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CONTRIBUTION OF DESIGN ERGONOMICS TO THE SAFETY OF OFFSHORE PRODUCTION UNITS

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Abstract

This study shows some ergonomic demands of operators that work in an oil platform. It was analyzed how the lack of ergonomic studies in design during the projects focusing in arrangement has negative consequences at work, especially related to accessibility to instruments and equipment. The identified users demands can be useful for the design of process plants more suited to operators' needs, avoiding the occurrence of work accidents, occupational diseases as well as reducing costs after the start of operation.

Keywords: Project; ergonomics; accessibility to valves and instruments

1. INTRODUCTION

Concerns and attitudes aimed at improving working conditions in the oil industry, whether on the part of the employer, the union or the Ministry of Labor, have been minimizing the impact on workers. In addition to this, there is an increasing need to apply ergonomic concepts in new process plant projects in order to reduce dissatisfaction and risks in work environments.

When ergonomic aspects are considered in projects, the ergonomist is asked to evaluate the human-system interface, aiming to reduce the probability of human error, inappropriate postures and improve comfort. However, in some cases, this involvement does not occur as planned, resulting in serious interface problems, resulting in limitations to make fundamental changes (HENDRICK, 2001).

During the project, many engineering disciplines are involved, such as process techniques, mechanical, electrical, civil and instrumentation. Engineering is considered efficient when all disciplines are fully employed and when there is a perception of mutual empathetic behavior. However, budget constraints are dangerous for good integration, and may

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cause a conflict between areas in obtaining resources and in the construction stages (RESSINK and UDEM, 1999).

Accessibility to instruments and equipment was explored with more emphasis, since it is a subject of greater relevance and requires greater effort from the worker. The greatest difficulty lies in improving working conditions after the beginning of the operation, since sometimes the change in the physical arrangement is unfeasible, making the worker adapt to unfavorable conditions, which is a factor for the occurrence of undesirable events. In this study, some cases of accidents were analyzed in which the worker's difficulty in accessing valves and instruments was perceived. Even knowing that there is not just one causal factor, poorly designed arrangements can contribute significantly to the occurrence of the event.

According to Rensink and Uden (1998), by verifying the user's capabilities and constraints during the conceptual phase of the project, it is possible to prevent many problems in the useful life of the installations. We might wonder why preventive human factor engineering is not always used instead of curative human factor engineering. Some arguments can be cited:

- Lack of competence of designers: many professionals receive only technical education. There is a priority for the technology involved in the process in relation to usability, that is, designers do not have sufficient knowledge of people's physical and mental behavior;
- Lack of adequate standards and guidelines: many technicians do not have knowledge of the physical and mental behavior of human beings to understand the human/machine interface. Abstract guidelines and norms do not promote the integration of the human factor in the project. Ergonomists must have actions that translate ergonomic standards so that they can be used by technicians. This translation should focus on the frequent operational and maintenance problems. For this, an analysis of the most frequent problems is useful and the existing rules and regulations of the governing body can help to choose priorities;
- Image problem: due to the lack of knowledge of the art of ergonomic engineering, which is still only related to the design of furniture, many underestimate the power of applying the principles of the human factor in the facilities of an industrial area;

- Recognition problem: when the human factor is considered superfluous and with little added value, the criteria of the end user are developed during the detailing of the project, resulting in changes in its scope and extra investments. These experiences reinforce ideas of implementing the human factor as being costly and having a negative effect on the schedule.

In view of the above, it is necessary for the ergonomist to clarify the consequences of some technical or organizational decisions taken and the methods to achieve certain objectives such as improving efficiency and quality, reducing the difficulties faced by workers, etc., which should be through the approach to work (DANIELLOU, 2004).

2. GOAL

The objective is to analyze some ergonomic demands related to the absence of adequate access in the process plant of an oil platform and to verify how ergonomics can help workers to perform their activities safely, thus contributing to the reduction of the risk of occupational accidents.

3. MATERIALS AND METHODS

The population analyzed in this study is composed of employees and collaborators of an oil platform, specifically operators and technicians who access valves, instruments and equipment in the operational area. Initially, a bibliographic research was carried out in books, monographs and articles related to the subject. The observational research method was used, with photographic records, in order to support the conclusions of this study.

Some accidents that occurred in maritime units whose underlying causes are related to the lack of adequate access were selected. Then, photographic records of real situations were made showing some resources used to minimize the working conditions found; among them, the Platform for Work at Height (PTA). It was also analyzed how ergonomics in the design phase contributed to the improvement of some activities and workplaces.

4. FINDINGS

4.1. Accidents that occur due to difficulty of access

Two events related to inadequate positioning of valves and equipment and non-existent or deficient access were selected.

In the first accident, during the operation of changing the filter of the hot water pumps, a steel bar was used to close the filter cover, when the operator suffered the impact of the bar against the thumb of the left hand. Among the corrective actions adopted are the creation of an aid device to carry out the task of opening and closing the filter and improving access to the equipment.

