

APPLIED RESEARCH ON THE EVALUATION OF THE MANAGEMENT SYSTEM OF A WELDED STRUCTURE MANUFACTURING

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Rezumat

Implementarea unui sistem de management a devenit tot mai mult o necesitate pentru organizații, unul din principalele scopuri fiind stabilirea acțiunilor de atingere a obiectivelor referitoare la calitate. La ora actuală sunt multe sisteme de management însă pentru un producător de structuri sudate, pe lângă sistemul de management al calității conform EN ISO 9001:2015 se recomandă și implementarea EN ISO 3834-2:2021 “Cerințe de calitate pentru sudarea prin topire a materialelor metalice. Partea 2: Cerințe complete de calitate” Lucrarea prezintă cercetarile aplicative privind evaluarea sistemului de management al unei organizații producătoare de structuri sudate prin efectuarea, la interval de 7 luni, a două audituri interne în cadrul unei astfel de organizații precum și analiza evoluției sistemului de management după stabilirea unor măsuri corective stabilite după primul audit efectuat.

Cuvinte cheie: sistem de management, audit intern, ISO 9001, ISO 3834-2.

Abstract

The implementation of a management system has increasingly become a necessity for organizations, one of the main purposes being to establish actions to achieve quality objectives. Currently there are many management systems but for a manufacturer of welded structures, in addition to the quality management system according to EN ISO 9001:2015 it is recommended to implement EN ISO 3834-2:2021 "Quality requirements for fusion welding of metallic materials. Part 2: Comprehensive quality requirements" The paper presents applied research on the assessment of the management system of a welded structure manufacturing organisation by conducting two internal audits at 7-month intervals as well as the analysis of the evolution of the management system after the implementation of corrective measures established after the first audit performed.

Keywords: management system, internal audit, ISO 9001, ISO 3834-2

1. INTRODUCTION

The success of an organization depends on understanding and meeting the needs and expectations of current and potential customers. All the activities and measures necessary to create product quality are grouped under the name of quality management system with the role of directing and controlling the organization in terms of quality [1]. The organizations may choose to implement and subsequently certify management systems according to the standards presented in Figure 1.

References for accredited certification bodies according to ISO/IEC 17021-1:2015 Conformity assessment — Requirements for bodies providing audit and certification of management systems — Part 1: Requirements	
References	The purpose of implementing reference
EN ISO 9001:2015 Quality management systems — Requirements	Improving the overall performance of the organization by increasing the ability to consistently deliver products and services that meet customer and applicable legal requirements while providing opportunities to increase customer satisfaction
EN ISO 14001:2015 Environmental management systems Requirements with guidance for use	Helps an organisation to achieve its environmental management system objectives of increasing environmental performance while meeting compliance obligations
EN ISO 45001:2023 Occupational health and safety management systems — Requirements with guidance for use	Provides a framework for managing occupational health and safety risks and opportunities, preventing work-related injury and illness, and ensuring healthy and safe workplaces.
EN ISO 50001:2018 Energy management systems — Requirements with guidance for use	Enables an organisation to achieve continuous improvement of its energy performance and energy management system
References for accredited certification bodies according to ISO/IEC 17065:2012 Conformity assessment — Requirements for bodies certifying products, processes and services	
References	The purpose of implementing reference
EN ISO 3834-2:2021 Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements	Compliance with quality requirements for fusion welding of metallic materials
EN ISO 3834-3:2021 Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements	
EN ISO 3834-4:2021 Quality requirements for fusion welding of metallic materials — Part 4: Elementary quality requirements	
EN 1090-1+A1:2011 Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components	Establishment of requirements for conformity assessment of performance characteristics for steel and aluminium structural elements
Reference for independent certification bodies recognized by the European Committee for Welding of Railway Vehicles - ECWRV -	
Reference	The purpose of implementing reference
SR EN 15085-2+A1:2023 Railway applications - Welding of railway vehicles and components - Part 2: Requirements for welding manufacturer	Establishing certification requirements for manufacturers of welded structures performing welding work on railway vehicles, components and sub-assemblies

Figure 1. Standards for the implementation and certification of management systems in organizations producing welded structures

By implementing and certifying a management system, the welding process is better kept under control, so this becomes more and more a condition of competitiveness for organizations producing welded structures [2].

The Figure 1 also shows the cataloguing of standards according to the accreditation standard of the certification bodies and the purpose of implementing them at organizational level.

The audit process is defined according to SR EN ISO 9000:2015 as a systematic, independent and documented process for the purpose of obtaining objective evidence and evaluating it objectively to determine the extent to which audit criteria are met and consisted of the steps presented in Figure 2 [3].

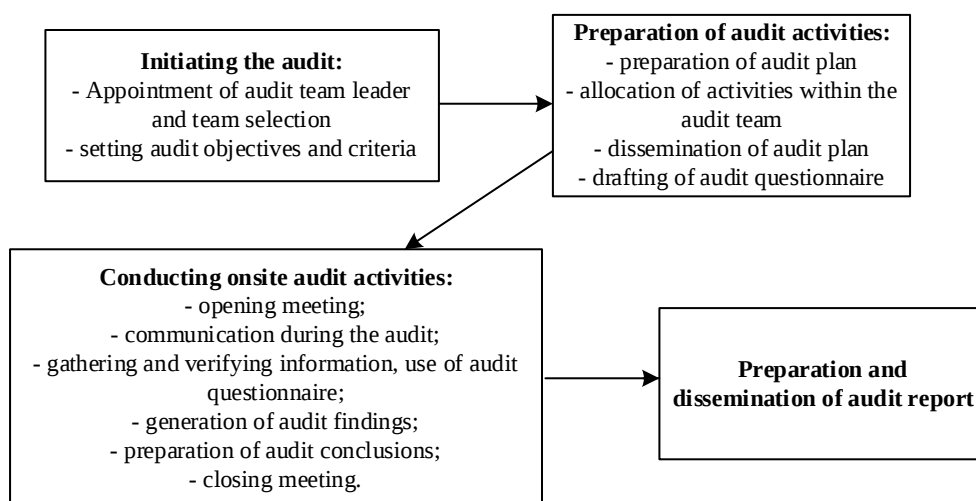


Figure 2. General steps in the audit process

The design and implementation of a management system involves going through several steps to prepare documented information against the requirements of the reference standards, including the internal audit stage where the implemented management system is assessed against the audit criteria.

The article presents the results of the internal audits (in the form of recommendations or non-conformities), the corrective measures proposed and implemented by the organization and their effects for a manufacturer of welded structures that was audited using SR EN ISO 3834-2:2021 and SR EN ISO 9001:2015 as audit criteria. The internal audit identified several non-conformities and recommendations that were analyzed and for which a plan of corrective measures and corrective actions was established. Subsequently, after 7 months, the audit was repeated with the aim of analyzing the progress of the management system implemented in the organization.

