



THE CONTRIBUTION OF WORK PERMITS TO SAFETY: THE CASE OF A THERMOELECTRIC PLANT

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Abstract

The Work Permit (WP) process is a system widely used in high-risk industries to achieve high levels of safety. It is included in several activities within companies, but its purpose becomes evident in the dialogues and interactions between Maintainers and Operators in the field. This article aims to highlight the relationship between WPs and safety and respond to the demand for the efficiency of this process in a thermoelectric unit. To this end, a case study is used that uses Ergonomic Work Analysis (EWA) as the main tool for data collection and analysis. The WP is identified as a document that, in addition to helping prevent risks, creates an opportunity for reflection before the activity, thus contributing to the safety and integrity of the facilities. In addition, the study highlights three main deficiencies related to this process in the unit: i) high volume of documentation and requests in the field; ii) communication failure with lack of relevant information; iii) Low room for maneuver in a complex environment. Finally, these issues are analyzed using the literature collected, providing support for discussing them with the company and the study group, thus favoring an improvement in this process and its role in safety.

Keywords: Work Permit; Safety; Ergonomics.

1. INTRODUCTION

This article addresses the contribution of Work Permits (PT) to increase safety in a Thermoelectric Power Plant (UTE), using concepts of ergonomics of the activity. The focus is

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on the activities of operators and maintainers, highlighting their influence on the overall safety of the unit. It is worth mentioning that this work is carried out within the scope of an ongoing research project, which aims to develop a methodology for the integration of Human and Organizational Factors in Industrial Safety (FHOSI).

Over time, the concept of occupational safety has been intrinsically intertwined with the history of human work. Based on the broad concept of health, occupational safety represents a multidisciplinary approach and strategy aimed at eliminating or reducing the risk of accidents during the execution of professional activities (Figueiras; Scienza, 2021).

In view of this, according to Assunção and Lima (2003), the ergonomics of the activity has as its objective the modification of working conditions, aiming to increase the reliability and safety of the systems, in addition to preventing work-related damage. In this way, it is based on knowledge about the human being in activity, simultaneously thinking about its physiological, cognitive and social dimensions (Falzon, 2018).

This multifunctional perspective raises several relevant issues related to the well-being of workers and the performance of activities. Among them, some studies point to the relationship between fatigue and temporary loss of efficiency (Falzon; Sauvagnac, 2007); the crucial role of the cognitive aspect for understanding the situation and decision-making (Hoc, 2007; Antipoff; Soares, 2021) and the importance of communication for good coordination and sharing of information (Karsenty; Lacoste, 2007).

In addition, with regard to safety aspects, standards, rules and procedures play a fundamental role in guiding actions in the field. Generally, such guidelines incorporate past experiences, scientific knowledge, and current legislation, aiming to prevent unwanted occurrences in the future (Rocha; Vilela, 2021). In this context, the Work Permits (PT) process stands out, which is a system widely used in the high-risk industry to achieve high levels of safety, with an emphasis on isolations, which are a safety precaution that aims to restrict the access and exposure of individuals to potential risks and dangers in a specific location.

The *Health and Safety Executive* (HSE) (2005), Britain's national regulatory body for health and safety in the workplace, defines a work permit as:

"A work permit system is a formal, registered process used to control work that is identified as potentially hazardous. It is also a means of communication between site/facility management, plant supervisors and operators, and those who perform hazardous work" (HSE, 2005, p. 7).



This article presents a case study carried out in a UTE whose methodology for collecting evidence is the Ergonomic Analysis of Work (AET), aiming to highlight the relationship between TSTs and safety, seeking to respond to the demand about the inefficiency of this process in the operational unit and its impact on the maintenance of the integrity of the facilities.

