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INDICATORS BASED ON SERVICE VERIFICATION SHEETS: CASE STUDY IN VERTICAL BUILDINGS

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Abstract: Planning and control are essential management activities for the success of the construction industry market. Continuous monitoring and monitoring of the development of a project must be carried out by professionals who actively participate in its execution, supporting the obtaining of process feedback indicators and advances in improving productivity. This study aims to verify the contribution of the data contained in the Service Verification Sheets (FVS's) to the development of indicators that serve as input for planning the execution of a vertical building. To this end, the documents completed during the verification of services relating to the fronts of hydro-sanitary installations were analyzed. Through the analysis carried out, it was verified that there were absences/deficiencies in the details of the projects, inadequacies in filling out the inspection documents and inefficiency of the FVS used to verify the services. From the analyzes obtained, it appears that important steps were neglected, important necessary checks were not inspected and, due to the lack of/deficient training and qualifications of the quality management team, inadequacies and subjectivity were detected in filling out the documents.
Keywords: indicators, management, planning.

INTRODUCTION

The success of a company is directly associated with the effectiveness of its management, in the sense of making assertive decisions, generating the minimum possible impact. In general, businesspeople have become convinced that a company's mission, vision, values and strategies are of no use if these concepts are not connected to the processes and procedures practiced internally. And this is where the discussion of planning and management comes in.

These sectors and their activities are fundamental for any company or project, as in addition to allowing the direction of the business, aligned with the company's strategies, it also provides the development of people and the collaborative integration of these interfaces, in an increasingly detailed and detailed. Through this perception, administrators continually direct their efforts in order to guarantee the lowest production and operating costs for a company. This can be achieved efficiently through the tools made available by planning and quality management.

Planning is not just transcribing project ideas into a formal document. It means optimizing everything you intend to do as much as possible, in order to support the decisions that must be made to accurately guarantee the objective. Until this objective is achieved, it is usually necessary to monitor and review points that were not sufficiently foreseen. Furthermore, through indicators, a primary tool for management and control, the manager, with due analysis, interpretation and monitoring, will make decisions that will influence the business.

The level of detail in projects, the reduction in profit margin and the difficulty in adhering to new construction methods are limiting factors, but they are not the most likely causes of business planning errors. It can be considered that these demands constitute factors that lead to the development of efficient planning, as a tool to support decision-making regarding the project. Thus, the manager must use planning to define the execution and monitoring roadmap, allowing the allocated resources to be effectively managed (LEITE, 2012).

Considering that the preparation of planning influences and directly impacts the control of the quality of services and, therefore, the overall performance of a project, there is a need to develop studies that contemplate the scenario of execution of services in works, their inadequacies and the limitations of inspection procedures.

This work aims to verify the contribution of data compiled in the Service Verification Sheets (FVS) to the development of indicators that serve as input for planning the execution of a vertical building.

As specific objectives, it is also intended to study the inadequacies in filling out the FVS's applied to the execution fronts of aerial branches, as they portray higher rates of post-work calls from the analyzed company, map neglected steps in these executive processes, analyze by through indicators, the probable causes of the detected inadequacies, and, propose a new FVS that meets the inspection criteria.

THEORETICAL FOUNDATION

MANAGEMENT

Management is nothing more than directing, organizing, executing and developing projects with the aim of introducing innovations and changes, adding value, optimizing deadlines and resources. With this it is clear that the elaboration of a good project, with its current studies, investigations, effective planning and management, aligned with the commitment of everyone involved in the process, contribute to the success of any enterprise (SILVA, 2011).

Machado (2003) defines that the basic functions of production management systems are planning and control. While planning establishes the goals and the order that must be followed to achieve the objectives, control determines whether or not this order comes close to what was planned, directly influencing the knowledge to be used in the replanning and feedback stages.

Process clarity minimizes the occurrence of errors in production. Thus, control is simplified by eliminating visual objections and using indicators to improve the triggering of information in the work environment (GUTHEIL, 2004).

For Goldman (2004), the role of management becomes increasingly important. This role is definitive and monitors the work in its physical and financial aspects on a daily basis. This assignment is generally delegated to the direct manager of the work, who largely makes up one of the engineer's roles. The manager has the duty to indicate, throughout the execution phase, decisions and interferences that add productivity and gains in relation to viability.

PDCA CYCLE

Developed by WA Shewhart, the cycle called PDCA (*Plan, Do, Check and Action*), is an essential method for the Quality Management system and aims to organize and make the activities carried out by organizations more effective. It is applied to achieve results within a management system independent of the area of activity. Thus, it must be used to diagnose problems and seek solutions or to implement any change (JESUS, 2011).

Costa (2016) states that PDCA is a method that seeks to promote continuous improvements in the organization's activities, and can be applied to control its management. It is a sequence of logical procedures and is based on facts and data. In Figure 1, the PDCA Cycle is illustrated.