Figure 1. Simulation of the accident

In the second event, the worker, while closing a valve, lost his balance and fell from the level of 40 cm in height, suffering a contusion with misalignment of the wrist and abrasion in the anterior region of the arm. During the analysis of the accident, it was noted that force majeure was required due to the internal pressure of the system and that the valve was installed at a height of 2.15m from the base of the *skid* (valve maneuvering place). However, due to the limited space to support the feet, the operator suffered the fall. Among the corrective actions adopted is the installation of a grid floor leveling the floors of the *skids* and the installation of a rod extension device, so that the operator can perform the activity with proper posture.

Figure 2. Location of the valve in relation to the *skid*

In the events analyzed, we can see that, when the project is conceived with flaws, the worker creates alternatives for the execution of the task. The events listed are some demonstrations with unintended consequences of known issues. In figures 3 and 4, there are examples of other operating points in places of difficult access. In this scenario, the safety professional must have a decisive role in every workplace where there are no appropriate means of access, whether by recommending the installation of chain mechanisms in valves, permanent or temporary access (scaffolding) or the use of automated platforms.

Figure 3. Inadequate access 01

Figure 4. Inadequate access 02

4.2. Mechanisms and equipment used

Since permanent accesses require the preparation of a project and material and human resources, and temporary accesses require compliance with a series of current standards and recommendations contained in safety manuals and company standards, some alternatives were chosen, such as the use of Platforms for Work at Height (PTA), as shown in figure 5. However, this type of resource has limitations due to the difficulty of use and due to this some equipment becomes underutilized. During an experimental phase, it was noted the difficulty of reaching operating and use points due to the platform floor.

Figure 5. Automated platform

Another alternative is the use of a valve operated with the aid of chains, as shown in figure 6. This type of valve is used on a large scale in industrial areas that have little space available for access installation.

Figure 6. Chain valve

4.3. The effects of applying ergonomics in projects

Ergonomics aims to increase the efficiency, reliability and quality of industrial operations. A company's safety success begins with the continuous improvement of equipment and working conditions through macroeconomic policies (ROCHA, 2017).

In terms of design ergonomics, we can mention the changes that occurred in the design phase of the platform studied, when another maritime unit was used as a reference situation. On this occasion, the improvement in the elevation, by approximately 400 millimeters, of the valves and pipes of the main deck and the installation of deluge valves (*Automatic DelugeValve* - ADV) along both the starboard and port ends, stand out. The change provided greater safety to the worker who transits through the region. On the other hand, other points of improvement

were not foreseen in the project, such as the ease of access in the CO2 battery room, which are arranged in two rows, one in front of the other, creating difficulties to carry out the exchange and maintenance of cylinders weighing 45 kg. there is an increased risk of accidental CO2 firing in a given environment or an accident with limb press.

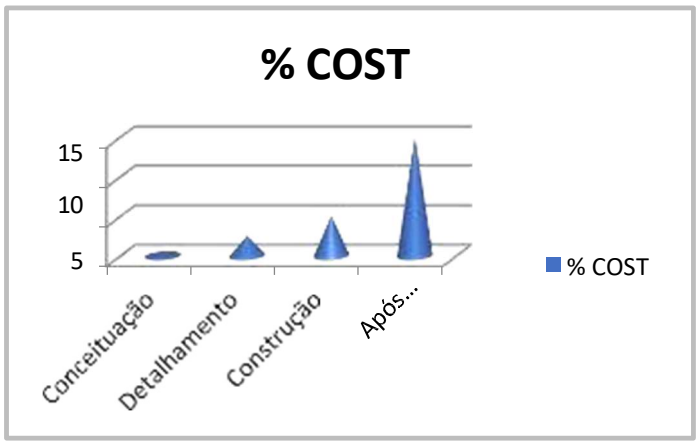
Figure 7. CO2 Battery Room

According to Rensink and Uden (1998), the benefits of an ergonomic view are felt both in the financial aspect and in the improvement of working conditions. Based on historical records, it is possible to identify that good planning can result in a reduction of:

- 0.25 to 5% of the capital spent;
- 1 to 10% of project time; and
- 3 to 6% in the life cycle cost of the facilities.

A study on the use of ergonomic concepts in the elaboration of projects (AUBUM ENGINEERS, 2001 *apud* GUIMARÃES, 2002) considers that if they are implemented in the conceptualization phase, only 0.5% is added to the cost; in the detailing phase, between 2 and 3% is added; in the construction phase of the system, it can add 5% and if it is considered after the project has been completed, The values can represent 10 to 20% of the cost of the project. The graph in figure 8 shows that the costs of ergonomic actions increase considerably as they are implemented later.

Figure 8. Cost from actions Ergonomic in function Of phase of the project



5. Conclusion

In the study presented, it is clear that the concept of ergonomics is not generally applied in projects of new installations. Thus, many non-conformities are found during the operation phase of the process plants, reflecting in worker dissatisfaction and eventually in the occurrence of accidents. We can also see that maritime units with a short time of operation have problems that could have been observed and corrected in the design phase. It is important to emphasize that costs are mitigated if the ergonomic study is started right at the conceptual stage or in the definition of guidelines.

Even if there are modifications in the process plant, with the incorporation of new products or new technologies, it is essential to observe and analyze the conditions of physical discomfort that operators are subjected to and the ways that are being adopted to mitigate design flaws. The techniques used for access in places that were not designed for this are often not carried out safely or the available resources are not efficient. Therefore, the ergonomic approach in new industrial plant projects is extremely important.

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