2. CASE STUDY ON THE EVALUATION OF THE MANAGEMENT SYSTEM OF A WELDED STRUCTURE MANUFACTURING ORGANIZATION

To start the research on the evaluation of the management system of an organization producing welded structures, the agreement to carry it out in a company whose field of activity is "Production and assembly of components for medical devices. Production and assembly of low-voltage electrical equipment for medical devices. Production of metal components and electrostatic painting, including medical devices" was requested and received. The welding processes used in the audited organization fall into the category of fusion welding processes (WIG, plasma, MIG, MAG) which is considered relevant to this research.

In view of the confidential nature of the work carried out by the organization where the management system assessment was carried out, the identification data of the company and the persons involved on its behalf will be presented in the form of acronyms as follows:

- PS S.R.L. - name of the audited company
- S1, S2 and S3 - the names of the welders
- M. L. - name of welding coordinator
- T. C. - responsible for dimensional control
- C. I. - responsible for cutting and rolling

The research on the evaluation of the management system of PS S.R.L. consisted of an audit with the objective of evaluating the metal garment production department against the following audit criteria:

- SR EN ISO 3834-2:2021 Quality requirements for fusion welding of metallic materials. Part 2: Comprehensive quality requirements;
- SR EN ISO 9001:2015 Quality management systems. Requirements;
- Integrated Management System (IMS) documentation;
- Legal and other requirements.

PS S.R.L. has about 30 employees of which: a welding process coordinator (international welding engineer IWI), 3 certified welders (welder S1 - processes 131, 135, 141, welder S2 - processes 131, 135, 141, welder S3 - processes 131, 135) and 4 qualified welding procedures for processes 131 (MIG welding) - 2 qualified procedures, 135 (MAG welding) and 141 (WIG welding).

Other information about the audited organization:

- Total area: 1200 sqm of which,—for welding processes: 400 sqm, warehouse: 200 sqm
- Underlying technological processes: cutting, rolling, etc.

- Material groups according to SR CEN ISO/TR 15608 :2017: Al AW 5083 H111 - subgroup 22.4, AW 5754 H111 - subgroup 22.3, steel S355J2+N - subgroup 1.2 etc.

- Typical sizes of welded components: 6 and 10 mm sheet metal

The initial audit took place in September 2022 when a total of 14 requirements with 31 applicable sub-requirements according to EN ISO 3834-2:2021 and 39 requirements and sub-requirements according to EN ISO 9001:2015 except requirement 8.3 were audited. Requirement 8.3 - Design and development of products and services - was excluded because the execution project is provided by the client.

The audit team consisted of 3 members, a team leader and two technical experts.

Table 1 shows the rating assigned according to the scores awarded [4].

Table 1. Rating obtained according to the scores awarded

Score awarded P	Rating
$1 \leq P < 2$	Unsatisfactory
$2 \leq P < 3$	Satisfactory
$3 \leq P < 4$	Good
$4 \leq P < 5$	Very well
5	Excellent

Table 2 presents the scores awarded according to the findings at the time of the audit and what the score is awarded for.

Table 2. Scores based on audit findings

Score awarded	Explanations
5	Compliant requirement
4	Requirement with a recommendation
3	Requirement with a minimum of two recommendations
2	Requirement with a non-conformity and recommendations (if applicable)
1	Requirement with minimum 2 non-conformities and recommendations (if applicable)

The following definitions were used in the research:

Compliance = fulfilment of a requirement [5]

Non-compliance = failure to meet a requirement [5]

Recommendation = an opportunity for improvement related to the organization's processes, which minimally meet the requirements of the standard but can be improved.

The standards used in the audit were EN ISO 3834-2:2021 and EN ISO 9001:2015. After identifying the requirements to be audited in the two standards, a matching of the two standards was carried out and the result is presented in Table 3.

In Table 3 one can observe the recommendations (identified in the table with italic text) and non-conformities of the audit carried out in September 2022 (their ordering was based on EN ISO 3834-2 requirements), as well as the audit criteria against which non-conformities and/or recommendations were identified.

Table 3. Recommendations and non-conformities of the audit carried out in September 2022

Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
1	It is recommended to update the welder's job description with current welder qualification requirements	7.2	5.3
2	It is recommended to consider the possibility of changing the position of Mr. M. L., welding coordinator, from mechanical engineer to welding engineer, COR code 214496	7.3	5.3
3	It is recommended that a level 2 visual inspection (VT) course to be carried out by the person in charge of dimensional inspection, Mr. T. C.	8.2	7.2
4	It is recommended to examine the technical and financial feasibility of mechanizing the welding process.	9.2	7.1.3
5	It is recommended to draw up a checklist of maintenance activities in accordance with requirement 9.5 of ISO 3834-2 in conjunction with the technical books of the welding equipment.	9.5	7.5.1
6	It is recommended that a range of process parameter values to be identified on the welding procedure qualification certificate (according to ISO 15614:2005 chapter 4).	10.3	8.5.1 f
7	It is recommended that Personnel procedure code PI-7.1.2 should contain more accurate references to the management of welder/welding operator qualification certificates	10.5	7.5.2
8	It is recommended to include the Manufacturing Register in the management system	10.5	7.5.2
9	Welding material distribution form should be used when handing over welding consumables to welders	11.3	7.5.1
10	More accurate occupational safety and health signaling in the production area is recommended	14.2	7.1.4
11	It is recommended that visual examination reports shall contain clear identification of the product examined, e.g. No 015 / 18.02.2022 contains no reference to the product code examined, C2	14.4	8.5.2
12	Customer project, e.g. drawing WP1800-01 is incomplete in terms of butt welds and non-destructive examination	5.1	8.2.2

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Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
13	Changes to the project made by the client are identified without control, with no approval other than that of the position making the change available	5.1	8.2.4
14	Technical requirements analysis sheet not available	5.2 5.3	7.5.3.1
15	No evidence available on training of welders/welding operators with WPS	7.2	7.3
16	The job description of mechanical engineer M.L. (welding coordinator) is not signed, not approved, the job description should not be approved by the technical director but by the general manager, the tasks are not clearly specified according to ISO 14731:2019, the appointment decision with specific tasks and responsibilities for the welding coordination activity is not available.	7.3	5.3
17	The decision to appoint a dimensional control officer (T. C.) is not available	8.1	5.3
18	According to the organization chart / 01.03.2022 CTC control activity is not independent from production (according to ISO 17635:2016)	8.1	5.3
19	No evidence of calibration of welding equipment available (those purchased in June 2021)	9.3	7.1.3
20	The Equipment Preventive Maintenance Plan / 2022 does not contain the planning of these activities	9.5	7.1.3
21	Welding map not available	10.1	8.1 a
22	Welding process tracking sheet NF 015 C2 / 23.06.2022 is incomplete, missing weld seam identification and missing process parameters on each part	10.1	8.5.1. a
23	Product tracking sheet is not completed on time (before the start of production) but after the processes in the organization, not all fields are completed, e.g. planned date	10.1	8.5.1 a
24	Stainless steel welds are made in production without qualification procedure and welder qualification	10.3	7.5.1
25	WPQR qualified by certificate 01 202 RO/V-22 0041 / 14.03.2022 is incorrectly defined, e.g. DC to polarity - instead of AC for procedure 141	10.3	7.5.1
26	In the Documented Information procedure there are no references to the development and control of WPS, WPQR	10.5	7.5.3
27	List of applicable external documents / 10.02.2022 does not contain references to external documents applicable to welding and related processes	10.5	7.5.2
28	The quality plan is not correctly drawn up (it is a flow chart of the production process without all the inspection and testing steps and related documents issued)	14.1	8.5.1 c
29	Measurement sheet / 02.05.2022 for cutting and rolling is not signed by the responsible C. I.	14.2	8.5.1 c
30	At the time of the audit the frequency of visual inspection is not adequate	14.4	8.5.1 c

