Outsourcing and Accidents in the Electrical Sector

Alessandro José Nunes da Silva[a], Rodolfo Andrade Gouveia Vilela[b] and Ildeberto Muniz de Almeida[c]

[a]Center for Worker Health Reference in Piracicaba
São Paulo, Brazil

[b]School of Public Health
São Paulo University, Brazil

[c]Botucatu Medical School
UNESP – Univ Estadual Paulista, Brazil

ABSTRACT

In Brazil, the accident rate in the electrical sector is 5.5 times higher than in the other formal segments of the economy. In 2011, outsourced work represented 56% of the workforce in this group and his mortality from workplace accidents reached 8 times that of permanent workers in the sector as a whole. This study aims to ascertain how third-party outsourcing contributed to an accident that victimized a worker and to provide an elaboration of strategies for surveillance and prevention in the sector. Study supported in the model of analysis and prevention of accidents (MAPA). The worker suffered amputation of the left leg during maintenance of a de-energized secondary line. A crossarm that supported an energized primary line just above, broke allowing the cable to fall on the leg of the worker that was working on a ladder about 5 meters in height. Accident involving a lack of barriers against electrical risk previously identified in a system deteriorated due to decades without maintenance. The national strategy of third-party outsourcing adopting as evaluative indicators the lowest price of service, the frequency and duration of interruptions of the energy supply to consumers has contributed to the origins of the event. New studies are required to explore up to what point the findings demonstrated herein represent characteristics of the process of third-party outsourcing of activities in the electrical sector in the state.

Keywords: Third–party outsourcing, Electrical sector, Work accidents, Accident analysis, Model of analysis and prevention of accidents (MAPA)

INTRODUCTION

In Brazil, work accidents (WA) constitute the main health complaint among workers, with elevated social and economic costs that can consume 10% of GDP, reaching values de approximately 71 billion reals (R$) /year. The country remains in a critical situation in the international scenario with three deaths every two hours and three non-fatal workplace accidents every minute.

The accident rate in the electrical sector is 5.5 times higher than in the other formal sectors of the Brazilian economy. In 2011, outsourced labor represented 56% of the workforce in the sector. The mortality by workplace accidents in this segment increased significantly, reaching 8 times that of permanent employees of the sector (Dieese, 2010).

Studies suggest a relationship between the occurrence of WAs and the dissemination of third-party outsourcing of electrical service that, according to (Dieese, 2010), occurred throughout the 1990s in the context of redefinition of the sectorial model and strong transference (privatization) of shareholder control of companies from the public to the private sector. The logic of private operation, centered on profit, and the strong regulatory incentive to reduce costs without effective laws that would impose limits, have been crucial factors in creating the current situation, in which more than half of the workforce are not employed in companies holding the concession for offering the activity. According to the Report on Fatal Accident Statistics in the Brazilian Electrical Sector, produced by the COGE Foundation[1], in the years 2006, 2007 and 2008 there was reported, respectively, 93, 71 and 75 WA.

In 2008, the mortality rate in the electrical sector workforce was 32.9 deaths per 100 thousand workers. Segmented analysis reveals that among the outsourced the rate was 3.21 times higher than for those of permanent workers. While the rate among those contracted was 47.5, that of the permanent employees was only 14.8 (Dieese, 2010).

In this context of new economic models and of governmental reform, the companies were stimulated to undertake internal processes of production restructuring and to create flexible production sectors. The current era is witnessing the thriving of models of production organization and management called reengineering of workplaces, “Toyotism”, the demands for worker polyvalence and also of Just-in-Time, Kanban, CQCs (Quality Control Cycles), working in cells and policies of planned layoffs of staff, denominated “downsizing” (Baumgarten, 2002).

The current configuration of the labor world has had a negative impact on the health of workers, as shown by the elevated incidence and prevalence of work-related accidents and diseases (Minayo-Gomez, et al., 2003), (Druck, et al., 2007) (Alves, 2011), (Antunes, 2005).

CHARACTERISTICS OF THE BRAZILIAN ELECTRICAL SECTOR

In 2012 electricity consumption in Brazil rose almost 38%, eight points above the average global increase of 30%. According to data from the International Energy Agency (IEA), the country is the tenth greatest energy consumer on the planet. After its generation, electrical energy is then transmitted to distribution centers that concentrate their activities on the final process of supplying it to the consumer (Creder, 2007). Most of the workforce in the Brazilian electrical sector is concentrated in the area of energy distribution. This segment also presents the greatest quantity and diversity of activities performed both in energized and de-energized systems.

The process of privatizing Brazilian governmental companies was initiated in the 1980s, when the state avoided expanding its participation in the productive sector. During the 1990s, privatization was operationalized through the National Privatization Program (Law number 8.031/90) especially starting in 1995, when bids for public services in the areas of electricity, transport and communications began to be transferred and granted to the private sector. The initiation of the privatization of the electrical sector in 1998 led to the introduction of new technologies and materials and, especially, significant changes in the processing and organization of work in the sector (Brazil, 2011).

In the Brazilian electrical sector, it is possible to identify three preponderant types of activity: distribution, generation and transmission of electrical energy. Each of these has distinct characteristics that define its respective workforce: (a) Distribution – aggregates a greater number of activities, and also a higher demand for workers. Its principle function is to guarantee the supplying of electrical energy to different classes of consumers: residential, industrial, commercial, rural, public sector and others. (b) Generation – has the function of producing electrical energy to distributors who carry it to consumers. It is characterized by a large investment in fixed capital and low labor density. (c) Transmission – has the function of transferring energy from power generation plants to distribution companies. It also employs few workers and a large part of its activities is programmed.

[1] The foundation COGE is a private non-profit legal corporate entity whose mission is to provide knowledge and solutions for business management that add value to the technical culture of organizations, prioritizing the energy sector.