1.1. Features of the Work Permit process

In order for the objectives of the Work Permit to be achieved, there are some challenges in its operability. Andrade (2016) points out that some of them are: "allowing the adaptation of the planned PT to the reality of the context in the field, and facilitating the same knowledge of the work, its risks and the current situation of the PT." (Andrade, 2016, p. 32). In addition, Iliffe *et al.* (1999) elaborate three distinct functions for which the PT system should be responsible.

"First, they assist in identifying potential hazards, along with the concomitant precautions that must be taken; Second, they help coordinate the enforcement of precautions, the effective execution of the maintenance task, and the eventual removal of precautions. Third, they provide a written record of what was done, by whom, when, and how." (Iliffe *et al.*; 1999, p.70).

Another challenge discussed by Ramiro and Aísa (1998) is the effective appropriation of PT's performers. The author presents that it is common for workers to only read the description of the work to be done, since most of the tasks are routine and the content of the permissions is similar. In addition, current systems assume that document issuers are competent to identify risks, however this is not always valid due to the high complexity of the modern workplace (Iliffe *et al.*, 1999)

Also due to the complexity of the systems, another point is that PTs should not be immutable. This issue is pointed out by Iliffe *et al.* (1999), who state that the PTs should be easy to modify to meet the circumstances and needs of the workers, and should also be specific to a given plant.

In his study, Souza (2013) points to the PT activity as the one that consumes the most time during the work shift of the operation technicians. In this sense, Ramiro and Aísa (1998) state that it is advisable for the issuer of the PT to accompany the worker to explain the main risks of the activity, as well as at the end to verify what was executed, collecting the signed document. Considering these issues, the importance of sufficient time for the verifications, the HSE (2005), highlights the number of PTs that a single issuer can manage as a limiter. Thus,



the simultaneity of critical activities can have negative consequences for the cognitive process necessary to carry out the activities (ICSI, 2021).

Finally, Andrade (2016) concludes by stating that it is not in its rigor that PT guarantees the safety of activities, but rather in the dialogues and interactions between the actors who discuss the safety factors located in a service.

1.2. PTs in the context of the Oil, Gas and Energy industry

In the Oil and Gas Industry, Work Permits constitute a significant part of the activities, being a process inscribed within the broader maintenance segment, which includes the planning of the work, the release with the participation of different actors, the support for the execution and the discharge of the work (Andrade, 2016). In this sense, accidents recorded in this field in recent decades have revealed inefficiencies in this system to support safety (Atherton; Gil, 2008).

One of the most prominent was the explosion and fire that occurred on the *Piper Alpha* offshore *oil and gas* platform, whose analyses show failures in the PT system, deficient hazard analysis and inadequate training in safety procedures (Jahangiri *et al.*; 2016). After the accident, several lessons to be learned were elaborated. Appleton (2001) presents, as one of them, that the PT system must involve a safe method of locking valves to avoid inadvertent openings, requiring a systematic evaluation of all potential hazards and interactive effects.

In addition to the accident mentioned, there were others in which PT appears in the analyses, such as *BP Grangemouth* (UK, 1987), *Shell Port Eduoard Herriot Depot* (France, 1987), *Phillips Chemical Company* (USA, 1989) and *Motiva Enterprises LLC* (USA, 2001) (Atherton; Gil, 2008). Some of the main points highlighted by the analysis of these events highlight failures in communication between teams, the need for greater attention to the changes that may occur in the workplace during the execution of the activity, lack of information about the job description and risk assessment with insufficient on-site checks.

1.3. The research method

This study follows the steps of the Case Study proposed by Yin (2015), seeking to investigate a contemporary phenomenon in its real-world context. To achieve these objectives, the following steps were carried out: planning, design, preparation, evidence collection, evidence analysis, and reporting.



In the **planning** stage, it was defined that, in order to achieve the objective of the study, an exploratory and descriptive case study would be carried out, which aims to fill the gap of previous studies on the energy production industry and present interpersonal situations and their key phenomena. In this context, it is worth mentioning that the selection of this pilot unit in question was based on the oil and gas company itself, which defined which units would participate in the FHOSI project. In addition, the development of the PT process emerges as a demand to improve the safety performance of the unit, and the participation of workers was done voluntarily, following the procedures of confidentiality of the workers.

