

# Modernization of the Data Transmission System: Assessment of Risks Arising from the Insertion and Maintenance of Fiber Optic Networks in Manaus- AM

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## Abstract

*The most acceptable condition to obtain an attribute at work is to keep the operators in conditions of safety and health. The work presented here aims to analyze the conditions of activities carried out by telecommunications workers in Manaus, the main condition is to prevent and contain operational risks in the execution and maintenance of fiber optic network installed on public lighting poles. Therefore, it is convenient to consult the regulatory standards applicable to the activity, familiarize yourself with the technical*

*standards adopted by a telecommunications company operating in Manaus. The field inspections were carried out and made it possible to verify in loco the integration of regulatory standards and observations of possible failures. The analysis ranges from the PPE used, such as a parachutist seat belt, conditions of use, and validity. Road signs were also checked, whether distances were being respected, among others. What was found is that in many cases the norms are neglected and not being respected, which leads workers to take unnecessary risks and not measure the real dimension of the danger to which they are subject. It is important to emphasize the requirement to comply with the rules and scale improvements in safety conditions in general, to maintain the health and physical integrity of workers.*

**Keywords:** Maintenance, modernization, Fiber optics, Operators.

## INTRODUCTION

In the communications environment, the request is increasing and currently the need to deploy the broader range of data, with the emergence of the internet, a system that expands the scope of increasingly faster and virtual communications, the dissemination of information either in the form of text, audio, photography or even a film or video. Data concession has become indispensable whether for a small, medium, or large company, but above all connecting people in all parts of the world.

One of the hurdles that need to be overcome is the way in which this data is transmitted. It is known that fiber optics proves to be a highly effective means of communication that can efficiently meet the demand, as it amplifies transmission, creating a super wide range of information transmission.

History shows that optical fiber was obtained by Corning Glass Works (BLASZCYK, 2018.p. 15) using a combination of silica and titanium, whose losses reached 20 dB/km, even so, it proved to be viable for use as a medium of communication in telecommunications.

Vardas (2020) indicates that evolution improved the material and losses were being minimized for multimode transmission, thus, it became in the order of 3 dB/km at wavelengths around 850 nm (first low attenuation), losses of less than 0.4 dB/km for transmissions at 1300 nm (second low attenuation) and even smaller losses, around 0.15 dB/km at wavelengths around 1550 nm (third window of low attenuation). These wavelengths were experimentally determined to be suitable for communications during the 1970s.

Optical fibers in telecommunications are now widely used, as they have a higher transmission capacity than those currently using metallic conductors. Another advantage attributed is immunity to external noise in general, such as electromagnetic interference from electrical installations high voltage or those caused by atmospheric discharges, interference from radio and radar stations frequencies, and electromagnetic impulses caused by nuclear explosions.

França (2018) mentions that the use of optical fiber suggests great reliability related to the confidentiality of the information transmitted because it adds high quality of transmission (low bit error rate) this low attenuation facilitates the system to cover large distances with efficiency in delivery.

Referring to metallic conductor cables due to the item resistance to weathering and other factors such as tensions and torsions exerted on them during manufacture and installation, which differs when it comes to optical cables, as the transmission characteristics depend only on the optical fiber, thus the system is fragile, but the advantages related to optical fibers outweigh the disadvantages, so handling optical fiber requires great care with compression and curvature so that the attenuation does not compromise the quality of the sent signal.

Lima (2020) indicates that some procedures should be avoided, such as never making bends to 90 degrees, making smooth and elongated bends, with a minimum bending radius of 250 mm (long bend), thus minimizing signal attenuation.

Regarding traction and torsion, it is considered that excessive tensions should not be applied to the fiber, as it has a theoretical rupture at 1800 kgf/mm. It is advisable not to exceed 250 kgf/mm tension for 125 mm husk fibers.

Thus, when it comes to the maintenance and installation of fiber optic cables, whether overhead or underground, it is assumed that the specialized technical team is able to make the optical splices, accommodated in splice boxes, using specific capable equipment. to correctly cut and fuse the fiber.

It must be agreed that in the advance of the work, the operators need to be clearly instructed about the dangers arising from the work and even more attentive to avoid accidents. At any stage, be it launching or maintenance of aerial cables, every precaution must be taken as there are potential dangers due to height, proximity to the electrical network, flow of people and vehicles in the vicinity.

The need to remedy the practical artifices linked to the working conditions performed, such as at heights for companies in the

telecommunications sector, must be a constant, the prevention of accidents, whether for the company's specialized technical staff, employees of the provider companies service and others.

Equipped with such necessary rites, based on Regulatory Standard No. 35 - Work at Height, published on 03/23/2012, regarding the authorization, registration, and identification of employees qualified to perform activities at height, qualification, training of employees, as well as the acquisition of equipment.

The installation and maintenance of a fiber-optic network in an aerial form are carried out on poles shared with the electricity network, exposing another imminent risk, as the proximity to high voltage electrical wiring poses a risk of electrical shock to workers.