The distributors operate lines of medium and low tension, also called secondary and primary networks. The low-tension (secondary) networks, in other words, those that act with voltages between 110 and 440 V, are affixed to the same concrete posts that sustain the medium-tension networks, being located at a lower height. The low-tension networks convey electrical energy to residences by means of so-called branch connection lines. Supermarkets, commercial shops and medium-size companies acquire electrical energy directly from medium-tension networks, having to transform it internally to lower levels of tension, under their responsibility. In Brazil, the medium-tension (primary) lines are those with an electrical tension between 2.3 kV and 44 kV, and are easily visible in streets and avenues of large cities, frequently composed of three aerial conducting wires sustained by wooden crossarms on concrete posts (Abradee 2013).

There are four types of networks for distributing electrical energy in Brazil, namely the Conventional Aerial Distribution Network, the most commonly found type of electrical network in the country. In it, the conductors are exposed or without insulation. For precisely this reason, these networks are more susceptible to the occurrence of defects, short circuits or accidents, especially when there is contact between tree branches and electrical conductors. The Compact Aerial Distribution Network: Emerging in Brazil during the 1990s, the compact networks are much more protected than conventional networks, not only because the conductors have an insulation layer, but also on account of the fact that the network itself occupies much less space, resulting in fewer perturbations. The Isolated Aerial Distribution Network: This type of network is well protected, since the conductors are encased with sufficient insulation to be braided. Generally more expensive, this network is utilized under special conditions. Underground Distribution Network: An underground network is that which provides the highest level of reliability and also the best esthetic result, given its location. However, underground networks are much more expensive than the other solutions, being common only in regions of high density or those under restrictions for installation of the aerial networks (Abradee 2013).

THIRD-PARTY OUTSOURCING

According to Hätönen (2009), third-party outsourcing was initiated in the 1950s, but was not widely adopted by organizations until 1980. Since then the strategy has evolved from an approach strictly focused on cost. Third-party outsourcing has been associated with an increasing danger of work since, as a managerial technique that aims to reduce costs, either by avoiding obligations of labor law, or by differentiation in levels of salary and benefits between contracted and permanent employees (Krein, 2007; 2009).

To Dieese (2007), the process of third-party outsourcing always occurs between two companies, in other words, a situation of a “mother company” and a third party company is determined by a specific relationship between them. For this reason, in this process a “mother company” can be a third party company in another process and vice-versa. Third-party outsourcing is carried out in two non-exclusive forms. In the first, the company stops producing goods or services utilized in its production and starts to buy them, which provokes a partial or total deactivation of sectors that formerly functioned inside the company. Another form is the contracting of one or more companies to execute, within the “mother company”, tasks previously performed by workers contracted directly.

Despite their multiple forms of manifestation, third-party outsourcing is identified by the search for cost reduction, organizational flexibility, a capacity to rapidly attend to new demands of the product market and the sharing of risks from conducting business with another economic agent, as a strategy for dealing with a scenario in which financial capitalism prevails and in which the companies are exposed to greater competition due to deregulation of the economy and to low and unstable product growth (Chiang, 2009; Krein, 2007). Third-party outsourcing must be understood as a greater strategy of productive restructuring, in a context of new sources of capital accumulation that has as their objectives, among others, the outlining of barriers to this accumulation created by workforce costs and by the resistance of workers (Druck, 1999, p.149).

The advent of outsourcing has promoted, according to Druck (2011), an increasing hazard in working conditions, which is evidenced in an erosion of salary and of rights, augmented intensity of work and of risks to worker health, besides the difficulties faced by labor unions in unifying the common struggles. To the author, third-party outsourcing is the principle form by which work has become more dangerous in the past two decades (Druck, 2011).

According to Kyoung, et al. (2013) in a study carried out in South Korea, the outsourced employees face a greater risk of acquiring work-related diseases and have a higher absenteeism rate than permanent employees. Furthermore,

work conditions as well as psychosocial factors contribute to the health inequalities observed between outsourced functionaries and proper employees of the companies.

In Brazil, according to data published by the Brazilian Institute of Geography and Statistics (IBGE) in 2011, approximately 8.2 million workers were outsourced, which represents 24% of a current total of 37 million formally contracted workers. The segment of energy and telecommunications is one of the industrial sectors that most often outsources labor in the country. According to studies elaborated by the Inter-Union Department of Statistics and Economic Studies (Dieese, 2011), in the eight years from 2003 to 2011, the third-party outsourcing in the electrical sector increased by 288%, rising from 39,649 to 137,525 workers.
This study explores the relations between third-party outsourcing and the accident rate and applies in-depth analyses to the accidents that could contribute to elucidation of the complex relationships between the process of implantation and / or dissemination of strategies for hiring tertiary companies and the increase of the accident rate in the São Paulo electrical sector. Rather than explore the extent to which evidence might be correct in studies suggesting an augmented risk of accidents in outsourced activities, this work intends to explore, in a specific accident case in the sector, the presence or absence of contributing factors and aspects whose origins are associated with choosing this strategy in the form as adopted in the state. The findings obtained aim to provide an elaboration of strategies for surveillance and prevention of accidents in the country.

METHOD

Model of Analysis and Prevention of Workplace Accidents "MAPA"

The Model of Analysis and Prevention of Workplace Accidents (MAPA) is a tool for supporting the development of Surveillance Practices in Worker Health (VISAT) in cases of accidents, in other words, that aims to contribute to the development of intervention that integrates an approach of: a) macro-determinants, such as choices of development models and policy decisions about the regulation of processes that create dangers and risks with; b) situations of exposure in the installation and / or functioning of processes that embed hazards and risks and also, c) immediate and delayed consequences of exposures to such hazards and risks. Situations that create exposures, severe events such as accidents and incidents, prolonged exposures to risky situations and acute or chronic consequences for the health of workers, for inhabitants of neighboring or distant regions, for future generations and also reflections in the environment, cultural or historical heritage, economic losses, social injuries, etc., are explicitly described as events with a history, involving antecedents and consequences and not only immediate results (Almeida and Vilela, 2010). This model is supported by concepts that guide the collection and interpretation of data from multiple sources in order to identify the most information possible related to the history of the events in order to identify contributions from the organizational dimension of the system in the origins of the accident. The prevention strategies being suggested, whenever possible, should address the three dimensions mentioned.