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Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
31	No non-conformity reports are completed, e.g. corner weld crack, product PS 026-L3S2 etc.	15	8.7.2
32	No calibration certificates are available for measuring equipment used during the welding process, e.g. for welding fixture series 4830, welding template series 4832-1, ruler	16	7.1.5.2
33	No evidence of maintaining identification and traceability throughout the manufacturing process, e.g. for parts starting with the cutting process	17	8.5.2
34	No decision or procedure on transfer of the marking available	17	8.5.2
35	In the Delivery / Receipt in Production / 29.04.2022 for the metal sheet, the batch recorded (batch no. 80078453) is not found in the material certificate.	17	8.5.2
36	Incomplete files containing quality records identified, e.g. missing product tracing file	18	7.5
37	The organizational context and the needs and expectations of stakeholders regarding the welding process are not clearly identified, e.g. suppliers of filler materials generating risks with negative effect on delivery times or impossibility of delivery, availability of personnel on the labor market, etc.	-	4.1, 4.2
38	The organization's process matrix does not contain clearly defined the welding process, e.g. incomplete input/output elements	-	4.4

Table 4 related to EN ISO 3834-2 and Table 5 related to EN ISO 9001 show the scores and rating obtained from the analysis of recommendations and non-conformities identified in the September 2022 audit for each requirement audited under the two standards.

Table 4. Scores and rating obtained by PS SRL following the audit carried out in September 2022 on each ISO 3834-2 requirement audited (scores assigned according to Table 2, rating assigned according to Table 1)

Crt. no.	Requirement EN ISO 3834-2**	Audit 09.2022	
		Score awarded*	Rating
1.	5 Review of requirements and technical review	Average: 1.67	Unsatisfactory
	5.1 General	1	Unsatisfactory
	5.2 Review of requirements	2	Satisfactory
	5.3 Technical review	2	Satisfactory
2.	6 Sub-contracting	Average: 5	Excellent
	6 Sub-contracting	5	Excellent
3.	7 Welding personnel	Average: 3	Good
	7.1 General	5	Excellent

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Crt. no.	Requirement EN ISO 3834-2**	Audit 09.2022	
		Score awarded*	Rating
	7.2 Welders and welding operators	2	Satisfactory
	7.3 Welding coordination personnel	2	Satisfactory
4.	8 Inspection and testing personnel	Average: 2.5	Satisfactory
	8.1 General	1	Unsatisfactory
	8.2 Non-destructive testing personnel	4	Very well
5.	9 Equipment	Average: 3.6	Good
	9.1 Production and test equipment	5	Excellent
	9.2 Description of production equipment	4	Very well
	9.3 Suitability of equipment	2	Satisfactory
	9.4 New equipment	5	Excellent
	9.5 Maintenance of equipment	2	Satisfactory
6.	10 Welding and related activities	Average: 2.6	Satisfactory
	10.1 Production planning	1	Unsatisfactory
	10.2 Welding procedure specifications	5	Excellent
	10.3 Qualification of the welding procedures	1	Unsatisfactory
	10.4 Work instructions	5	Excellent
	10.5 Procedures for preparation and control of documents	1	Unsatisfactory
7.	11 Welding consumables	Average: 4.5	Very well
	11.1 General	5	Excellent
	11.2 Batch testing	Not applicable	-
	11.3 Storage and handling	4	Very well
8.	12 Storage of parent materials	Average: 5	Excellent
	12 Storage of parent materials	5	Excellent
9.	13 Post-weld heat treatment	Not applicable	-
	13 Post-weld heat treatment	Not applicable	-
10.	14 Inspection and testing	Average: 3.2	Good
	14.1 General	2	Satisfactory
	14.2 Inspection and testing before welding	2	Satisfactory
	14.3 Inspection and testing during welding	5	Excellent
	14.4 Inspection and testing after welding	2	Satisfactory
	14.5 Inspection and test status	5	Excellent
11.	15 Non-conformance and corrective actions	Average: 2	Satisfactory
	15 Non-conformance and corrective actions	2	Satisfactory
12.	16 Calibration and validation of measuring, inspection and test equipment	Average: 2	Satisfactory
	16 Calibration and validation of measuring, inspection and test equipment	2	Satisfactory

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Crt. no.	Requirement EN ISO 3834-2**	Audit 09.2022	
		Score awarded*	Rating
13.	17 Identification and traceability	Average: 1	Unsatisfactory
	17 Identification and traceability	1	Unsatisfactory
14.	18 Quality records	Average: 2	Satisfactory
	18 Quality records	2	Satisfactory
TOTAL:		Average: 2.93	Satisfactory

* the average is the arithmetic mean, rounded to two decimal places, of the scores awarded to each sub-requirement

** the requirement number is in accordance with the standard

Table 5. Scores and grades obtained by PS SRL following the audit carried out in September 2022 - ISO 9001 standard audited

Crt. no.	ISO 9001 requirement	Audit 09.2022	
		Points awarded	Qualification
1.	4 Context of the organization	Average: 2.75	Satisfactory
	4.1 Understanding the organization and its context	2	Satisfactory
	4.2 Understanding the needs and expectations of interested parties	2	Satisfactory
	4.3 Determining the scope of the quality management system	5	Excellent
	4.4 Quality management system and its processes	2	Satisfactory
2.	5 Leadership	Average: 3.67	Good
	5.1 Leadership and commitment	5	Excellent
	5.2 Policy	5	Excellent
	5.3 Organizational roles, responsibilities and authorities	1	Unsatisfactory
3.	6 Planning	Average: 5	Excellent
	6.1 Actions to address risks and opportunities	5	Excellent
	6.2 Quality objectives and planning to achieve them	5	Excellent
	6.3 Planning of changes	5	Excellent
4.	7 Support	Average: 3.4	Good
	7.1 Resources	Title	-
	7.1.1 General	5	Excellent
	7.1.2 People	5	Excellent
	7.1.3 Infrastructure	1	Unsatisfactory
	7.1.4 Environment for the operation of processes	4	Very well