In the **project** stage, a survey of the literature was carried out to deepen the theme and the study questions. A Brazilian thermoelectric unit was used as the object of research. The choice was influenced by the fact that it is an old unit that, in order to ensure the reliability of equipment and facilities, has a high number of maintenance in its daily life that involves the PT process.

In the **preparation** stage, the research protocol was elaborated. It was defined that the evidence collected through an Ergonomic Work Analysis (AET), a method that uses open observations and verbalizations with the workers to build a diagnosis of the situation. This method proved to be adequate because it contributed to the understanding of the work and the logics of use of the document.

In the **evidence collection** stage, direct observations of typical work situations and open interviews with workers were carried out (GUÉRIN *et al.*, 2001). The data collected were demand-driven, and the EWS process followed three central steps: (1) the exploration of the functioning of the organization, (2) the understanding of the work permit process; (3) systematic observations of the activity, followed by open interviews; and the formulation of analyses and notes.

The studies of the organization's operation were carried out based on biweekly remote meetings with the various sectors of the company between March and November 2021, in addition to a three-day visit to the unit (12/01/2021 to 12/03/2021) to learn about the facilities and recognize the key sectors and activities of the workers. The analysis of the activity, in turn, considered 8 visits to the thermoelectric plant, in a total of 21 days in the field. In these visits, 7 work situations involving work permits were observed. In this article, two cases were selected, one with a production operator who released PTs and one monitoring of maintenance service, with these activities being directly impacted by the PT process. These systematic observations are structured in chronicles of the activities that allow the observation of the observed variables



(Guérin *et al.*, 2001), and complemented with open interviews to broaden the understanding of the challenges and problems faced by workers in their tasks, using the approach known as self-confrontation (Mollo; Falzon, 2004).

The **analysis of the evidence** is presented in the discussion chapter, in which the technique of theoretical propositions (Yin; 2015) is used, deepening the analyses and diagnosis, confronting what is observed with the discussions held with the teams and the literature on the subject of work permits.

Finally, the **reporting stage** is presented in the next section of this article and constitutes the result of the research.

2. DEVELOPMENT AND RESULTS

2.1. The functioning of the organization

The main inputs of the UTE are natural gas and water, and the operation of the plant in an open cycle occurs with gas turbines operating in isolation, that is, the gases are discharged into the atmosphere after passing through the turbine and are not reused, so that thermal efficiency is reduced. The amount of energy demanded for the unit is reported daily by the Integrated Operations Center, with priority in the matches organized by the unit. It is important to note that the turbines are not requested to be in continuous generation, and what is offered by the UTE is their availability for generation on demand.

Another relevant point for the operation of the unit is the understanding that, although it has a strong workforce of its own, the maintenance of the plant is outsourced. Chart 1 briefly presents the work teams most related to the PT process.