The method proposes a description of the habitual work or of established practices (Rasmussen and Svedung, 2000) considering the most frequent variabilities and, especially those related to the accident, in agreement with changes habitually established in strategies and operational modes adopted by workers for the correction or adjustment of these variabilities. Also to require an analysis of changes including incidental ones would be in components of the system or in interactions of these components among themselves and / or with elements of the environment into which it is inserted or even in habitual practices of adaptation to these changes. This approach even associates the analysis of barriers as suggested by (Hollnagel, 2004 and 2008) and, finally, suggests that the appropriate analysis always be complemented with the support of concepts from different areas of knowledge already applied in studies of accidents and which are useful in this case in question. The latter step was denominated conceptual enlargement of analysis, which, when considered necessary, must imply the mobilization of cooperation of professionals better acquainted with these concepts. Prominent among the proposed concepts are those from Activity Ergonomics (Assunção et al., 2001; Guérin et al., 2001); those from the theory of a normal or systemic accident, especially the notion of interactive complexity of (Perrow, 1999); the notions of comprehension and cognitive commitment as developed by (Amalberti, 1996); the models of organizational accident of (Reason, 1997) and (Llory, 1999a, 1999b); the notions of normalization of deviations (Vaughan, 1997) or of systems' migration to accidents of (Rasmussen, 1997). Special emphasis has been given to the notion of cognitive traps (Reason et al 2003; Almeida, 2004) not only in cases that involve omissions in task steps but also in situations already described as arising from automatic surprises, mode errors, predictable bypasses, feedbacks that hamper or impede the comprehension of operators on the mode or status of the system, etc.

MAPA requires the collection of information with the workers, fellow team members, intermediary supervisors and from related sectors, documents examinations, analysis and observation of the work process. The guide contains the following steps: (a) Identification of the companies and victims; (b) Description of the habitual work (without accidents); (c) Description of the accident itself including analysis of changes and analysis of barriers; (d) analysis of the conceptual aspects useful in the comprehension of behaviors of the operators as well as the interactions and proper connections of the functioning of the system; (e) Measures adopted by the company after the accident; (f) Conclusions organized in the form of contributions (f1) of managerial and organizational aspects generally revealed via management of production properly told (choices of technologies and practices in the management of variabilities), management of maintenance, staff, materials and projects, etc... (f2) of aspects of management of worker health and safety; (h) Conclusive synthesis on the origins of the accident; (j) Recommendations for prevention.
The interventions based on MAPA seek to break with comprehensions of accidents as events that are exclusively technical or resultant from human error of the operator at the sharp end of the system. They stimulate the utilization of analyses as revelatory tools of social mediations, of decision-makers, of the exercise of autocratic power in workspaces, of the imposition of hazardous work and safety conditions as well as of constraints that limit margins for maneuvering workers in the exercising of their activities. It encourages the understanding that the behaviors that contribute to accidents are consequences and not causes; it necessitates comprehending rather than judging them. The "errors" must be interpreted as points of departure and not the end of the analyses.

RESULTS

Summary of the Accident

The wooden crossarm that supported the energized cables of the primary line of the electrical network situated on the upper portion of a post broke, thereby occasioning the fall of one of these cables onto the leg of a network maintenance worker (contracted team – third party). The task of the team was to replace an old secondary line, which was found de-energized, with new and safer wiring. The secondary wiring is supported slightly below the primary network, on the same post. The electrician suffered shock and subsequently had to undergo a leg amputation. The fall of both the crossarm and the cable had origins in the intervention of team colleagues of the electrician when they stretched the cable amidst the trees, the new cables of the network secondary.

Task Context and Service Preparation

The intervention of the contractor team starts with a service request issued by the contractor. From the defined section in which replacement of wiring is done, the contractor sends a supervisor to the area in order to evaluate the viability of the task. In case of accident, the analysis performed did not register the existence of fragility in the crossarms installed on the posts of the primary network, which had gone more than 25 years without maintenance. An authorization of intervention in conventional networks is preceded by shutdown of the secondary line, but the primary line is kept energized, aiming to minimize supply interruptions and impacts on the consumers and users of the system.

Once the service order is received, the contracted team initiates its intervention by carrying out a Preliminary Hazards and Risks Analysis, which, besides diagnosing the situation, must indicate the appropriate preventive measures such as signalization, grounding, the use of personal protective equipment, the tasks and roles of each member of the team, etc. On these occasions the habitual practices of the contracted party does not include the observation of eventual wear and tear of the crossbeams. In the case of electricians, the performance of work at a great height requires the use of double-lanyard safety belts specifically designed to break any fall and fixed to a lifeline, on the same post. The work equipment also includes tension detectors for evaluating the (de)energizing of the line to be replaced. With the aim of controlling the times during which the secondary line remains turned off, the tasks are programmed by the concessionary with a predefined duration, giving rise to time pressures, especially when the preliminary planning does not consider variabilities such as the presence of trees between posts. In case of delays, the contracted party is punished with fines.