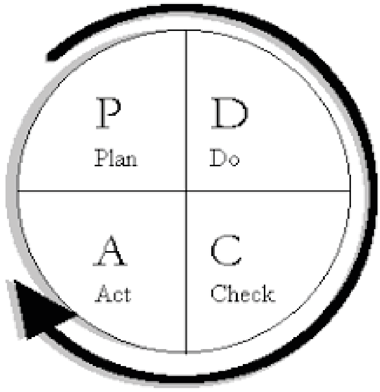

Figure 1 – PDCA Cycle. Source: Mattos (2013).

According to Jesus (2011), the PDCA cycle can be defined by the concepts *Plan,* establishing goals and their forms of execution; *Do* (execute), implementing the planning carried out; *Check,* checking through indicators, such as the use of FVS (Service Verification Sheets); *Action* corresponding to the correction of non-conformities found.

For Costa (2016), managing or controlling a process is the act of seeking the causes (means) of the impossibility of achieving a goal (end), establishing countermeasures (action plan) and standardizing in case of success.

PLANNING

Silva (2011) defines planning as a dynamic and continuous process that makes up a set of tactics for a future objective, with the purpose of providing advance decision-making. The measures adopted must be characterized in such a way that their implementation is more convenient, observing elements such as deadline, costs, quality and safety, among others.

Brandalise (2017) establishes planning as a means to discuss the best solutions to be practiced during the execution of a project, providing possible conditions for them to be practiced. The planning must also contain clear and succinct objectives, designed to guarantee a perfect direction of the actions adopted, without allowing uncertainty, attributing responsibility to each member of the process, ensuring effective supervision and increasing the team's efficiency.

Planning is the system that centralizes information and knowledge from the most diverse sectors of the company, so that this data can be fully applied in the construction process. According to the author, planning becomes necessary given the need to organize in a complex environment, which is the construction of a building (GOLDMAN, 2004).

For Machado (2003), planning justifies actions such as providing the interface of information according to its level of importance, creating and making available indicators that help in the management and control of production. According to the author, the act of planning includes judging the ideas implemented in a given space of time, ranging from initial measures to their implementation. Each trial is linked to a different time, according to the complexity and level of detail required. Furthermore, perfection in planning depends on the proposed hierarchy and the perfect synchronization with which it will be executed, always allowing a new decision to be made when the previous one is not being met.

According to Brandalise (2017), planning is characterized as an administrative task capable of designating goals and how to achieve them. And it is through this attribution that the administrator proposes the work of everyone who makes up the team, and they need to be trained to execute what was planned. Among the administrator's activities, planning is the one that has priority, as both management and direction depend on its monitoring.

Decision-making is the basis of the administrator's responsibility. The manager must continually decide what, who, when, where and how to do. The information essential for decision-making techniques is obtained through measurements. Measurement is the method by which one decides what to measure/process, and which data must be evaluated (LANTELME, 1994).

In the context of the construction industry, Brandalise (2017) states that planning represents a composition for execution, covering both programming and budget. The latter helps to interpret economic factors and the schedule, which directly affects execution productivity.

Goldman (2004) structures the entire planning system according to the flowchart shown in Figure 2.

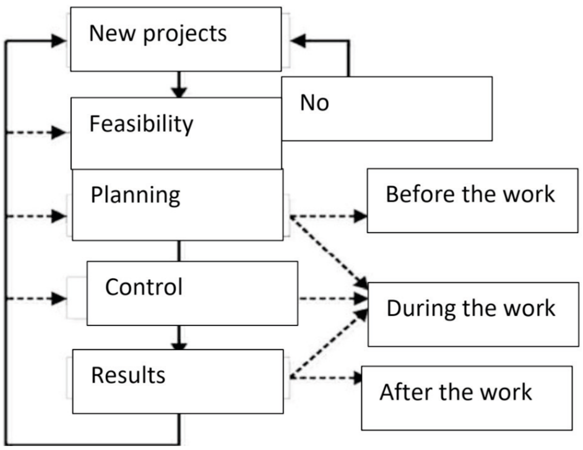

Figure 2 – Flowchart for preparing the planning. Source: Goldman (2004).

In the first two stages, Goldman (2004) assigns planning responsibility to the study and technical feasibility of the enterprise. In the next stage, planning, responsibility covers the technical part in more detail at two levels: one in advance, aimed at the complete elaboration of the execution schedule; and another, throughout execution, concerned with the reevaluation of initial planning information.

In the control stage, the main link is with monitoring the quality of planning, obtaining data and enabling effective control. Finally, in the results stage, the focus is on comparisons of control data with predicted results, allowing corrective actions to be carried out. In the latter, there is a gathering of information from the entire executive phase of the project to be used in new planning, a stage called feedback (GOLDMAN, 2004).

LONG, MEDIUM- AND SHORT-TERM PLANNING

The planning model highlighted by Brandalise (2017) presents three stages: preparation, planning and control and, finally, evaluation. The author also highlights that the planning and control stages are linked to long, medium and short-term cycles.

