to establish intervention priorities and develop a replacement plan based on technical and economic criteria.

Furthermore, the design of this asset management system helps establish a culture focused on the continuous improvement of the system using key performance indicators. The goal is to measure the effectiveness of the implemented system and determine whether the actions align with the organization's needs.

Finally, this paper lays the foundation for a future ISO 55001:2024 certification, potentially serving as an initial document and a starting point for the implementation of the standard at EDAM Fonsalía. This would position FCC Aqualia S.A. as one of the pioneering companies in the application of ISO 55001 in the seawater desalination industry and could serve as a tool to justify investments before public institutions.

Acknowledgments

This work has been co-funded by INTERREG MAC 2021–2027 program, within the IDIWATER project (1/MAC/1/1.1/0022), which is integrated into the DESAL+ Living Lab Platform (desalinationlab.com (accessed on 20 April 2026)). Special acknowledgments to FCC Aqualia S.A. for its collaboration in the development of this study.

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