The following quotations illustrate the view of the electrician from the contracted company on differences between his work and that of the contractor's staff:

> *"They are all capacitated, aren't they?! Be calm and don't worry. There, people don't …, there the people already have that weight they need, don't they, to do! The people have the responsibility, have the safety technician examining everything, on top of things. The people are somewhat . . .*
>
> *"It's like this: there they have a certain time to finish the task; did you understand?! So, that is to say the shutdown begins at one o'clock. And at three o'clock, it must be turned off. Many things are still lacking; there comes that hurrying, did you understand?"*

Asked about what happens in the event the goals are not achieved, the worker responds:

> *"Well, it depends. If much time passes, these things, a fine if imposed, these things, understand?! So, there is much complaining ..."*

The Task of Replacing the Secondary Network

The concessionary company responsible for energy distribution contract third parties to carry out maintenance activities in secondary lines and installation of new lines. In theory, these third parties must work only on systems without energy. But in various locations in the Brazilian system of distributing electricity to residences, the primary lines are installed on wooden structures called crossarms situated on the upper portion of the posts while the secondary ones pass about 1m below and the same posts also receive, about 1m lower, the telephone lines. Figure 1 shows a Conventional Aerial Distribution Network whose secondary lines consist of 4 wires separated by a short distance that are unprotected from contact shocks.

Although the interventions at the posts would be conducted by electricians, this maintenance work is done in proximity to the primary line energized and the activity to be performed is formally framed as civil construction. In conventional networks there is no maintenance programmed for the replacement of crossarms, so that the presence of degraded structures is common even in the aspect of their functioning, thus weakening the system since in the event of breakage due to *wear (and tear*) or deterioration of the wood, cables of the energized primary line would fall.

The description of real work shows that the maintenance service to be performed by staff of third parties is considered an activity of civil construction, without electric risk. The contractual requirements adopted do not include requisites for experience and competencies for the recognition and management of risks of real work with electricity on the part of all members of the teams. Furthermore, while the concessionary is from the electrical sector and has its workers represented by a union of electricians, the employees of the contracted companies are represented by civil construction unions. This division does not arise by chance. The electricians' unions tend to be politically stronger and more active in obtaining superior salaries and rights in relation to those of construction civil. This division hampers the establishment of cooperative relations between the respective groups of workers, a fact that is more evident where there are new teams working.

The accident victim, Mr. "C", aged 24 years, had been working for 1 year and six months for a company of the electrical sector, where he participated in the electricians' course determined in Brazilian law. On the day of the accident, he had been employed for only twelve (12) days and, despite having performed the same task for his previous employer, was acting for the first time with the new team.

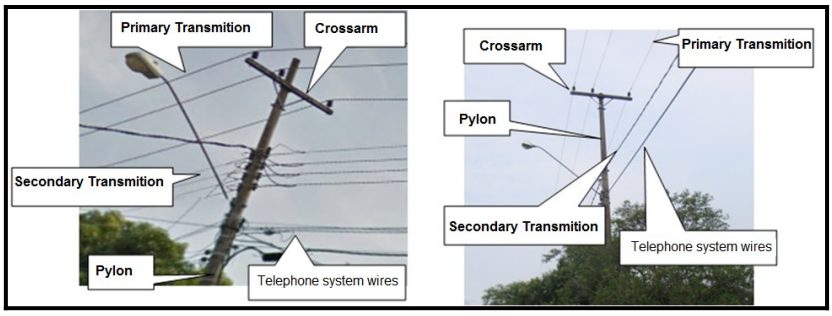
The task attributed to contracted team was the replacement of a *secondary network of conventional aerial distribution*, older and unprotected, by an *isolated* aerial *distribution network*, recognized as a better and safer technology, since the cables in it are entangled, encased to protect against contacts and shock to facilitate economy of electric charge (Figure 1). The team in charge of replacing networks was composed of three electricians, two assistants and one driver of the Munck truck that interact in the field. Only the electricians work on posts by removing the conjunction of cables of the secondary conventional line and installing a single new cable with wiring. Once in the field the assistants and driver act on the ground to help the electricians.

A substitution of network cables is effected in sections that are generally composed of four posts separated by distances of approximately 35 meters. Before elevating the new cable, the assistants extend the wiring on the ground along the span of the four posts. Next, it is necessary that the first electrician fix the cable onto the first post, which is about 5 m in height. As illustrated in the schematic in Figure 2, the other electricians position themselves at the

second and fourth posts of the section. At the top, the wiring is fixed or "headed" and, at the opposite extremity, it is pulled or stretched in a space of more than 100 meters with the aid of one ratchet. This process stretches the cable. In the span where the accident occurred, there were two trees among the posts, (Figure 2), which hampered the visualization, communication and coordination of the task among the team members.

The presence of trees among the posts is a relatively common variability in this activity. One of the strategies used by the teams in these situations consists of extending a mechanical arm from the Munck truck for lifting the wiring. The operation of this device is commanded by one of the assistants and requires slow cautious movements besides the help of colleagues to indicate the desired height and location for the cables. Next, tension must be added to this wiring, by means of a ratchet, up to the point considered ideal, which is recognized based on both visual inspection and the experience of the electricians.

Figure 1. Primary and secondary lines in conventional distribution networks (left side) and isolated (right side of the figure)

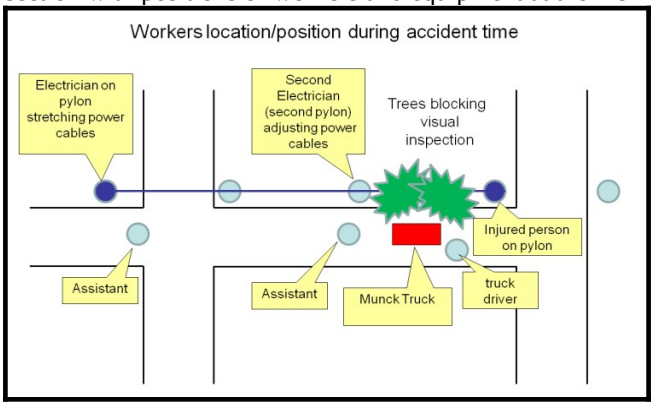


Conventional line Isolated line

The Accident

On the day of the accident, the team of Mr. "C" replaced cables inside a residential condominium. After the removal of the old line, at about 5:43pm, the electrician had begun the fixation of the cables onto the first post. The task was performed under time pressure since the presence of trees between the first and second pylons had delayed the team.