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Crt. no.	ISO 9001 requirement	Audit 09.2022	
		Points awarded	Qualification
	7.1.5 Monitoring and measuring resources	2	Satisfactory
	7.1.6 Organizational knowledge	5	Excellent
	7.2 Competence	4	Very well
	7.3 Awareness	2	Satisfactory
	7.4 Communication	5	Excellent
	7.5 Documented information	1	Unsatisfactory
	8 Operation	Average: 3.36	Good
5.	8.1 Operational planning and control	2	Satisfactory
	8.2 Requirements for products and services	1	Unsatisfactory
	8.3 Design and development of products and services	Not applicable	-
	8.4 Control of externally provided processes, products and services	5	Excellent
	8.5 Production and service provision	Title	-
	8.5.1 Control of production and service provision	1	Unsatisfactory
	8.5.2 Identification and traceability	1	Unsatisfactory
	8.5.3 Property belonging to customers or external providers	5	Excellent
	8.5.4 Preservation	5	Excellent
	8.5.5 Post-delivery activities	5	Excellent
	8.5.6 Control of changes	5	Excellent
	8.6 Release of products and services	5	Excellent
	8.7 Control of nonconforming outputs	2	Satisfactory
	9 Performance evaluation	Average: 5	Excellent
6.	9.1 Monitoring, measurement, analysis and evaluation	5	Unsatisfactory
	9.2 Internal audit	5	Excellent
	9.3 Management review	5	Unsatisfactory
7.	10 Improvement	Average: 5	Excellent
	10.1 General	5	Excellent
	10.2 Nonconformity and corrective action	5	Excellent
	10.3 Continual improvement	5	Excellent
TOTAL:		Average: 4.03	Very well

Based on the information in Tables 4 and 5, for an easy comprehension, graphs representing the variations of the averages obtained on each ISO 3834-2 requirement, Figure 3, respectively ISO 9001 audited, Figure 4, have been elaborated.

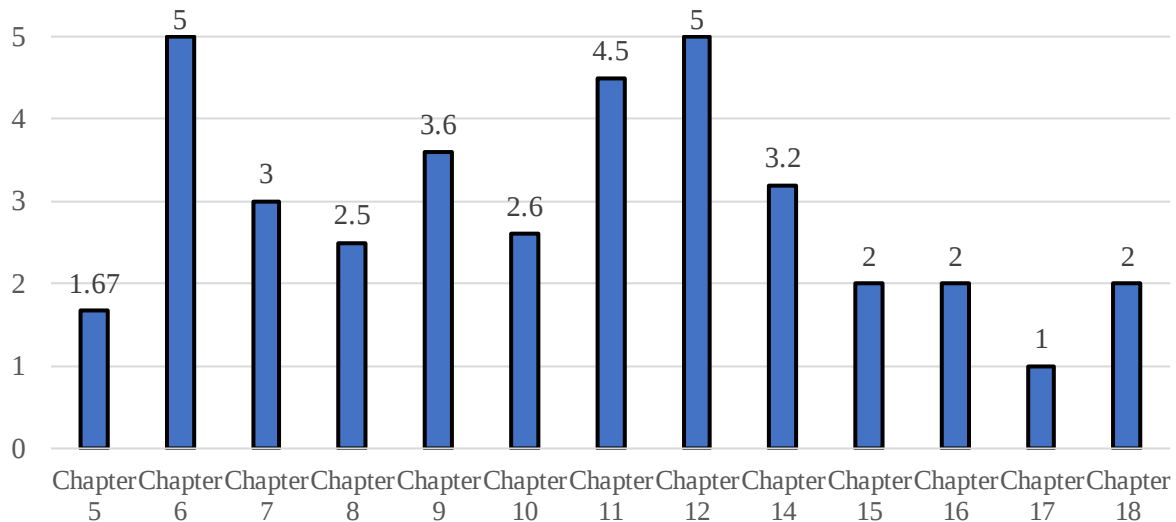


Figure 3. Graphical representation of the averages obtained on each requirement
- ISO 3834-2 standard

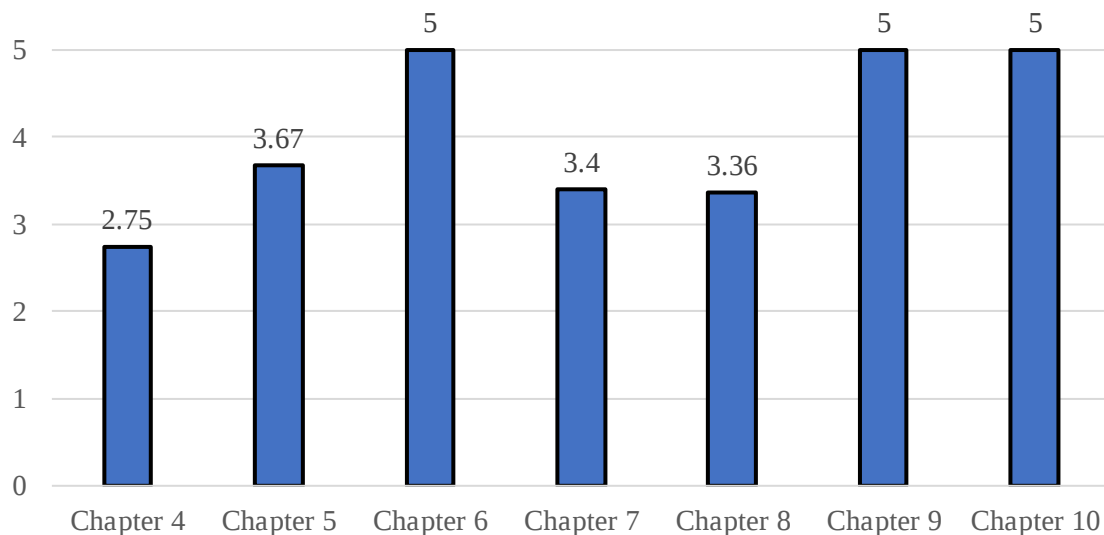


Figure 4. Graphical representation of the averages obtained on each requirement
- ISO 9001 standard

Following the audit, the audit team and the auditee's management determined the corrective actions, time periods allocated and responsibilities, as indicated in Table 6, needed to be taken to implement the recommendations made and to remove the non-conformities found.

Table 6. Corrective measures resulting from the audit carried out in September 2022

Crt. no.	Description of recommendations and non-conformities	Corrective measures
1	It is recommended to update the welder's job description with current welder qualification requirements	Job descriptions will be updated with current welder qualification requirements Responsible: HR Deadline: 2 months
2	It is recommended to consider the possibility of changing the position of Mr. M. L., welding coordinator, from mechanical engineer to welding engineer, COR code 214496	Change the position of Mr. M.L. welding coordinator from mechanical engineer to welding engineer, COR code 214496 Responsible: HR Deadline: 2 months
3	It is recommended that a level 2 visual inspection (VT) course to be carried out by the person in charge of dimensional inspection, Mr. T. C.	Identifying a training provider for visual inspection course The necessary budget will be allocated The course will be attended by Mr. T.C. Responsible: welding coordinator, general manager, welding manager Deadline: 6 months
4	It is recommended to examine the technical and financial feasibility of mechanizing the welding process.	The possibility of mechanizing the welding process will be analyzed: identification of suppliers, cost-benefit analysis Responsible: production manager, general manager Deadline: 10 months
5	It is recommended to draw up a checklist of maintenance activities in accordance with requirement 9.5 of ISO 3834-2 in conjunction with the technical books of the welding equipment.	The technical books of the welding equipment will be analyzed and a checklist will be drawn up for the maintenance activity. Responsible: production manager Deadline: 3 months
6	It is recommended that a range of process parameter values to be identified on the welding procedure qualification certificate (according to ISO 15614:2005 chapter 4).	The certification body shall be requested to update the welding procedure qualification certificate. Responsible: welding coordinator Deadline: 2 months
7	It is recommended that Personnel procedure code PI-7.1.2 shall contain more accurate references to the management of welder/welding operator qualification certificates	Revise personnel procedure code PI-7.1.2 with more accurate references regarding how to manage welder/welding operator qualification certificates. Responsible: HR, Production Manager Deadline: 2 months
8	It is recommended to include the Manufacturing Register in the management system	Revise procedure code PC-8.5 Product and Service Provision Control on the inclusion of the Manufacturing Register Responsible: quality manager Deadline: 2 months