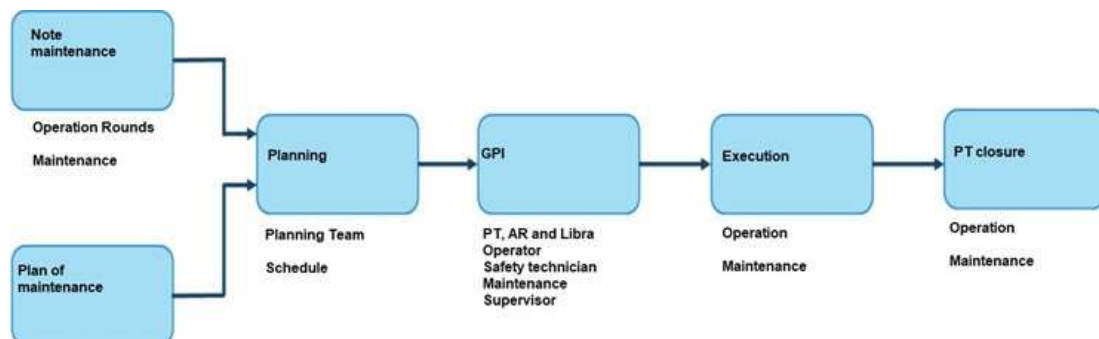
**Table 1:** UTE teams

Maintenance	Operation	Planning
The Enforcement team is outsourced and includes experts in various areas, each with its own field inspector and a team of performers. The person in charge of each specialty performs risk analysis in collaboration with Planning.	It is composed of five operators per shift, one supervisor, one panel operator and three field operators, and at night, the number is reduced to four. Its main activities are the start-up processes of the generating units and the release of PTs in the field. In addition, they carry out rounds to check the operation of the unit.	It is responsible for preparing Maintenance Orders (OM), in addition to organizing the weekly schedule of activities. The occupational safety technician and an operator prepare documents such as PTs, Risk Analyses (RAs) and LIBRAs (A System of Release, Isolation, Blocking, Racket and Warning). These documents are collected by the person in charge and distributed to the maintenance performers.

Source: The Authors, 2023

2.2. The process of PTs in the unit

To understand the steps and teams involved in the PT process, **Figure 1** presents a simplified scheme of its steps, along with the main teams involved in each of them.

Figure 1: Simplified model of the PT process

Source: Pereira, 2022

The process can be initiated in two ways: the opening of a maintenance note (NM) by a maintainer or operator in the field; or through the unit's maintenance plan. The planning team prepares the Maintenance Orders (OM) pointing out what will be executed, what safety procedures are necessary, what is foreseen by the standard of that activity, what is contemplated in the maintenance contract, the necessary tools, the sizing of the team and the time required to perform the service. The planner of each specialty is also responsible for preparing the weekly schedule of services.

With the OM and the weekly schedule, the Integrated Planning Group (GPI) is in charge of preparing the documentation of the PTs, ARs and LIBRAs. There is also a schedule of



days/times in which the maintenance officers of each specialty must attend the GPI for the preparation of the RAs, and the PTs are prepared one day before the service is performed. To this end, the software is used to request, prepare, issue, close, cancel and audit PT. Another relevant point is that the AR number enters the PT, so that if there is a review in the risk analysis with a change in numbering, the referring PT needs to be canceled and another issued. There is no procedure for reviewing PT after it has been issued, and any adjustment requires cancellation of the document and issuance of a new one.

After the documentation is ready, on the day of the service, it is the responsibility of a field inspector (third party) to collect the PTs of the day in the control room and divide them among the maintenance specialties for execution. Clearance and closure must take place in the field near the service site, and are signed and supervised by an operator.