Figure 2 – Schematic of the section with positions of workers and equipment at the moment of the accident.



Up to the present, the analysis has had access to and considered two versions of the event. According to the first, when Mr. "C" had already partially grasped the new cable to be installed on the first post of the section, his work was affected by the intervention of team colleagues that, with the aid of the arm from the Munck truck, passed the same cable above the tops of the trees located between the first and second posts of the section. The tension to which the wiring was submitted had balanced the post on which Mr. C was positioned, breaking the crossarm situated slightly above the point where he was working and leading to the fall of the energized cable of the primary line onto his leg.

In second version, the cable being replaced had already been passed above the trees and was being pulled by the ratchet used by a fellow electrician that was on the fourth post situated at a distance. This electrician had not been advised that the cables were stuck in some branches of the trees. Assistants of the team acted to detach the cables from the branches, dissipating the tension by a curling movement reaching the first post several times and making it ascend so that the crossarm broke and knocked down the energized wire of the primary line.

Both versions have the same outcome: the breaking of the crossarm and the fall of the energized cable onto the body of Mr. “C”. Upon perceiving the imminence of electric shock, the electrician tried to descend the ladder, released the first lanyard of the safety belt and jumped to the rear. However, he was trapped by the second lanyard and fell seated on the telephone cables situated slightly below. At this point the cable of the energized line (primary) struck the worker provoking electric shock that entered by the anterior facet of his left leg and exited in the region of the buttocks in contact with the telephonic wiring, thereby provoking very severe burns and subsequent amputation of the struck leg.

A description of the system reveals contributions from other of its components to the accident. The network is equipped with an automatic shutdown-restart system that operates with the logic of minimizing the time of interruption of the supplying of energy to the public. In the period immediately after the shock suffered by Mr. C, the system turned off and restarted three times augmenting the severity of his wounds. This characteristic of the system had already contributed to increasing the severity of other accidents involving energy distribution networks and, from a safety point of view, can be indicated as a failure of design since, in the quest to minimize an interruption of the energy supply, elevates the potential severity of injuries in the event of accidents.

Analysis of Changes

At this point of the analysis are explored changes made present by the occasion of the accident in components of activity, in the environment in which this develops, in interactions of these components with each other or with those of the environment or even in response to these changes. In the accident situation, the task was corrective maintenance, in other words, a task carried out only in a small portion of the total time, in long intervals, with the aggravating circumstance to be performed by a recently constituted team.

Mr. C, the electrician who suffered the accident, had been working only twelve days on the team that was working together for the first time. Although he already had had experience in activities of occupation, he was recently contracted by a third party, which was accustomed to assembling teams according to the demands received from the contractor. This is one of the forms by which the strategy of third-party outsourcing contributes to accidents.

The substitution of four-wire conventional installation with a cable of the new type was hampered by the presence of trees between posts, a known variability of the system that enables the use of a arm from the Munck truck in an attempt to achieve a solution. The communication and visibility among the assistants and the electricians situated in distant ladders were hindered by the presence of an obstacle being also affected by low luminosity associated with the hour of the accident, already about 6pm, and also, it may be suggested, by the fact that the team was still in the process of formation, operating for the first time in a section that presented trees between posts. In other words, its members still had not worked together in similar situations and did not share the same knowledge and / or strategies of problem solving. This is another form in which third-party outsourcing contributes to the occurrence of accidents.

The main changes registered in this accident were the failure of one of the materials, a crossarm installed high on the first post, and the consequent fall of a wire of a primary energized line that ended up striking the electrician. In the two explanations indicated, the new cable that was being installed had been tensioned excessively, by the action of a colleague that passed it over the trees with the aid of a mechanical arm, operated by the action of another electrician who tightened this cable by means of a ratchet, starting from the fourth post of the section. The traction to be exerted on the cable is defined based on visual observation and the experience of the professionals involved. In this second version of the accident, these competencies would be required of the fourth electrician that operated the ratchet at a distance and of the other team members who were helping him in the task from the ground. In the hypothesis of tension due to the elevation of the cable by using the mechanical Munck arm, the experience of the equipment operator and of his helpers gains relevance. Dealing with a task performed for the first time by a new team in circumstances that hindered visualization and communication, the coordination among the workers becomes more difficult and in this manner, small changes either in the skill of the operation of the mechanical arm or in the ratchet

operation could lead to loss of control of the task and trigger the accident. Moreover, the elevation of the cable without being caught on a tree branches also depends on the height of the branches and cooperation of colleagues who work in the situation.

Furthermore, analysis of the broken crossbeam shows that the same presented evident signs of wear that diminished its resistance. In fact, the system operated with materials in a poor state of conservation as a function of delays in the maintenance program, in particular with the inexistence of preventive maintenance. So far, the analysis has not succeeded in clarifying the reasons for these managerial choices except with regard to short-term economic considerations, but it is possible to indicate the contribution of maintenance management failures as another condition associated with the origins of this accident.

Another condition that resulted in worsening of the injuries was the automatic consecutive restarting of the power, a measure adopted by the contractor in view of the urgency to restart the supply, which, however did not consider the safety aspects for workers or even for the public in cases of network anomalies.

Barriers Analysis

The analysis showed that one of the barriers for prevention and protection present in the system against this type of accident was its work permit system, the job of a contractor, which includes among the obligations of the hired party, the performance of a preliminary analysis of the hazards and risks (APPR) in the section to receive the intervention. The analyses of the contractor and of the contracted party did not report the presence of trees between posts of the section nor the presence of crossarms in a poorly conserved state. The implications of these facts for safety were not considered in the planning of the task. According to the hired team, it was not among their obligations to analyze the material conditions of the section in which the contractor demanded and authorized their work. Furthermore, it is highlighted that these analyses, especially APPR, do not indicate the proximity of the energized primary line as a hazard or source of risk. For this reason, it was not isolated and turned off. This analysis did not clarify the reasons for these failures. It is possible that given the option of granting permission to work on an energized primary line, in Brazil this practice configures an example of a situation of assumed risk adopted without explicit information to diminish the chances of resistance from the legal system and / or from the workers. Yet with regard to APPR performed by members of the hired company, the analysis still did not clarify who or which workers that conducted it and how. In practice, it was possible to clarify that the fact the hired company did not indicate the need for insulation or a shutdown of the network met the immediate interests of the contractor as to the streamlining of the replacements. These aspects reveal the contributions of failures in safety management of the contractor and the contracted company in the origins of this accident and also of the gaps in the safety norms of the sector.