In civil construction, long-term cycles, based on the principle of productivity in the execution process, are the most influential. They present the entire period of the work as a perspective, aiming, as a general objective, to conceive its initial plan. These cycles cover tactical decisions, such as essential steps, execution plans and establishing the number of teams. It is in long-term planning that the standards in which the main production processes must be carried out are determined. Together with the budget data, the standards define a flow of expenses that must be consistent with the feasibility study carried out in the strategic planning phase of the enterprise (GUTHEIL, 2004).

According to Gutheil (2004), medium-term planning has as one of its principles the perception of limitations presents in the production environment in order to provide actions to avoid them, thus obtaining the reliability of short-term planning. For Brandalise (2017), medium-term planning is defined as development over a longer period of time, not requiring a detailed plan in relation to short-term planning. Its purpose is to assess the circumstances for the start or progress of activities that are being fully attended to and for debate, if there are difficulties, so that essential solutions can be planned.

Short-term planning must be carried out in order to protect production from uncertainties. We try to draw up plans with a high probability of being re-executed. Short-term planning has the function of directing the execution of the work, generally being carried out in weekly cycles, assigning physical resources to the tasks programmed in the medium-term planning (GUTHEIL, 2004).

For Brandalise (2017), the necessary adjustments are conditioned to verify compatibility, as well as available resources, team efficiency and performance of deadlines and costs. It must be used to attract the manager's attention, in order to determine whether the plan is being implemented, bringing immediate solutions, so that the result is achieved in the future.

PRODUCTIVITY

It is with planning that the manager will properly control the business. This way, data is obtained that will allow the analysis of the processes involved. In the construction industry, productivity control is important monitoring data, as it is directly related to time management, a step that is increasingly required, and cost control. Productivity management takes on a systemic nature and has become essential, as without it, the company will have difficulty achieving efficiency and consolidating itself in the market. This management is one of the most relevant factors for designing competitiveness strategies (MACEDO, 2012).

Macedo (2012) divides productivity management into three procedures. The first is measuring productivity or the production process. The second consists of identifying and analyzing the factors determining productivity bottlenecks. The third involves defining and applying proposals to overcome bottlenecks found in all stages of the production process.

INDICATORS

In order to control productivity, there is a need to measure the performance of the execution stages. For Silva (2015), time is the most important indicator, as its lack of control profoundly influences the overall performance of the project. The author emphasizes that the lack of time management impacts the final execution deadline, increases the project cost estimation parameters and generates wear and tear and even legal actions between the parties involved. Oliveira (2014) presents indicators as quantifiers of the characteristics of products and processes that allow the company to analyze its performance, the form of intervention and the goals that must be achieved.

Costa (2003) states that the evolution of the measurement process must be analyzed by the corporation through a set of indicators relating to the corporation's strategies, action plans and objectives. The performance measurement system is made up of a series of indicators used to evaluate the efficiency or effectiveness of a process.

Lantelme (1994) states that productivity indicators represent the efficiency of the process to obtain the expected results, and the concept of quality can also encompass the improvement of productivity.

According to Oliveira (2014), the main role of the quality indicator is to be an evaluation mechanism formulated on a measurable basis. The author presents that, with the implementation of indicators and the evolution of the quality system, non-conformities can be significantly reduced.

It is the manager's responsibility to ensure that processes are followed, through labor and production management. The inspection must be documented so that the same criteria for evaluating the quality of services are used. Procedure forms relating to service execution and inspection techniques must be registered with the organization to ensure the application of the method in its processes. The procedures must be standardized, and, for this, the following forms can be used: Service Execution Procedure (PES), Service Inspection Procedures (PIS), Service Verification Form (FVS), among others (OLIVEIRA, 2013).

METHODOLOGY

The methodology developed for this case study started from seeking authorization for a vertical building project, to monitor the inspection of services and to access the documentation adopted in planning and quality control.

on-site visit was carried out to the project, which has two towers (A and B), arranged in a mirrored, multi-floor *layout,* with apartments of approximately 180 m² and 200 m² and high-quality finishing. standard.

In the initial phase of this study, Tower A was in the installation's execution phase, while Tower B was in the rough work phase and beginning of installations execution.

Following the adopted methodology, the number of Service Verification Sheets (FVS's) of hydro-sanitary installations completed manually by the construction team was verified, on a printed form developed by the quality department, in version 05, revised on 10/30/2018 (Attachment). In total, 20 (twenty) FVS's were obtained, available for study. These forms were catalogued, identified and separated according to their similarities, allowing a more detailed analysis and establishing comparison criteria between the filling data.

Based on this analysis, 11 (eleven) FVS's were separated relating to the aerial branch execution service, duly completed for the services already performed in Tower A. The aerial branch execution service front consists of the installation of pipes and their connections, both cold water and sewage, from the outlet to the power, consumption and collection points on the structure (slab) to its interconnection with the plumbs.