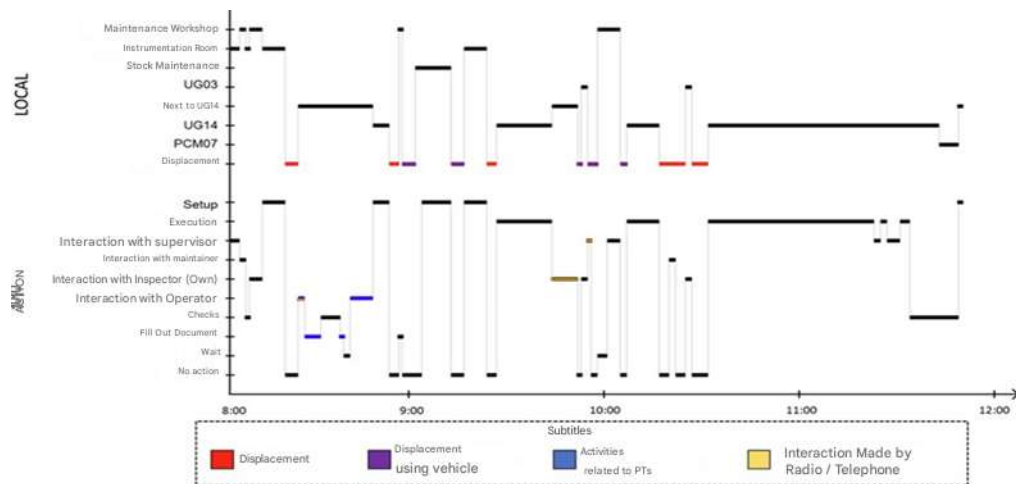
2.3. Systematic observations

According to the EWS methodology, two situations were chosen for systematic observations: one related to maintenance and the other to operation, aiming to provide an understanding of the real activity of these professionals and how TSTs are incorporated into their routines.

2.3.1. Instrumentation team activity: Gas valve inspection

The observation of the instrumentation team occurred during the corrective maintenance activity in one of the turbines, referring to a trip due to a failure in the gas valve. This inspection and repair on the valve was off schedule, but it was requested to be included on this day. An observation made by the person in charge is that, in addition to this PT, there was another preventive maintenance activity scheduled in another generator on that day, but it will not be carried out since the generator of this unit, in which the service would be performed, is out for maintenance "it was supposed to be released, but it is not, so it accumulates". (Instrumentation Officer).

Graph 1 represents the chronicle of the monitored activity and then there is a description regarding the main points of this monitoring. The chronicle is organized with the observables: Place and Action. There are several interactions with the maintenance inspector and the person in charge of decision-making, in addition to constant displacements, including the need to use a vehicle at times.

**Graph 1: Chronicle of Instrumentation Activity**

Source: Pereira, 2022

Upon receiving the PT, the technician, together with the person in charge and the supervisor (himself) interact to understand the history of that proposed service. This does not occur, in general, in preventive maintenance, in which teams usually already know what to do. This corrective PT comes from an old OM, with the following record: "During operation, the unit alarmed a fault to earth in the battery charger, causing a failure in the gas valve supply, following the trip". Upon obtaining this information, the person in charge of instrumentation comments "they must have solved it in the emergency, but it was recurrent and they took advantage of the text of that old OM".

When he arrives near the area of the generating unit where the activity will be carried out, the technician calls the operator by radio to open the PT and while waiting, he fills out the documents and puts his padlock in the red box of LIBRA. At this point, the worker says "here paper counts for a lot". When the operator responsible for the block arrived, he checked the tools together with the technician, and filled out the PT using paper and the *Personal Digital Assistant* (PDA). During the execution of the task, there was a need to use tools that were not with the material taken, making it necessary to travel to the outsourcer's internal stock, which is located in the UTE itself, but in a remote region, as well as another trip to the instrumentation workshop.

In the case of corrective maintenance, a search on a valve that has a defect, the maintainer who receives the service started the activity without much information about the case, having to resort to frequent interlocations with the proper inspector and his supervisor,