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Crt. no.	Description of recommendations and non-conformities	Corrective measures
9	Welding material distribution form should be used when handing over welding consumables to welders	Train the staff involved in the use of the welding material distribution form when handing over welding consumables to welders. Responsible: quality manager Deadline: 2 months
10	More accurate occupational safety and health signaling in the production area is recommended	Occupational safety and health signaling will be remade in the production area Responsible: occupational safety and health officer Deadline: 2 months
11	It is recommended that visual examination reports should contain clear identification of the product examined, e.g. No 015 / 18.02.2022 contains no reference to the product code examined, C2	Train staff carrying out visual examination of products on the clear identification of the products examined in the reports issued Responsible: quality manager Deadline: 3 months
12	Customer project, e.g. drawing WP1800-01 is incomplete in terms of butt welds and non-destructive examination	The client will be requested to update the designs submitted for execution with all the necessary information, including butt welds and how to carry out non-destructive examination. Responsible: director general Deadline: 6 months
13	Changes to the project made by the client are identified without control, with no approval other than that of the position making the change available	The client's opinion will be sought whenever a change to the project is required Responsible: production manager Deadline: when applicable
14	Technical requirements analysis sheet not available	Train technical staff on the use of the technical requirements analysis sheet Responsible: quality manager Deadline: 1 month
15	No evidence available on training of welders/welding operators with WPS	Welders/welding operators will be trained with WPS and training minutes will be issued Responsible: welding coordinator Deadline: 1 month
16	The job description of mechanical engineer M.L. (welding coordinator) is not signed, not approved, the job description should not be approved by the technical director but by the general manager, the tasks are not clearly specified according to ISO 14731:2019, the appointment decision with specific tasks and responsibilities for the welding coordination activity is not available.	Mr. M. L.'s job description will be revised in accordance with the observations raised in the non-compliance Responsible: HR Deadline: 2 months
17	The decision to appoint a dimensional inspection officer (T. C.) is not available	A decision will be drawn up appointing the person responsible for dimensional inspection Responsible: HR, Production Manager Deadline: 2 months

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Crt. no.	Description of recommendations and non-conformities	Corrective measures
18	According to the organization chart / 01.03.2022 CTC control activity is not independent from production (according to ISO 17635:2016)	The organization chart will be revised by ensuring the independence of the CTC control activity from production (it will be subordinated to the General Director) Responsible: HR, General Director Deadline: 2 months
19	No evidence of calibration of welding equipment available (those purchased in June 2021)	Welding equipment will be calibrated Responsible: production manager Deadline: 3 months
20	The Equipment Preventive Maintenance Plan / 2022 does not contain the planning of these activities	Review the preventive maintenance plan for welding equipment on the clear planning of their maintenance Responsible: production manager Deadline: 2 months
21	Welding map not available	Welding map will be drawn up Responsible: welding coordinator Deadline: 1 month
22	Welding process tracking sheet NF 015 C2 / 23.06.2022 is incomplete, missing weld seam identification and missing process parameters on each part	Welding process tracking sheets will be completed for all fields Responsible: welding manager, welding coordinator Deadline: 2 months
23	Product tracking sheet is not completed on time (before the start of production) but after the processes in the organization, not all fields are completed, e.g. planned date	Training staff involved on how to complete the product tracking sheet Responsible: quality manager Term: 1 month
24	Stainless steel welds are made in production without qualification procedure and welder qualification	Stainless steel will no longer be used as a base material for certain components Responsible: production manager Deadline: immediately
25	WPQR qualified by certificate 01 202 RO/V-22 0041 / 14.03.2022 is incorrectly defined, e.g. DC to polarity - instead of AC for procedure 141	The error will be forwarded to the certification body for WPQR review Responsible: welding coordinator Deadline: immediately
26	In the Documented Information procedure there are no references to the development and control of WPS, WPQR	Review procedure Documented information with reference to the development and control of WPS, WPQR Responsible: quality manager Deadline: 2 months
27	List of applicable external documents / 10.02.2022 does not contain references to external documents applicable to welding and related processes	List of applicable external documents will be updated with references to external documents applicable to welding and related processes Responsible: HR Deadline: 2 months
28	The quality plan is not correctly drawn up (it is a flow chart of the production process without all the inspection and testing steps and related documents issued)	The quality plan will be properly drawn up Responsible: quality manager, production manager Deadline: 2 months

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Crt. no.	Description of recommendations and non-conformities	Corrective measures
29	Measurement sheet / 02.05.2022 for cutting and rolling is not signed by the responsible C. I.	Training staff involved on the need to sign the measurement sheets Responsible: quality manager Deadline: 2 months
30	At the time of the audit the frequency of visual inspection is not adequate	The frequency of the visual inspection will be modified according to the customer's requirements Responsible: quality manager, welding coordinator Deadline: 2 months
31	No non-conformity reports are completed, e.g. corner weld crack, product PS 026-L3S2 etc.	Welding coordinator will be trained on how to complete non-conformance reports when defects / imperfections are identified Responsible: quality manager Deadline: 1 month
32	No calibration certificates are available for measuring equipment used during the welding process, e.g. for welding fixture series 4830, welding template series 4832-1, ruler	Identify all measuring equipment used in the welding process that does not have calibration certificates and perform calibration Responsible: quality manager, welding manager Deadline: 2 months
33	No evidence of maintaining identification and traceability throughout the manufacturing process, e.g. for parts starting with the cutting process	Training staff involved on the need to maintain proof of identification and traceability throughout the manufacturing process Responsible: quality manager Deadline: 1 month
34	No decision or procedure on transfer of the marking available	A procedure will be drawn up for the transfer of the marking Responsible: quality manager, production manager Deadline: 2 months
35	In the Delivery / Receipt in Production / 29.04.2022 for the metal sheet, the batch recorded (batch no. 80078453) is not found in the material certificate.	Training the supply manager on proper verification of material certificates when receiving materials Responsible: quality manager Deadline: 2 months
36	Incomplete files containing quality records identified, e.g. missing product tracing file	Training the quality manager and production manager on the content of product information file Responsible: director general Deadline: 1 month
37	The organizational context and the needs and expectations of stakeholders regarding the welding process are not clearly identified, e.g. suppliers of filler materials generating risks with negative effect on delivery times or impossibility of delivery,	The organizational context and stakeholder needs and expectations will be more clearly identified in the risk register Responsible: quality manager Deadline: 2 months

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Crt. no.	Description of recommendations and non-conformities	Corrective measures
	availability of personnel on the labor market, etc.	
38	The organization's process matrix does not contain clearly defined the welding process, e.g. incomplete input/output elements	Complete all elements of the welding process in the process matrix Responsible: quality manager Deadline: 2 months

Given that the maximum implementation deadline for the measures indicated in Table 6 was 6 months (point 12 of the table), a new audit was carried out in April 2023 at the same organization, the purpose of which was to assess the implementation of the corrective measures established after the September 2022 audit. An audit of the same requirements as in the previous audit was conducted: 14 requirements with 31 applicable sub-requirements according to EN ISO 3834-2:2021 and 39 requirements and sub-requirements according to EN ISO 9001:2015 excepting requirement 8.3 Design and development of products and services which is excluded as the execution project is provided by the client.