During the *on-site visit,* the FVS's made available for study were subjected to analysis, by checking their compliance with the service performed. In this activity, several inconsistencies were found, since the service front presented inadequacies (detected by the inspection), while the completed FVSs indicated approval in all evaluation criteria. It was also verified that the same team of professionals responsible for executing the services analyzed by the FVS's completed in Tower A were performing the service in Tower B.

As a result of observing the aforementioned inconsistencies, a new inspection was carried out, adopting the FVS available at the work (hereinafter referred to as FVS-Work), contained in Table 1 (Annex), in order to compare the judgment attributed by the researchers to each FVS criterion to the judgment attributed by the quality management team, when filling out the FVS's adopted in the study.

An analysis of the content of the FVS-Obra was also carried out, in order to verify whether its criteria included the specifications prescribed in the manufacturer's catalog of the material used (MEXICHEM, 2019), the design observations and ABNT NBR 5626:1998 – Cold Water Building Installation. Next, these criteria were evaluated, in order to identify whether the FVS information was sufficient to assist the objective judgment of the professional responsible for evaluating the service and whether the evaluation criteria clearly indicated what must be evaluated.

The present study also included the analysis of the design of hydrosanitary installations, in order to identify the existence of complementary data to the basic design, the designer's prescriptions in relation to the way in which services are carried out, as well as the adequacy of the design to the NBR 5626 standard (ABNT, 1998). Based on the findings, an FVS was proposed in accordance with the prescriptions of the NBR 5626 standard and the manufacturer's catalog (MEXICHEM, 2019). The Service Verification Form suggested in this study (hereinafter referred to as FVS-Standard) is available in Table 2 (Appendix).

The reinspection of the same services evaluated with FVS-Obra, for both towers, provided parameters adopted for comparing the filling results. These data were compared with the results obtained from inspections carried out on site. Next, the results of Tower A were compared with Tower B using the FVS-Norma, with the aim of identifying executive similarities and differences between the towers.

Finally, the criteria set out in the FVS-Obra were subjected to a comparative analysis with the FVS-Norma, with the purpose of identifying the level of adequacy existing between the two.

During this study, the *"as built"* document was prepared by the work for the aerial extensions executed in the kitchen and service area of the apartments in Towers A and B, as these presented inadequacies in execution and incompatibilities with the code of works and buildings in the municipality of Goiânia (GOIANIA, 2008), which did not correspond to the initial hydrosanitary project of the work.

After collecting all the data, they were tabulated, allowing the creation of indicators and the creation of tables and graphs that could allow an investigation of the results obtained.

RESULTS AND DISCUSSIONS

DESIGNED VERSUS EXECUTED

The most important step in carrying out the hydraulic installation service is designing the project efficiently, with as much detail as possible, with indications of the sections, inclinations, type of pipes, dimensions, as well as the connections to be used. The greater the level of detail in the design stage, the greater the ease in the construction stage. Although there is no specific standard for detailing this type of project, there is a consensus among designers that this prescription, at the executive project level, is essential.

The analysis carried out indicated that, for the service analyzed, only the basic project of hydrosanitary installations was available on site. One of the reasons for this statement is that the project presented low quality information, details and specifications.

In relation to pipes, NBR 5626 (ABNT, 1998) and the manufacturer's catalog (MEXICHEM, 2019) do not mention information regarding minimum distances for pipe fixing elements, which is essential for the purpose of ensuring correct fixation and prevent pipes from deforming, causing stress due to excessive curvature.

When inspecting the fixing, it was found that the accessory installation points are places of greater importance in the subsystem, notably more fragile, and present, in most post-construction calls, the main cause for the occurrence of pathological manifestations. Regarding the fixing of the siphoned boxes, it was verified that this service was carried out with perforated metal tape, fixed to the structural element, that is, to the slab, as shown in Figure 3.

This executive practice contradicts the specification indicated in the material manufacturer's catalog, according to which the fixation must be carried out using a screwon metal clamp, as shown in Figure 4.

Figure 3 – Siphon box fixed with metal tape.

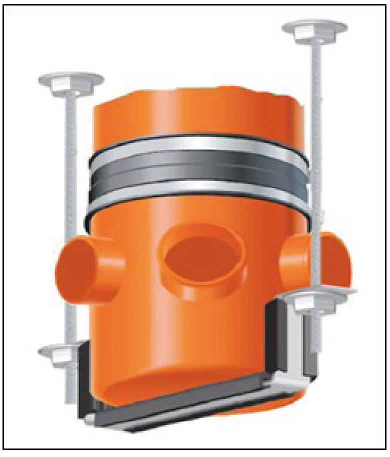

Figure 4 – Siphon box fixing specification. Source: Mexichem, 2019.

ANALYSIS OF THE RESULTS OF THE FVS-OBRA ITEMS

According to the criteria contained in the FVS-Obra, adopted for inspection of the water sanitary installations service, it appears that eight items are evaluated. Adopting this same FVS, the service front was reinspected, on site, verifying inconsistencies in the approval and release of notably non-conforming services. The results of judging the criteria, as assigned by the researchers, were compared with the data contained in the FVS's analyzed, as shown in Table 1.