Since the activity is performed at a height above 2 m, the requirement to comply with the guidelines of the NR-35 standard is essential, linked to the recommendations of NR-10, due to the proximity of fiber optic cables to the energized electrical network. As for the proximity of the transit of people and vehicles, the risk of accidents is predictable, so the signs must be redoubled, as well as care for the health of workers who are exposed to solar radiation, rain, and other forms of weathering.

It can be estimated that in urban centers, the risk situation is more prevalent, due to the very large flow of people and vehicles, to minimize the incidence of accidents for both workers and passersby, signaling and traffic should be redoubled care.

Currently, due to the high crime rate, individuals with the intention of assaulting, workers' belongings, as well as equipment, which mostly have high added value, can still appear.

This work integrates conditions to enable risk analysis and containment measures, in the activity of installation and maintenance of fiber optic networks in the city of Manaus, with the intuition of improving and increasing safety in the process. In this way, it will be possible to verify the operational risks and neglect to compare procedures and confront the relevant rules and legislation, instructing workers to improve conditions.

## **2. METHODOLOGY**

The work is configured in a case study, with field research, with visits to workplaces and monitoring of activities, in this proportion the activity is directly inspected, following the development with outstanding attention. Matoski (2013) indicates a methodology for field monitoring being:

- i) bibliographical survey of the standards used by the company and the Brazilian regulatory standards relevant to the focus of the work.
- ii) Mapping and selection of works to be inspected, observing the stages of launching or maintenance of fiber optic networks.
- iii) Instructions for readjustments and improvements in the safety of activities.

Once the steps for carrying out the inspections were determined, they were carried out randomly, at alternate times, either morning or afternoon, since the inspection system followed the schedule of the service providers, following their development. According to what was planned, the surveys tend to analyze the cable anchoring activities being carried out on poles of the electrical network that have the equipment, in fiber-optic network launches, as well as the signals in various activities in the fiber-optic network, highlighting urban environments with a higher incidence of accident risk.

### **3. RESULTS AND DISCUSSION**

What guarantees the minimization of the risk of accidents is effective compliance with the legislation, the Regulatory Standard NR-35, which indicates that works performed more than 2 meters from the lower level and with a risk of falling, are considered work at heights.

Nobrega (2020) indicates that the risk for work carried out at ground level is not neglected, as the worker performs the activity, in this way, movements must be combined, controlling mind and body, as the application of safety requires full positioning of the equipment such as belts and ropes.

On the other hand, signage in the activity environment must be respected and given all possible attention. According to NR-35, the risk analysis inherent to working at heights must consider the place where the services are performed, isolation, and signage around the work area.

Brazil (2012) describes that care tends to provide minimum technical standards, taking into account the legal aspects related to the Brazilian Traffic Code (CBT) (Law No. 9,503 of September 23, 1997, which instituted the CBT and the implementation of preventive procedures in which it concerns road safety signage, with the purpose of providing greater control of risks and the preservation of the physical integrity of workers and passersby and possible material damage that may result from a traffic accident.

Brazil (2008) specifies articles 46, 48, 80, 94, 95, 225, 246, and 256 which instructs on signage, conditions of use, and punishments. Figure 1 shows the street signposted so that workers can operate without risk.

In terms of working at heights, the risks involved in each stage of the work are not conditioned to the use of adequate equipment only, safety must be systematized, so that any anomaly caused can be foreseen or repaired without serious damage. Thus, according to Copel (2013), it is necessary that the places where the rope or other equipment is fixed, the distribution of forces generated in the fall is necessary, preventing the impact from being entirely transferred to the worker and the correct use of all equipment involved in the system.



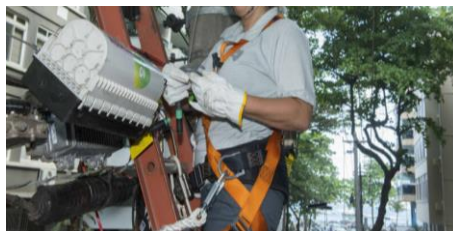
**Figure 1** – Installation of Fiber Optics

Source:<https://www.sinait.org.br/>

The regulation states that the PPE are always used to ensure the safety and health of the worker. The company has the obligation to provide the PPE appropriate to the risk, in perfect condition and working order.

It is up to the worker to also make use of their skills. Therefore, the company must require the employee to comply with the rules and always use it in activities that involve the risk of accidents, avoiding misuse, storing and preserving it properly and requesting the exchange whenever the validity of the PPE has expired or in cases that it is damaged or lost (BRASIL, 1978).

Figure 2 shows a worker with some of the mandatory items to carry out the activities.



**Figure 2**–equipped with EPI's to develop the transmission line assembler function.

Source: Folha de Londrina

As can be seen in figure 2, the worker needs to use the standard to act safely, it almost deals with work at heights, NR-35 defines specific PPE, the safety belt, type parachutist, which must be connected to a system of anchoring.