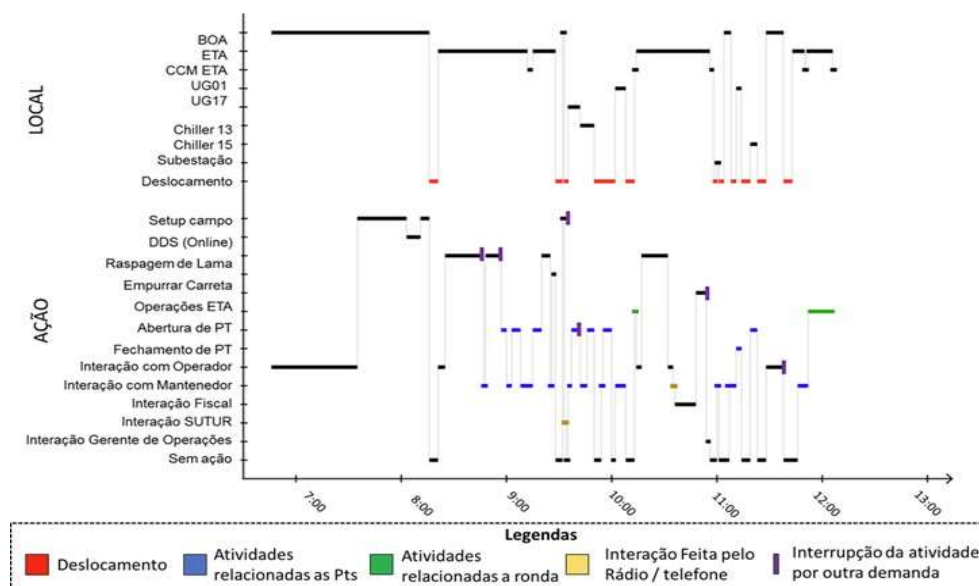


needing to travel in search of appropriate and specific tools, during the execution of the work itself. The opening and information of the PT document proves to be of little use during the process, adding only bureaucracy to the activity.

2.3.2. One shift of operator work

The accompanied operator is responsible for two distinct areas, which are at opposite ends of the industrial area, resulting in a significant need for displacement. Graph 2 presents the chronicle of the operator's activity in the morning, followed by some highlights of this period.

Graph 2: Operator's Chronicle - Morning



Source: Pereira, 2022

The chronicle allows us to observe the high rate of places that the operator travels through in the morning, evidencing displacements in the passages between the extremes of the operational area. Another issue to be pointed out is that due to the demands that arise in the morning, only a part of the checks of the round were carried out, leaving its closure to be done in the afternoon. It is worth noting that during the day the operator was called several times by the radio, but as they are quick interactions (lasting less than a minute) they are not represented in the chronicle. The content of these interactions is composed of maintainers and operators informing their positions, to know where services existed, waiting for release. Some relevant situations that occur during the shift are described below.

During service clearances in Block 5, the electrical team reports that they are unable to perform an engine test activity of a *chiller*, as the mechanical team had not yet installed it. In



this way, they were redirected by the person in charge to another activity in another *nearby chiller*. This is a typical situation, in which a service ends up being issued, even if it depends on another, which has not yet been completed.

Another important moment occurs when, during the displacement, an instrumentation maintainer asks for support for PT release and removal of LIBRA to perform a measurement. However, when analyzing the service, it was found that there was another team, mechanical, working within the unit, and that, therefore, the LIBRA could not be withdrawn. He found that the mechanics team should deliver the service at 2 pm and only then could the LIBRA be removed, for the instrumentation team to act.

During the shift, a situation that generates stress is being called by radio, but when you go to meet at the place of service there is no one. The operator verbalizes: "He called, but he doesn't wait at the place, that makes things difficult"

Among the service closures carried out on the day, one that draws attention is the substation that was not completed, remaining to continue in the coming days. About this closure it was mentioned: "it did not conclude because there is still more to change, but there is no stock, if I were to run the entire substation to check I can't, in the procedure I would have to see, but in the substation I ask what it did and close it". (Operator)

In the transition to the night shift, held at 6:30 p.m., among the day operators with those who arrived, some relevant cases were reported. One of them verbalized that during the day he withdrew several LIBRAS without any operation having taken place. When asked why this is the case, he states that this is a situation that has been occurring with certain frequency. "They (maintenance) ask to put LIBRA on, sometimes urgent and there is no person and there is no person and it doesn't do it, then we reprogram everything and we take LIBRA out." (Operator).

The group also reports that the high number of opening and closing requests directly impacts the quality of the work. "We have, on average, 20 PTs on the day that are divided with the workforce, in the meantime (while opening the PTs) emergency arises and plays for corrective, this impacts the preventive." (Operator). On this subject, another trader reports:

"During the day the operator does not stop, for nothing. There is no time left for the technical part, it is just putting out fires. The demand is too much for too little labor, both in maintenance and operation. The management does not accept this, a study was done and they say that it is enough. Our experience has compensated for this kind of thing" (Operator).