FVS-Obra Items	Construction Inspection		Reinspection	
	Tower A	Tower B	Tower A	Tower B
Quantity as per	8	8	5	8
Non-conforming quantity	0	0	3	0
Total amount	8	8	8	8
% According to	100%	100%	62.5%	100%
% Non-conforming	0%	0%	37.5%	0%

Table 1 – Conformity of the reinspected service, using FVS-Obra.

Comparison of the results obtained between the reinspection (carried out during the survey) and the original inspection (carried out by the construction team) indicated that, for Tower B, there was no change in the filling results. This way, 100% adequacy of the service execution was verified, for the FVS-Obra checking items.

In Tower A, with reevaluation of the service, it was found that 37.5% of the items evaluated did not meet service compliance. Of the eight items checked, three presented inadequacies in relation to the checking items. The extensions in the structure, the support fixation of the pipes and their assembly presented executive inadequacies. For these items, the completion made by the quality management team recorded that 100% of the service performed was adequate.

The complete data from the analysis carried out on this topic can be found in Table 3 (Appendix).

INADEQUACIES IN FILLING OUT THE FVS-OBRA

After the verification exposed in the previous item (indicating that 37.5% of the service verified for Tower A was inadequate), a careful review of the 11 (eleven) FVS's adopted in this study was carried out, referring to the aerial branch services performed from the

3rd to the 13th floor of Tower A. Among the 18 fields analyzed in the FVS's, 72.2% showed inconsistencies, which represents 13 items of the total.

Graph 1 (Appendix) illustrates the filling inadequacies detected in the FVS's analyzed. The highest frequencies of inadequacies were observed in six FVS-Obra fields (100% of filling inadequacies), namely: quantity verified; extensions in the structure; pipes with exposed openings; positioning; support fixation; and, assembly of pipes. The field intended for filling in the verified quantity was not filled in in any of the FVS's analyzed. Therefore, due to omission, it is not possible to measure how many and which units received service inspection, nor whether they were actually inspected. For the other fields analyzed, the inadequacies detected were attributed to the approval of services, which during reinspection were detected as non-conforming, that is, the service performed was different from that designed or did not fit the approval criteria for the items contained in the FVS -Constructions.

Verification of the tightness test recorded 91% of inadequacies. In other words, only one floor was subjected to this inspection even before the service verification was completed, while on the other 10 floors this step was skipped, leaving the verification of all these floors as completed.

Another relevant topic concerns the awareness of those responsible for releasing the service. It is through immediate monitoring of execution by those responsible that the planning and control team can make decisions that affect the physical/financial schedule of the work. Of the total of 11 (eleven) floors, eight could have their problems mitigated by the construction foreman. Or even, 10 (ten) of these floors could have been criticized by the technician responsible for the work, the engineer, in a timely manner.

The premise of immediate monitoring by those responsible also extends to the duration of the service, observed through the fields intended for filling in the beginning and end of the service front. Of the 11 (eleven) FVS's analyzed, 36% showed discrepancies in relation to the others. In seven records it was observed that the average duration of service totaled approximately three and a half days. In the other four FVS's, in which inadequacies were detected, there was double the time required to perform the same service (one case), approximately four times the time required (one case), while in two other cases, the period of execution of the service took 18 and 42 days, respectively, showing that the FVS's were completed completely, only during the audit carried out by the quality department.

Inadequacies in filling out the service location were also recorded through analysis of the FVS's. The record of 9% inadequacy was observed, inferring that one of the floors had received double inspection, while on another floor the inspection had been neglected. By analyzing the completion of the execution start and end date fields, execution team and service verification date fields, it is understood that these are different floors, denoting the conclusion of an error in the completion.

COMPARISON OF FVS-OBRA VERSUS FVS-NORMA

As the FVS-Work was insufficient to verify possible inadequacies in the construction stage of this subsystem, the FVS-Standard was suggested, available in Table 2 (Appendix), prepared based on the requirements that met the provisions of NBR 5626 (ABNT, 1998); the project of the work and its peculiarities; the construction method adopted by the construction company; and the specification of the material manufacturer, according to the catalog (MEXICHEM, 2019).

With the FVS-Norma suggested in this study and the FVS-Obra, it was possible to carry out a comparative analysis between them. Considering that an inspection item in the FVS-Obra was also an inspection item in the FVS-Norma, it was agreed that this item was compliant. For the FVS- Norm inspection item that was not foreseen in the FVS-Obra, it was judged as non-compliant.