Access to the investigative report of this accident, elaborated by members of the safety teams of the companies, revealed new failures in management of system safety. Failures indicated in the analysis of barriers, in management of safety, in management of maintenance and in management of third-party outsourcing were disregarded.

DISCUSSION

In the literature the relation between third-party outsourcing of activities and workplace accidents is controversial. In a recent study on work in the extraction of oil and natural gas via ocean platforms, (Figueiredo, 2012) described not only situations in which the strategy creates obstacles to the development of necessary expertise, negatively affecting safety, but also situation of its use in highly specialized activities such as deep-sea diving. For the author, it would be a mistake to reduce the increase of accidents found “to an intensification of third-party outsourcing” (p 168), but to a greater or lesser degree the logic that guided the advance of these practices would have “contributed to the escalation of accidents”. This study is added to those that seek to elucidate the complex relations between accidents and this modality of labor management.

According to Franco et al. (2010), the expansion of precarious work would have the following steps: (1) Absence of respect for the bonds of work and contractual relations, (2) Changes in the organization and in work conditions, (3) Negative impacts on of the health of workers, (4) Weakening of social recognition, of symbolic valuation and of the process of constructing individual and collective identities and (5) impacts on the nature of representation and collective organization (unionization).

A network of factors interacted to contribute to the origins of the accident reported in this study reveals elements of this process in the company in question. The amputation of the lower left limb suffered by the electrician involved repetitive electric shocks that appear to have origins in an automatic restarting device activated based on the logic of minimizing periods without the supplying of energy. The event had its immediate origin in the breakage of the wooden crossarm that had been kept deteriorated for years without preventive maintenance and consequent fall of a cable from the energized primary line onto the leg of a worker. In turn, the breakage of the crossbeam had in its origins the intervention of other colleagues from the contracted team for the substitution of the non-energized secondary line positioned on the same post.

Apparently, the actions used by the colleagues in the installation that resulted in breakage of the crossarm were the same as those an experienced team would utilize in work without an accident, but performed without the skill that tends to be acquired only with practice. On this occasion the team had been recently formed, composed only of recently hired members and that, for the first time, acted in a span with the presence of trees between posts at the end of the afternoon, yet without ideal conditions of visibility. In this study it was still not possible to explore in depth the eventual contribution of the aspects of (in)experience of third-party workers in this accident. Unanswered questions remain about the acquisition of their repertoire of specialized technical knowledge as to the so-called "tricks of the trade" indicated by (Dejours et al., 1994) as the main work tool of an electrician. For (Scopinho, 2002) the experience constructed day-to-day through the effective performance of work and of living harmoniously with companions is what enables detection of the causes of defects in the network with greater agility and precision, and execution of the work in a safer manner. The importance of formal theoretical training is widely recognized by electricians, but it is the unanimous opinion that to work efficiently and safely in energy distribution with a live line, electricians must have, at a minimum, five years of continuous work experience. These opinions are equivalent to that of (Amalberti, 1996) who identified comprehension of workers about the conditions and state of the system as a fundamental element for safety and reliability. Situations of loss of comprehension would be among the origins of accidents.
One fact that should be highlighted is that analysis reveals limits of the traditional approach to safety, in particular, as to the comprehension of preventing electrical accidents as a technical practice consisting essentially of compliance with the pertinent legal norms. In other words, in this case the permission to work in proximity to a live line was a habitual practice considered acceptable by the current norms. In this accident, the mere use of technical measures, such as isolation of primary cables, not utilized in this case, would not eliminate the risk of electrical shock for electricians, their colleagues or even those passing by similar activities that were being performed.

In other words, the accident has origins in the strategic decisions of the contractor such as authorizing interventions in proximity to the energized lines, or remaining for more than 25 years without preventive maintenance of its energy distribution network and adopting strategies of third-party outsourcing that transfer activity in exposure to electrical risk to civil construction companies without requirements of qualification or of practical experience that the work necessitates. The repeated use of these practices may have contributed to the normalization or banalization of risk that shall be recognized as such in preliminary analyses conducted by specialized professionals from both the contractor and contracted companies.

The presence of so-called conventional secondary distribution networks, even those with 4 conductor wires exposed or without insulation or protection against defects or energy waste, and the hazardousness of material conditions of the components of this network left without a program of preventive maintenance permit us to suggest that the electrical system in the region of the accident was not only obsolete but also operating under degraded conditions. The origins of workplace accidents have been increasingly associated in the literature with the contribution of maintenance management failures in systems apparently submitted to competitiveness pressures in service delivery times and cost reductions in general – whether or not in conjunction with changes aiming to intensify the pace of activity in climates that appear to favor the logic of production to the detriment of worker safety (Figueiredo, 2012; Llory & Montmayeul, 2010).

A study by Krein (2009) suggests that the effects of outsourcing accompanied by precarious working conditions are exerted via a combination of factors originating in changes in work practices in a new situation, including increased workforce turnover, elevated informal employment, adoption of part-time jobs, reduction of salaries, changes in labor union membership, etc. A study in oil refineries also points to destabilization and weakening of collective bargaining powers of labor unions with the consequent dilution and devaluing of their experience and practical *knowhow* (Ferreira, 2001). This study shows indications that these same conditions are ongoing in an electrical sector company in the most developed state in the country.