For the April 2023 audit, the audit team consisted of 4 members, the 3 who were part of the first team, to which an additional technical expert was co-opted.

Table 7 presents the recommendations (identified in the table with italic text) and non-conformities of the audit conducted in April 2023 (ordered according to EN ISO 3834-2 requirements), including the audit criteria against which non-conformities and/or recommendations were identified.

Table 7. Recommendations and non-conformities of the audit carried out in April 2023

Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
1	It is recommended to update the organization chart concerning quality control and welding engineer (coordinator) reporting directly to the General Director	8.1	5.3
2	It is recommended to draw up a checklist of maintenance activities in accordance with requirement 9.5 of ISO 3834-2 in conjunction with the technical books of welding equipment.	9.5	7.5.1
3	It is recommended to update procedure PC-8.5 on how to draw up the product tracking sheet (who does it, when it is done, based on which documents it is fulfilled), etc.	10.1	8.5.1 a
4	Noise and suspended particles determinations should be carried out in the production/welding area	10.1 g	8.5.1 c
5	It is recommended that Personnel procedure code PI-7.1.2 should contain more accurate references to the	10.5	7.5.2

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Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
	management of welder/welding operator qualification certificates		
6	It is recommended to implement verification measures, before welding, for the welding working conditions regarding environmental and worker safety as follows: - better anchoring of gas cylinders in individual racks without the possibility of knocking; - it is recommended to consider and implement special safety measures for welders in welding positions requiring knee contact with the ground; - it is recommended to mount a capture funnel at the mouth of the exhaust system above the welding area - it is recommended to draw up a welding process operational control checklist specific to Health and Safety, e.g., welders performing operations other than those specified in the job description, specific verifications before starting work (personal protective equipment, work equipment, etc.), etc. - clear demarcation of drilling/welding working areas for easy and safe access to the workplace is recommended	14.2 h	7.1.4
7	It is recommended to check the gas nozzle charge level periodically, e.g. every 2 hours of actual work.	14.3	8.5.1 c
8	It is recommended to brainstorm on the traceability of the marking based on the risks generated by traceability	17	8.5.2
9	It is recommended to have the rules for personal protective equipment provision available	18 n	8.1 e
10	It is recommended that the organization's process matrix should contain a more clearly defined welding process	-	4.4
11	Not all welded construction projects are available, e.g. C4 chamber	5.1	8.2.2
12	No evidence available on training of welders/welding operators with WPS	7.2	7.3
13	Welding process tracking sheet 006C3 SPL / 10.03.2023 is incomplete, missing weld bead identification and missing process parameters on each part	10.1	8.5.1 a
14	In the Documented Information procedure there are no references to the development and control of WPS, WPQR	10.5	7.5.3
15	Before welding begins, the welding working conditions (including the environment, the safety of welding personnel and other participants in the production process) are not properly checked, e.g. - there is no specially designed space with limited access for hazardous chemicals;	14.2 h	7.1.4

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Crt. no.	Description of recommendations and non-conformities	Unfulfilled requirement	
		EN ISO 3834-2	EN ISO 9001:2015
	- there is a P50 fire extinguisher in the production/welding area which is inaccessible in case of emergency; - non-metallic waste and chemicals are stored in the drilling/welding process preparation area; - in the drilling/welding process preparation area the operator does not wear safety glasses while performing the drilling operation; - there is no evidence of up-to-date verification of the earthing installation, e.g. bulletin no. 987 / 15.07.2021 is available; - safety signage of the presence of fire extinguishers and sanitary kits (specific pictograms) in the production/welding area is not available.		
16	At the time of the audit the frequency of visual inspection is not adequate	14.4	8.5.1 c
17	No non-conformity reports are completed, e.g. lack of fusion and continuity, pores etc.	15	8.7.2
18	No decision or procedure on transfer of the marking available	17	8.5.2
19	The organizational context and the needs and expectations of stakeholders regarding the welding process are not clearly identified, e.g. suppliers of filler materials generating risks with negative effect on delivery times or impossibility of delivery, availability of personnel on the labor market etc.	-	4.1, 4.2

Tables 8 and 9 present the scores obtained from the analysis of recommendations and non-conformities identified for each ISO 3834-2 and ISO 9001 requirement audited in September 2022 and April 2023.

NOTE: In Table 8 the positive evolution of the score awarded or the rating is identified with green color, the stagnation with blue and negative evolution with red.

Figures 5 and 6 represent graphically the averages obtained on each ISO 3834-2 and ISO 9001 requirement audited in September 2022 and April 2023.

Table 8. Scores obtained from audits carried out in September 2022 and April 2023 on each ISO 3834-2 requirement audited

No.	ISO 3834-2 requirement	Audit 09.2022		Audit 04.2023	
		Score awarded	Rating	Score awarded	Rating
1.	5 Review of requirements and technical review	Average: 1.67	Unsatisfactory	Average: 4	Very well
	5.1 General	1	Unsatisfactory	2	Satisfactory
	5.2 Review of requirements	2	Satisfactory	5	Excellent
	5.3 Technical review	2	Satisfactory	5	Excellent
2.	6 Sub-contracting	Average: 5	Excellent	Average: 5	Excellent
	6 Sub-contracting	5	Excellent	5	Excellent
3.	7 Welding personnel	Average: 3	Good	Average: 4	Very well
	7.1 General	5	Excellent	5	Excellent
	7.2 Welders and welding operators	2	Satisfactory	2	Satisfactory
	7.3 Welding coordination personnel	2	Satisfactory	5	Excellent
4.	8 Inspection and testing personnel	Average: 2.5	Satisfactory	Average: 4.5	Very well
	8.1 General	1	Unsatisfactory	4	Very well
	8.2 Non-destructive testing personnel	4	Very well	5	Excellent
5.	9 Equipment	Average: 3.6	Good	Average: 4.8	Very well
	9.1 Production and test equipment	5	Excellent	5	Excellent
	9.2 Description of production equipment	4	Very well	5	Excellent
	9.3 Suitability of equipment	2	Satisfactory	5	Excellent
	9.4 New equipment	5	Excellent	5	Excellent
	9.5 Maintenance of equipment	2	Satisfactory	4	Very well
6.	10 Welding and related activities	Average: 2.6	Satisfactory	Average: 3.8	Good
	10.1 Production planning	1	Unsatisfactory	2	Satisfactory
	10.2 Welding procedure specifications	5	Excellent	5	Excellent