FVS-Obra inspected eight items, separated into seven groups, while FVS-Norma inspected 15 items, distributed into seven distinct groups. Seven inspection criteria not covered by FVS-Obra were inserted. This involves inspecting the slopes of different pipe diameters; position of cutting and trimming of pipe burrs; sanding and applying a cleaning solution to pipes and welded connections; correct fit in connections; installation of aerial branches according to the project, allowing the connection of use and consumption branches; installation and diameter of accessories according to specification; and also, the minimum time to expose the pipes to pressure and tightness tests. The comparative result between the FVS's is presented in Table 2.

Items	Amount
According to	8
Non-conforming	7
Totals	15
% According to	53.3%
% Non-conforming	46.7%

Table 2 – Comparison between FVS's.

From the diagnosis obtained through this comparison, it was found that the FVS-Obra presented 53.3% compliance in relation to the FVS-Norma developed in this study. Thus, only eight items were included in both FVS's. The other 46.7% of non-compliance between one FVS and another was related to the addition of seven criteria, previously not inspected. It is noted that this addition, previously omitted, did not participate in the evaluation of the service, compromising the qualitative analysis of the services performed.

The complete data from the analysis carried out on this topic can be found in Table 4, available in the Appendix.

REINSPECTION OF THE SERVICE BASED ON THE FVS-NORMA

Based on the FVS-Norma, the services were reinspected, obtaining the data included in Table 3.

FVS-Norma Items	Tower A	Tower B
Quantity as per	8	14
Non-conforming quantity	7	1
Total amount	15	15
% According to	53.3%	93.3%
% Non-conforming	46.7%	6.7%

Table 3 – Conformity of the reinspected service, using the suggested FVS.

In Tower A, 46.7% of non-conforming items were found, while in Tower B, 6.7% of inadequacies were observed. It is estimated that the high rate of non-conformities in Tower A was due to design flaws, where it was necessary to change the pipe passages in the structure, to ensure better efficiency in their installation and positioning.

Furthermore, the ends of the aerial branches, which would receive the isometric branches in sequence, were not sealed, allowing the pipes to be obstructed, thus compromising the functioning of the subsystem.

Other factors observed in the assembly stage demonstrated that the pipes were not installed respecting the inclinations foreseen in the project, becoming curved and fixed under effort in Tower A, as shown in Figure 5.

Figure 5 – Pipes installed and fixed under stress, in Tower A.

Figure 6 illustrates the correct execution of fixing the pipes without effort, that is, without tensions and curvatures, as performed in Tower B.

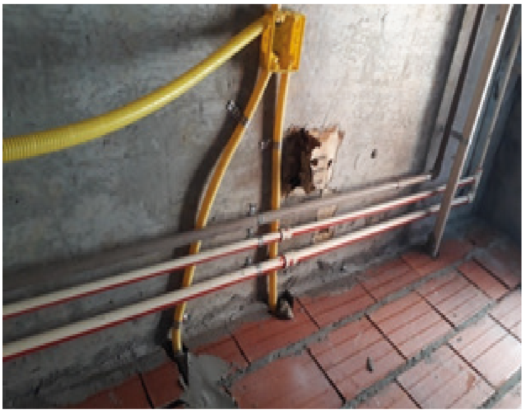

Figure 6 – Pipes installed and fixed without bends - Tower B.

It was observed that the ends were not sanded and cleaned with the cleaning solution recommended by the manufacturer. There were also deficiencies in the fit to the bottom of the bag, preventing fixation.

Due to the significant number of non-conforming items, it was necessary to reevaluate the project, mainly at the level of detail, requiring that part of the project be adapted during the execution of Tower A, with the need to develop the as-built *document.* It was found that most of the executive inadequacies found did not occur in Tower B, since the team was used to replicating the process correctly, as a result of the rework in Tower A. It is therefore justified to reduce the number of items not as observed in Tower B, with only one inadequacy remaining in the service check: the lack of sanding and the failure to apply a cleaning solution to the surface of the pipe ends.

The complete data from the analysis carried out on this topic can be found in Table 4, available in the Appendix.

CONCLUSIONS

It can be stated that the execution failures occurred due to the lack of information and detail of the basic project, insufficient to effectively guide the execution of the services, nor considering the recommendations of the manufacturer of the material used, nor the provisions of the standard.

In the service reinspection stage, the inadequacies observed were due to the lack of objective consideration of evaluation criteria in FVS-Obra, although there was an absence of important items for the complete judgment of the service. These justifications are evidenced through the indicators presented in Tables 1 and 3, where non-compliance in filling out the FVS's is noted, with a considerable percentage of non-compliance represented in the reinspection of the service, carried out for this study. However, it would not be possible to use these data as feedback measures for replanning, nor for future planning.

Furthermore, FVS-Obra lacked relevant information for the thorough inspection of the service, not presenting the necessary criteria for the evaluation, arranged didactically in order to assist and guide its completion.

Correct inspection and completion of the FVS's are extremely important for the quality control of a project, as neglecting this issue can lead to rework, impacting planning and control, as well as the work budget, as these evaluate performance of the construction stages and reflect the efficiency in obtaining the expected results.