This study also highlights the contributions of endangerment and degradation of working conditions in the Brazilian electrical sector, whose origins date back more than 20 years, a period prior to a phase of augmenting recourse to labor outsourcing strategies, as seen in the example of the wooden crossarms without maintenance, in the aging of the system and in indications of work-pace intensification. Another contributing factor with archaic origins in the Brazilian case appears to be the historically subordinate condition attributed to the management of worker's safety whose most obvious defeat seems to be illustrated by the normalization of the decision for work permits in networks where primary lines are kept energized. Nevertheless, the case allows us to identify indications that the growth of outsourcing practices is aggravating the safety situation of work in the sector, for example, introducing contractual artifices that not only register civil construction workers as teams responsible for interventions in proximity to live lines but also dismantle the old skilled electrician collectives in the utilization of individual and collective prevention strategies unknown to the new outsourced teams.

The current rules governing the management of the Brazilian electrical system impose fines against concessionaries in the event of a power outage that exceeds a determined duration. It is possible that, without efforts to change these rules and, aiming to avoid such punishments, the managers of hired companies are seeing in acceptance and even in the incentive to carry out interventions without a complete shutdown of the system, the only possible path to staying viable in a competitive market.

FINAL CONSIDERATIONS

The accident discussed in this study shows diverse paths that can be taken to address the accident rate in outsourced work activities. It is true that many of them could be present, in the same manner, in leading companies that did not include safety as one of their management strategic functions.

Among the aspects that are highlighted in the case of the Brazilian electrical sector is the possibility that the dissemination of third-party outsourcing is developing in a manner that is aggravating safety impacts due to precarious work in the sector. That is, the choice of this strategy appears to be developing after years without adequate investments in modernization and maintenance of physical networks of distribution.
Addressing an accident that occurred in the most developed state in the country, this study seeks to serve as a warning for the necessity for careful evaluations of material conditions of the energy distribution networks as well as of the policies and practices of maintenance that are being adopted in the system. In this approach it is necessary to highlight the presence of technical characteristics such as those of automatic network restarting devices that appear to be associated with an increase in the potential severity of injuries resulting from electrical shocks. The logic of not interrupting the supply of electrical energy must not continue to detract from the health of workers as it has until now. It is also possible to alert safety professionals in the sector, to give supreme attention to a more rigorous evaluation of the work situation and to continue addressing in their practices the most frequent variabilities in their work locations.

The utilization of MAPA helped identify gaps and aspects that still need to be elucidated in the analysis of the case. We emphasize here the fact that the activity involves interactions between tasks of electricians and assistants situated on different posts with the use of diverse technical resources. After all, what was the underlying foundation of the reliability and real safety determinants of the electrician and his colleagues? Is the formal safety evaluation considering the influences of the waning late afternoon light or of the presence of trees between the posts, or the fact that the task is carried out in those conditions for the first time by a team that had been working together for only 15 days?

If the findings presented on the origins of work accidents in other outsourced companies of the Brazilian electrical sector prove similar to those identified in this study, it becomes fundamental that prevention also come to act in determinants that permit this strategy to be disseminated in these conditions. This signifies not only disseminating the use of best engineering practices such as reviewing policies, practices and maintenance, but also, most of all, associating with the repertoire of traditional practices those of so-called real safety, centered in the facilitation of comprehension of the state of the system and in an incentive to adopt activities of cooperation, communication and coordination among workers of the same team and of different teams present in the company.

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REFERENCES

Agência Internacional de Energia *"AIE"* (2014|) - acesso dia 07/01/2014 as 20h43 http://www.bbc.co.uk/portuguese/noticias/2012/03/120331_brasil_ranking_consumo_energia_df_rw.shtml

Almeida IM, Vilela RAG. (2010) *"Modelo de Análise e Prevenção de Acidentes de Trabalho"* - MAPA. CEREST Piracicaba, Piracicaba SP.

Almeida IM. (2004) *"A gestão cognitiva da atividade e a análise de acidentes do trabalho"*. Rev. Bras. Med. Trab., Belo Horizonte Vol. 2; No 4, p. 275-282, out-dez.

Alves, G. (2010) *"Trabalho e Subjetividade – o espírito do toyotismo na era do capitalismo manipulatório."* São Paulo: Boitempo.

Amalberti R. (1996) *"A condução dos Sistemas de Riscos"*. Imprensa Universitária da França, 1ª Ed. Paris. (La conduite de sistémes a risque . PUF)

Agência Nacional de Energia Elétrica - Aneel (2014) - http://www.aneel.gov.br/area.cfm?idArea=77 acesso dia 12/01/2014 as 7h10.

Antunes, R. (2005) *"O caracol e sua concha - ensaios sobre a nova morfologia do trabalho"*. São Paulo: Boitempo.

Antunes, R. (2008) *"Século XXI: Nova Era da Precarização Estrutural do Trabalho?"* Seminário Nacional de Saúde Mental e Trabalho - São Paulo, 28 e 29 de novembro de 2008

Associação Brasileira de Distribuidores de Energia Elétrica - Abradee (2013) – acesso dia 11/01/2014 as 16h52 http://www.abradee.com.br/setor-eletrico/redes-de-energia-eletrica.

Assunção A, Lima FP. (2001) *"A contribuição da ergonomia para a identificação, redução e eliminação da nocividade do trabalho"* in René Mendes (org.) A Patologia do Trabalho Ed. Atheneu BH, (p.1768-1789).

Baumgarten, M. (2002) *"Reestruturação produtiva e industrial."* In: CATTANI, A.D. (Org.) Dicionário crítico sobre trabalho e tecnologia. 4.ed. Petrópolis/ Porto Alegre: Ed. Vozes / Ed. UFRGS,; p.268-271

Belcourt M (2006) *"Outsourcing — The benefits and the risks"* Human Resource Management Review 16 - 269–279.