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No.	ISO 3834-2 requirement	Audit 09.2022		Audit 04.2023	
		Score awarded	Rating	Score awarded	Rating
	10.3 Qualification of the welding procedures	1	Unsatisfactory	5	Excellent
	10.4 Work instructions	5	Excellent	5	Excellent
	10.5 Procedures for preparation and control of documents	1	Unsatisfactory	2	Satisfactory
7.	11 Welding consumables	Average: 4.5	Very well	Average: 5	Excellent
	11.1 General	5	Excellent	5	Excellent
	11.2 Batch testing	Not applicable	-	Not applicable	-
	11.3 Storage and handling	4	Very well	5	Excellent
8.	12 Storage of parent materials	Average: 5	Excellent	Average: 5	Excellent
	12 Storage of parent materials	5	Excellent	5	Excellent
9.	13 Post-weld heat treatment	Not applicable	-	Not applicable	-
	13 Post-weld heat treatment	Not applicable	-	Not applicable	-
10.	14 Inspection and testing	Average: 3.2	Good	Average: 3.6	Good
	14.1 General	2	Satisfactory	5	Excellent
	14.2 Inspection and testing before welding	2	Satisfactory	2	Satisfactory
	14.3 Inspection and testing during welding	5	Excellent	4	Very well
	14.4 Inspection and testing after welding	2	Satisfactory	2	Satisfactory
	14.5 Inspection and test status	5	Excellent	5	Excellent
11.	15 Non-conformance and corrective actions	Average: 2	Satisfactory	Average: 2	Satisfactory
	15 Non-conformance and corrective actions	2	Satisfactory	2	Satisfactory
12.	16 Calibration and validation of measuring, inspection and test equipment	Average: 2	Satisfactory	Average: 5	Excellent

No.	ISO 3834-2 requirement	Audit 09.2022		Audit 04.2023	
		Score awarded	Rating	Score awarded	Rating
	16 Calibration and validation of measuring, inspection and test equipment	2	Satisfactory	5	Excellent
13.	17 Identification and traceability	Average: 1	Unsatisfactory	Average: 2	Satisfactory
	17 Identification and traceability	1	Unsatisfactory	2	Satisfactory
14.	18 Quality records	Average: 2	Satisfactory	Average: 4	Very well
	18 Quality records	2	Satisfactory	4	Very well
TOTAL:		Average: 2.93	Satisfactory	Average: 4.05	Very well

From the analysis of Table 8 one can observe that out of a total of 13 requirements, 4 were constant and 9 had a positive evolution, and out of a total of 31 sub-requirements, 13 remained constant, 17 had a positive evolution, one (14.3 Inspections and tests during welding) showed an involution.

In terms of average scores, it was found that all of them increased, even reaching the maximum value of 3 in the case of requirement 16 Calibration and validation of measuring, inspection and test equipment.

Table 9. Scores obtained from audits carried out in September 2022 and April 2023 on each ISO 9001 requirement audited

Crt. no.	ISO 9001 requirement	Audit 09.2022		Audit 04.2023	
		Points awarded	Qualification	Points awarded	Qualification
1.	4 Context of the organization	Average: 2.75	Satisfactory	Average: 3.25	Good
	4.1 Understanding the organization and its context	2	Satisfactory	2	Satisfactory
	4.2 Understanding the needs and expectations of interested parties	2	Satisfactory	2	Satisfactory
	4.3 Determining the scope of the quality management system	5	Excellent	5	Excellent

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Crt. no.	ISO 9001 requirement	Audit 09.2022		Audit 04.2023	
		Points awarded	Qualification	Points awarded	Qualification
	4.4 Quality management system and its processes	2	Satisfactory	4	Very well
2.	5 Leadership	Average: 3.67	Good	Average: 4.67	Very well
	5.1 Leadership and commitment	5	Excellent	5	Excellent
	5.2 Policy	5	Excellent	5	Excellent
	5.3 Organizational roles, responsibilities and authorities	1	Unsatisfactory	4	Very well
3.	6 Planning	Average: 5	Excellent	Average: 5	Excellent
	6.1 Actions to address risks and opportunities	5	Excellent	5	Excellent
	6.2 Quality objectives and planning to achieve them	5	Excellent	5	Excellent
	6.3 Planning of changes	5	Excellent	5	Excellent
4.	7 Support	Average: 3.4	Good	Average: 3.8	Good
	7.1 Resources	Title	-	Title	-
	7.1.1 General	5	Excellent	5	Excellent
	7.1.2 People	5	Excellent	5	Excellent
	7.1.3 Infrastructure	1	Unsatisfactory	5	Excellent
	7.1.4 Environment for the operation of processes	4	Very well	2	Satisfactory
	7.1.5 Monitoring and measuring resources	2	Satisfactory	2	Satisfactory
	7.1.6 Organizational knowledge	5	Excellent	5	Excellent
	7.2 Competence	4	Very well	5	Excellent
	7.3 Awareness	2	Satisfactory	2	Satisfactory
	7.4 Communication	5	Excellent	5	Excellent
	7.5 Documented information	1	Unsatisfactory	2	Satisfactory
5.	8 Operation	Average: 3.36	Good	Average: 3.73	Good

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Crt. no.	ISO 9001 requirement	Audit 09.2022		Audit 04.2023	
		Points awarded	Qualification	Points awarded	Qualification
	8.1 Operational planning and control	2	Satisfactory	4	Very well
	8.2 Requirements for products and services	1	Unsatisfactory	2	Satisfactory
	8.3 Design and development of products and services	Not applicable	-	Not applicable	-
	8.4 Control of externally provided processes, products and services	5	Excellent	5	Excellent
	8.5 Production and service provision	Title	-	Title	-
	8.5.1 Control of production and service provision	1	Unsatisfactory	1	Unsatisfactory
	8.5.2 Identification and traceability	1	Unsatisfactory	2	Satisfactory
	8.5.3 Property belonging to customers or external providers	5	Excellent	5	Excellent
	8.5.4 Preservation	5	Excellent	5	Excellent
	8.5.5 Post-delivery activities	5	Excellent	5	Excellent
	8.5.6 Control of changes	5	Excellent	5	Excellent
	8.6 Release of products and services	5	Excellent	5	Excellent
	8.7 Control of nonconforming outputs	2	Satisfactory	2	Satisfactory
6.	9 Performance evaluation	Average: 5	Excellent	Average: 5	Excellent
	9.1 Monitoring, measurement, analysis and evaluation	5	Unsatisfactory	5	Unsatisfactory
	9.2 Internal audit	5	Excellent	5	Excellent
	9.3 Management review	5	Unsatisfactory	5	Unsatisfactory
7.	10 Improvement	Average: 5	Excellent	Average: 5	Excellent
	10.1 General	5	Excellent	5	Excellent

Crt. no.	ISO 9001 requirement	Audit 09.2022		Audit 04.2023	
		Points awarded	Qualification	Points awarded	Qualification
	10.2 Nonconformity and corrective action	5	Excellent	5	Excellent
	10.3 Continual improvement	5	Excellent	5	Excellent
TOTAL:		Average: 4.03	Very well	Average: 4.35	Very well

From the analysis of Table 9 one can observe that out of a total of 7 requirements, 5 were constant and 2 had a positive evolution, and out of a total of 37 sub-requirements, 28 remained constant, 8 had a positive evolution, one (7.1.4 Process operating environment) showed an involution. In terms of average scores, it was found that they have remained constant or increased, even reaching a maximum value of 5 for Requirement 6 Planning.