During this study, it was observed the need to verify other services adjacent to the hydrosanitary installations, as it is a subsystem with large ramifications and connections with others. Therefore, for future studies, it is suggested to check the pipe passage services in the structures; installation and fixing of pipes in the plumbs; cold water piping installations in masonry; as well as carrying out pressure and tightness tests, established as conditional approval criteria for verifying the service of aerial branches.

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ANNEX S

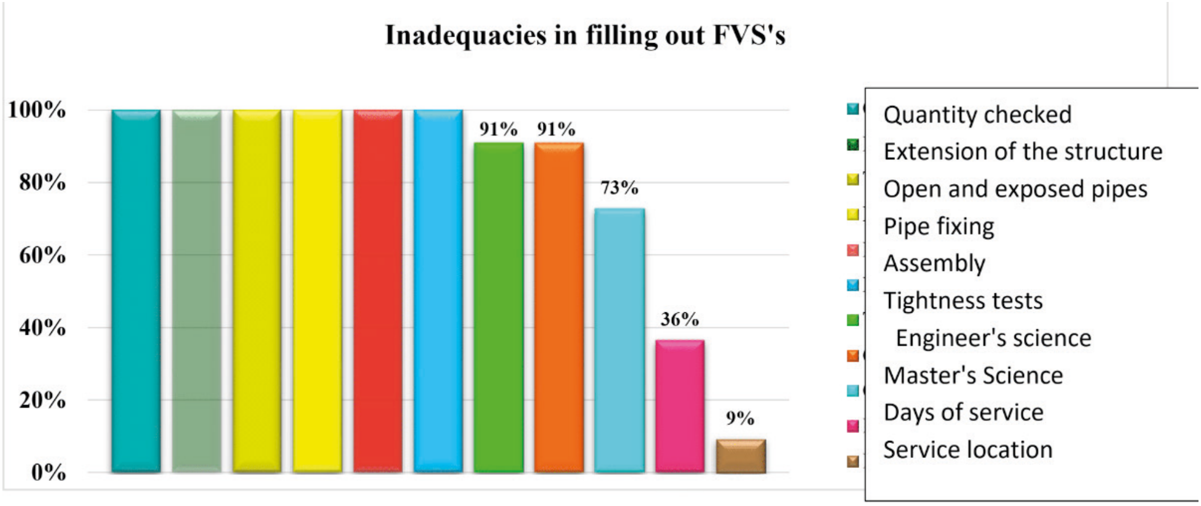
FVS – Hydraulic piping				FVS.05A V05
Reference	Work	Start	End	10/30/2018. Page: 1
Place of the service		Verified quantity		
Employee name	Role	Employee name		Position

Nº	Verification item	Methodology and evaluation criteria - verification	Approval	Notes and actions
1.	Start conditions	Check the extensions on the structure. Check that the place is clean, unimpeded and has materials, tools and equipment to perform the service.		
2.	Gauge	Visually check the piping.		
3.	Fixing/ support	Check the fixation/support of the pipes visually.		
4	Free area			
5.	Leakage	Test against water leakage using a hydraulic test pump.		
6.	Mounting	Visually check that the assembly is correct, without effort on the pipes (bent or fixed under tension) and with connections, according to the project.		
7.	Cleanness and terminality	Check the total completion of the work, the organization, the cleanliness of the place, the equipment and tools.		

SUBTITLE FOR VERIFICATION OF THE WORKS				
Not inspected (empty)		Approved = 0	Rejected = X	Approved after re-inspection = X
Master/Person in charge Storage Work file cabinet	Signature Recovery Identified folder: FVS	Date Protection Place with low light and humidity. Work administrator access	Engineer (signature) Retention Until the end of the project	Date Situation: dead file for 5 years

Table 1 –FVS-Work, practiced for inspection of hydraulic piping services.

APPENDICES



Graph 1 –Occurrences of inadequacies in filling out FVS-Obra.

Reference Place of the work	Work	FVS – Hydraulic pipes Document for verification of the service	End of inspection Tower	FVS FVS 05.A. 9/3/2019 Page: 1
Name of the employee		Position	Name of the employee	Role