Brasil (2011) *"Manual de Auxílio na Interpretação e Aplicação da NR10" Ministério do Trabalho e Emprego"* acesso ao manual da NR 10 do MTE no dia 08/01/2014 as 19h54. http://portal.mte.gov.br/data/files/8A7C816A2E7311D1012FEA9F9DCD4DD5/Manual%20de%20Interpreta%C3%A7%C3%A3o%20e%20Aplica%C3%A7%C3%A3o%20da%20NR-10.pdf.

Chiang, Y., (2009). *"Subcontracting and its ramifications: a survey of the building industry in Hong Kong"*. International Journal of Project Management 27, 80–88.

Creder, H. (2007) "Instalações Elétricas". 15ed. Rio de Janeiro: LTC.

Daniellou, F., Simard, M. et Boissières, I. (2010). *"Facteurs humains et organisationnels de la sécurité industrielle"* Institut pour une Culture de Sécurité Industrielle, Toulouse, France (ISSN 2100-3874). Disponible à l'URL http://www.icsi-eu.org/francais/dev_cs/cahiers/

Dejours, C., Abdoucheli, E. & Jayet, C. (1994). *"Psicodinâmica do trabalho: contribuições da escola dejouriana à análise da relação prazer, sofrimento e trabalho"*. São Paulo: Editora Atlas.

Dieese (2007) *"O Processo de Terceirização e seus efeitos sobre os Trabalhadores no Brasil"* http://portal.mte.gov.br/data/files/FF8080812BA5F4B7012BAAF91A9E060F/Prod03_2007.pdf - acesso dia 12/01/2014 as 07h22.

Dieese (2010) – *"Terceirização e morte no trabalho: um olhar sobre o setor elétrico brasileiro"* - Departamento Intersindical de Estatística e Estudos Socioeconômicos. http://www.dieese.org.br/esp/estPesq50TercerizacaoEletrico.pdf - acesso no dia 07/01/2013 às 9h09.

Dieese (2013) – *"A Terceirização no setor elétrico brasileiro"* – 34º Fórum de Acidente de Trabalho. http://www.moodle.fmb.unesp.br/course/view.php?id=52 - acesso no dia 12/01/2014 às 7h27.

Druck G, Franco T (2007). "A perda da razão social do trabalho. Terceirização e precarização". Boitempo Ed. Campinas., 240p.

Ferreira LL. (2001) *"A intensificação do Trabalho ou é proibido vascilar"*, in DUARTE, F (org) Ergonomia e Projeto na Ind. De Processo Contínuo. Ed. Lucerna – COPPE, RJ. P.268-280.

Figueiredo, M (2012) *"A Face oculta do Ouro Negro"*. Rio de Janeiro: Editora da UFF (367 p).

Franco T, Druck G, Seligmann-Silva E, (2010) *23* Revista Brasileira Saúde Ocupacional, São Paulo, 35 (122): 229-248, 2010

Guerin F et all. (2001) *"Compreender o trabalho para transformá-lo. A prática da Ergonomia"*. São Paulo: Edgard Blücher e Fundação Vanzolini; 2001.

Hätönen, J., Eriksson, T., (2009). *"30 + anos de pesquisa e prática da terceirização - explorar o passado e antecipar o futuro"*. Jornal da International Gestão 15 (2), 142-155.

Hollnagel E. (2004*) "Barriers and Accident Prevention."* Aldershot: Ashgate,. p. 226.

Hollnagel E. (2008) *"Risk + barriers = safety?"* Safety Science 46. 221–229

Krein JD. (2009) *"Tendências recentes nas relações de trabalho no Brasil"*. In: Baltar PEA, Krein JD, Salas C. (Org.). Economia e Trabalho: Brasil e México. 1 ed. São Paulo: LTr, v. 7, p. 199-226.

Krein, JD (2007) *"Tendências recentes nas relações de emprego no Brasil. 1990-2005"*. Campinas. Tese (Doutorado em Economia Aplicada) – Universidade Estadual de Campinas. São Paulo. Pag. 188 e 189

Kyoung B. Min, Shin G. Park, Jae S. Song, Kwan H. Yi, Tae W. Jang, Jin Y. Min (2013) – *"Subcontractors and Increased Risk for Work-Related Diseases and Absenteeism"* - American Journal of Industrial Medicine 56:1296–1306

Lima FPA. (2009) *"Ações coordenadas em saúde do trabalhador: uma proposta de atuação supra-institucional"*. Revista Brasileira de Saúde Ocupacional ; 34(119): 67-78.

Llory M. (a) (1999) *"Acidentes Industriais o Custo do Silêncio"*. Rio de Janeiro: Editora MultiMais, 320p.

Llory M. (b) (1999) *"L´Accident de la centrale nucléaire de Three Mile Island"*. Paris: L´Harmattan.

Llory M, Montmayeul R. (2010) *"L'accident et l"organisation"*. Bordeaux: Éditions Preventique.

Perrow C. (1999) *"Normal Accident. Living with high risk Technologies"*. Princeton, New Jersey: Princeton University Press, Afterword 353-387.

Rasmussen J. (1997) "*Risk management in a dynamic society"* Safety Science. 27: 183 – 213.

Rasmussen, J; Svedung I. (2000) *"Proactive risk management in a dynamic society*". Karlstad, Sweden: Swedish Rescue services Agency, 160 pag.

Reason J, Hobbs A. (2003) *"Managing maintenance error"*. Aldershot: Ashgate.

Reason J. (1997) *"Managing the risks of organizational accidents*". Aldershot: Ashgate.

Scopinho RA (2002) "*Privatização, reestruturação e mudanças nas condições de trabalho: o caso do setor de energia elétrica"* Cadernos de Psicologia Social do Trabalho, vol. 5, pp. 19-36

Vaughan D *"The trickle-down effect: Policy decisions, risky work, and the Challenger Tragedy."* California Management Review, 39(2): 80-102, 1997.