3. DISCUSSIONS

This work was guided by apparent dissatisfaction with the process, which is evident in the verbalizations of several workers, generally related to bureaucratization and overload in the team. Thus, from the cases studied, it is possible to characterize deficiencies aimed at: i) the high volume of documentation and requests in the field; ii) failure to communicate with the absence of pertinent information; and iii) a low margin of maneuver in a complex and dynamic environment.

Regarding the volume of work, an excess of fronts with which operators interact during their activity is perceived, confirming Souza's (2013) point about the PT activity being one of the most time-consuming for operators. Through the monitoring, it was possible to notice the high rate of requests in the field, with the opening of services with PT being one of the most constant. This volume can mean a loss in terms of more effective investigations and time to actually interact with maintenance teams, since it is "the simultaneity of several critical tasks that divides the attention of operators" (ICSI, 2021, p. 9). In this sense, Hoc (2007) reaffirms that it is necessary to build a cognitive commitment to understand the situation and decide to act.

"Comprehension often extends over a wide time span, in parallel with decision-making processes with a minimum level of comprehension to keep the supervised process in check" (Hoc, 2007, p. 447)

This scenario also leads to operator fatigue, as a result of the physical effort of having to move between the UGs, and cognitive fatigue, generating a loss of efficiency in identifying risk situations (Falzon; Sauvagnac, 2007). In addition, Antipoff and Soares (2021) discuss how attention, another cognitive process present in the activity, plays a fundamental role in decision-making during the activity.

The loss of the main purpose of the PT in this situation is also highlighted, which would be the creation of collective spaces for discussion to deal with the TP and the monitoring of the activity that is conceived the work task and its adaptation to the field, as highlighted by Ramiro and Aísa (1998) and Andrade (2016).

The case of maintenance highlights the issue focused on communication, which according to Karsenty and Lacoste (2007), should ensure the coordination of decisions and the sharing of information. In this sense, it can be seen in the activity accompanied by the instrumentation maintainer, a high workload in the search for information on the history of the machine so that he could understand what needed to be done, in addition to displacements to search for materials identified as necessary only after the beginning of the activity. In such



situations, the PT ends up not fulfilling one of its functions of helping to coordinate the precautions of the activity and its execution (Iliffe *et al.*, 1999).

The third issue raised about PT processes concerns their lack of flexibility. During the discussions with the workers, it was observed that there is no possibility of review. Any necessary change, including in related documents such as AR or LIBRA, results in the cancellation of the current PT and the requirement to start a new process. This aspect was pointed out by Iliffe *et al.* (1999) as one of the weaknesses of the system, since in its essence, the PT should enable relevant discussions and allow modifications to meet the needs of workers in various circumstances.

4. CONCLUSIONS

This article demonstrated, through two situations analyzed from an ergonomic perspective, deficiencies experienced by the operation and maintenance teams of a UTE during their activities engendered by the current TP process. The main function of the PT document is to create an opportunity for reflection, since it is precisely the perception of risks and their reflection that can prevent the occurrence of serious accidents and an overestimation or underestimation of existing risks. Thus, the merely bureaucratic document loses its function and distracts the team from what should really be questioned. At this point, Daniellou and Béguin (2007) reaffirm that the difficulties for the operator are not limited to what is done, but also to what he would like to do, but cannot.

The limits found during the preparation of this work are the high number of relationships that the PT process has with all areas of the company, representing a series of possibilities for deepening. In addition, ergonomic action requires the construction of practical solutions together with the unit. It should be noted that this work is inserted in the context of a research project, FHOSI, in progress. This is a project that foresees in its final stage the construction of transformation actions that will be monitored by the researchers, so that the present study intends to provide subsidies for the discussion and elaboration of them with the company and the study group.

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