Number (Item for verification)	Methodology and evaluation criteria - verification	Tolerance	Approval – flat 1	Approval – flat 2
1 – Start conditions	Check whether the passages embedded in the structure were built according to the project.	∅ zero		
	Check that the place is clean, unimpeded, with materials to perform the service.	∅ zero		
	Check that the isometric pipes and extensions in the structure are covered and free of residue.	∅ zero		
2 – Piping features	Check visually, and with the help of a tape measure, whether the pipes correspond to the design indications (diameter, type of pipe: CPVC, PVC)	∅ zero		
3 – Leaning	Check, with the help of measurement, whether the pipes have an inclination as indicated in the project. Check that the pipes were cut, ensuring perpendicularity, and that the internal and external burrs were sanded. Check, with the help of measurement, whether the pipes have an inclination as indicated in the project. Check that the pipes were cut, ensuring perpendicularity, and that the internal and external burrs were sanded.	0,01%		
		∅ zero		
4 – Fixing / Mounting	Check that the pipes and welded connections have been sanded and cleaned with the cleaning solution. Check that the pipes were fitted to the bottom of the bag, ensuring that it is secure.	∅ zero		
		∅ zero		
		∅ zero		
	Visually check whether the pipes were fixed using clamps, metal tapes and rivets. Visually check that the assembly is correct, without strain on the pipes (curved or fixed), under tension.	∅ zero		
	Visually check whether the pipes are installed according to the project (position, fitting, connections, accessories, pipe routing, consumption point).	∅ zero		
5 – Position / Installation	Check that the valves and registers were installed as per the project instructions and that the type and diameter are in accordance with the project specification.	∅ zero		
6 - Operation	Check that the beginning of the tightness and pressure test was carried out 12 hours after assembly and installation.	5 min		
	Check visually and through testing whether the installations (still visible) are watertight and in perfect working order.	∅ zero		
7 – Cleanness and terminality	Check the total completion of the work, the organization and cleanliness of the place, equipment and tools.	∅ zero		
NOTES AND ACTIONS				

Not inspected (empty)		SUBTITLE FOR VERIFICATION OF THE WORKS Approved = 0	Rejected = X	Approved after re-inspection = X
Master/Person in charge Storage Work file cabinet	Signature Recovery Identified folder: FVS	Date Protection Place with low humidity and light. Project administrator.	Engineer Signature Retention, until the end of the work	Date Situation: Dead file for 5 years

Table 2 –FVS-Standard, based on the provisions of NBR 5626, project specifications, construction method

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adopted by the construction company, and specifications from the material manufacturer.

Verification item	Methodology and evaluation criteria – verification	Inspection - work		Re-inspection	
		Tower A	Tower B	Tower A	Tower B
	Check the extensions of the structure	0	0	X	0
1 – Start conditions	Check that the place is clean, unimpeded and has materials, tools and tools to perform the services.	0	0	0	0
2 - Gauge	Check the pipe gauge visually.	0	0	0	0
3 – Fixing - support	Check the fixing and support of the pipes visually.	0	0	X	0
4 – Free area	Visually check the positioning of the pipes, according to the project.	0	0	0	0
5 - Leakage	Test against. Water leak, using hydraulic test pump.	0	0	0	0
6 - Mounting	Visually check whether the assembly is correct, without straining the pipes. Curved or fixed under tension, and with connections, according to the project.	0	0	X	0
7 – Cleanness and terminality	Check the total completion of the work, the organization and cleanliness of the equipment and tools location.	0	0	0	0
	SUBTITLE FOR VERIFICATION OF THE WORKS				
Not inspected (empty)	Approved after re-inspection = x	Rejected = X		Approved = 0	

Table 3 –Re-inspection of the service, using FVS-Obra.

Item for verification	Methodology and evaluation criteria - verification	Tower A	Tower B	FVS Work
1 – Start conditions	Check whether the passages embedded in the structure were executed, according to the project.	X	0	0
	Check that the place is clean, unimpeded, with materials to perform the service.	0	0	0
	Check that the isometric pipes and extensions on the structure are covered and free of residue.	X	0	0
2 – Piping features	Check visually, and with the help of a tape measure, whether the pipes correspond to the design indications (diameter, type of pipe, CPVC, PVC)	0	0	0
3 - Leaning	Check, with the help of measurement, whether the pipes have an inclination, as indicated in the project.	X	0	X
4 – Fixation / Mounting	Check that the pipes were cut, ensuring perpendicularity, and that the internal and external burrs were sanded.	0	0	X
	Check that the pipes and connections are weldable, the surface has been sanded and cleaned with the cleaning solution.	X	X	X
	Check that the pipes have been fitted to the bottom of the bag, ensuring their fixation.	X	0	X
	Check whether the pipes were fixed using cable ties, metal tapes and rivets.	0	0	0
	Visually check that the assembly is correct, without straining the pipes (bent or fixed under tension).	X	0	0

5 – Position / Installation	Visually check whether the pipes are installed according to the project (position, fitting, connections, accessories, pipe routing, consumption points).	X	0	X
	Check that the valves and registers were installed as per the project indication and that the type and diameter are in accordance with the project specification.	0	0	X
6 - Working	Check whether the beginning of the tightness and pressure test was carried out 12 hours after assembly and installation.	0	0	X
	Check visually, and through testing, whether the installations (still visible) are watertight and in perfect working order.	0	0	0
7 – Cleaning and terminality	Check the total completion of work, organization and cleanliness of the place, equipment and tools.	0	0	0

SUBTITLE FOR VERIFICATION OF THE WORKS			
Not inspected (empty)	Approved = 0	Rejected = X	Approved after re-inspection= X

Table 4 –Re-inspection of the service using the FVS-Norma, and comparison between the FVS's.