The graphical representation of the comparison of the averages for each requirement in the case of EN ISO 3834-2 is presented in Figure 5.

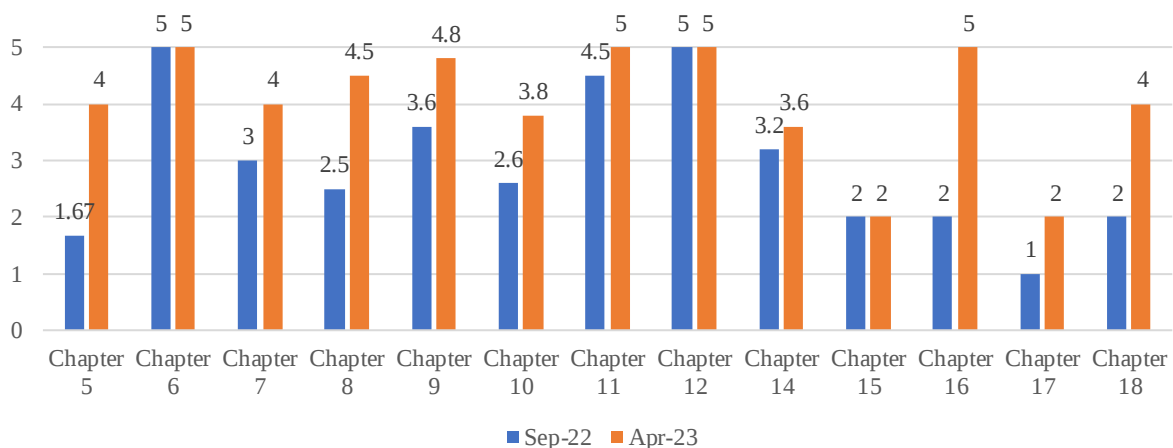


Figure 5. Graphical representation of the averages obtained on each ISO 3834-2 requirement audited in September 2022 and April 2023

The graphical representation of the comparison of the averages for each requirement in the case of EN ISO 9001 is presented in Figure 6.

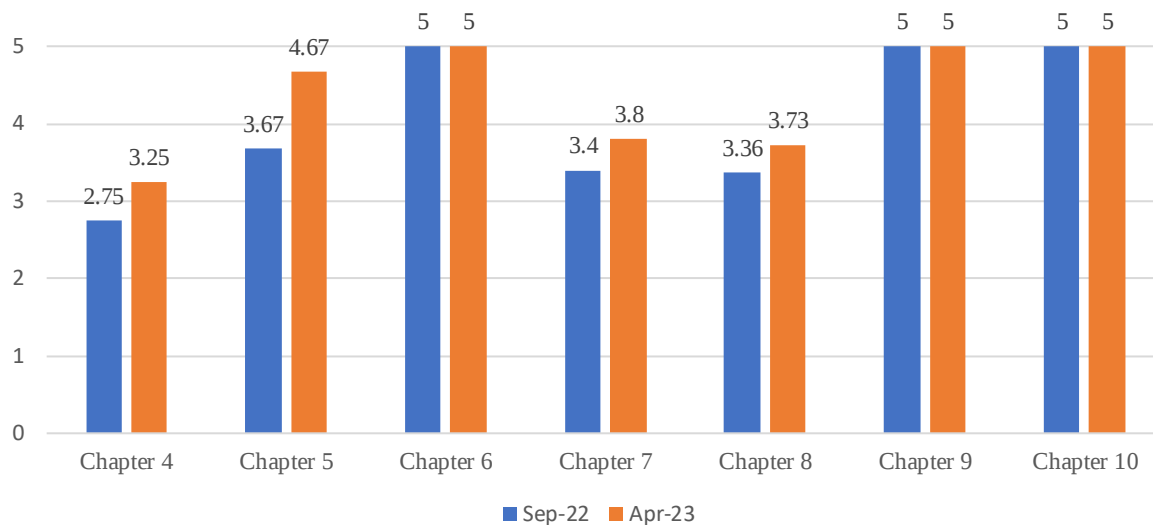


Figure 6. Graphical representation of the averages obtained on each ISO 9001 requirement audited in September 2022 and April 2023

3. CONCLUSIONS

Based on the theoretical research, the audits carried out, the results obtained and their interpretation, the following conclusions can be drawn:

- general
 - ✓ The process of implementing, maintaining and improving a quality management system leads to better oversight of the processes carried out within the organization.
 - ✓ The process of implementing, maintaining and improving a quality management system involves a number of activities, including internal auditing;
 - ✓ In order to obtain adequate results, the internal audit is recommended to be carried out by an internal audit team which may include, in addition to a lead auditor, technical experts in the audited area.
 - ✓ There are several standards against which a management system can be implemented
 - ✓ If recommendations and non-conformities are identified during the audit, a list of recommendations/measures to reduce or eliminate them should be drawn up
- valid under the conditions of the research:

- ✓ The April 2023 audit revealed that the organization had implemented 81.8% of the recommendations suggested in the September 2022 audit and had removed 74.1% of the non-conformities identified in the same audit.
- ✓ An increase in the average score for EN ISO 3834-2 requirements from 2.93 in the September 2022 audit to 4.05 in the April 2023 audit, and by default in the rating from "satisfactory" to "very good", was identified.
- ✓ An increase in the average score for EN ISO 9001 requirements was identified, from 4.03 in the September 2022 audit to 4.35 in the April 2023 audit, the rating remained at "very good".
- ✓ Satisfactory rating for requirements 15. Non-conformities and corrective actions respectively 17. Identification and traceability of ISO 3834-2 require an improvement of these processes.
- ✓ Substantial increase in the qualification requirements 5. Requirements analysis and technical analysis (by 58.25%), 8. Inspection and testing staff (by 44.44%), 16. Calibration and validation of measuring, inspection and testing equipment (by 60%) and 18. Quality records (by 50%) of ISO 3834-2 indicate an effective implementation of the measures proposed after the first audit in the organization.
- ✓ With reference to the EN ISO 9001 reference, the audited company has implemented the proposed solutions, but did not maintain the level identified in the first audit for one of the sub-queries, 7.1.4 Environment for the operation of processes, which led to the change of the rating from Very good to Satisfactory.
- ✓ With reference to EN ISO 3834, the audited company has implemented the proposed solutions, but did not maintain the level identified in the first audit for one of the sub-queries, 14.3 Welding inspection and testing, which led to the change of the rating from Excellent to Very good.

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