The worker must remain connected to the anchorage system during the entire period that he is at height with risk of falling. Thus, NBR-15836 cites the parachutist-type seat belt as a "component of a fall protection system, consisting of a device attached to the body to stop falls".

The integral parts of a parachute-type belt, with a hitch element for protection against a dorsal fall and a hitch element for positioning, are Upper primary straps; Engagement elements for protection against falls; thigh primary tapes; adjustment buckle; Dorsal hitch element for fall protection; Attachment Buckle (NBR-15836).

Figure 3 shows an example of a parachutist type seat belt.



**Figure 3** - Skydiver type safety belt  
Source: Superepi

Together with the fall arrest harness, it is a device designed to prevent the user from falling. The most common fall arrester is made of steel, consisting of a locking mechanism with or without polyamide tape extension or shock absorber. According to Felix (2018) this extension must have a maximum length of 30 cm and must have a connector at its end to hook the seat belt. According to NBR-14628/2010, the retractable fall arrest device is a fall arrest device that has an automatic locking function and an automatic recoil mechanism that maintains the retractable line in tension.

Branchtein (2018) indicates that anchorage is the means of connecting a work system, safety equipment, ropes or carabiners to an existing point in the workplace.

Anchor points can be natural or artificial. In industrial areas, anchorages are usually artificial (columns, beams), anchors anchored in rocks are also called artificial. Natural anchors are trees or rocks that can be looped. As established in NR-35, the people responsible for carrying out the rescue and rescue measures must be able to carry out the rescue, the rescue, and provide first aid. They must also have the physical and mental aptitude.

The rescue and rescue team can be made up of employees who carry out work at height, depending on the characteristics of the activities.

For the work in question, the company demonstrated that the existing practical procedures establish the use of minimum equipment and/or tools to carry out activities at height, propose training for those involved, define a document for the Work Permit (PT) and for the Preliminary Risk Analysis (APR) and also proposes a procedure for authorizing, registering and identifying employees/outsourced workers authorized to perform activities at height.

Before the activity is performed, the APR must be completed and signed by an authorized professional from the contracting company and by a qualified professional from the contracted company. These professionals, in activities on fiber-optic networks, are the construction inspectors of both companies, who must have the training and the Occupational Health Certificate (ASO) appropriate to the activity. Observing the work logistics of the contracting company and outsourced workers, from service providers, before field activities, the outsourced technical team participates in an integration meeting carried out by the work safety team of the contracting company.

At the integration meeting, issues such as mandatory use of PPE necessary for work at heights, contractors are instructed and alerted to maintain a safe distance from the low and medium voltage network, and others. According to the inspections carried out in the fieldwork, it was found that the ladder was not sufficient to reach the anchorage point of the cable to the pole, therefore, the proposal is to use lifting baskets or lifting platforms to lift the worker to the point of work with greater safety and comfort. Regarding maintenance that requires the opening of optical splice boxes located in the spans of the posts, and the stairs, they are anchored in the cable strands, and the same can slip and knock the worker down, the lifting basket would greatly reduce the risk of the worker falling and would offer greater mobility and comfort for the worker.

As for the use of lifting baskets, what restricts it is that the truck occupies a very large space and in the urban sector it makes it unfeasible. In some of the inspections, there were situations in which pedestrians entered the work area delimited by the cones, this happened because they were



without the zebra tape, causing a risk of falling material/tools on the pedestrian, in addition to causing and suffering accidents, being more common in urban centers, as observed, even with the signage made, it was still deficient.

The suggestion is that the signs are inadequate, the proposal is that the workers at the inspection site receive guidance from the inspector on the correct way to carry out the signs according to the conditions of the environment in which the activity is being carried out. Thus, due to the lack of signage, the solution is to make the outsourced company responsible for the work that does not have adequate signage pay a pre-determined fine in the contract. In cases where the signage is incorrect, both the inspectors and the company's security team must advise on the correct procedure to be adopted and, if possible, correct the signage at the construction site.

Under the use of PPE, such as a parachute belt, lanyard, and many times it was verified that the ladder was not anchored, being only leaning against the cable or the pole.

There were cases in which the worker was using the leather belt and the positioning lanyard, this PPE was used prior to the recommendations of NR-35. In these situations, it was observed that the outsourced company was not yet adapted to the current legislation. Workers were found, in some situations, wearing a parachute harness without a lanyard or fall arrester. This is because many of them offer resistance to the use of these PPEs because they think that the placement is too time-consuming and that it gets in the way, justifying that the task is quick, so there would be no need.

Regarding the workers' PPE, it was found that their conservation situation was precarious, with holes in their gloves, parachute-type belts, and very old and well-worn lanyards. The wooden stairs in several cases were looking old and one of them had just broken one of the steps, as described above. It was also observed a situation in which the outsourced company itself had acquired new PPE inappropriate for the function; they were shirts made of synthetic material to perform services involving electricity when they should be 100% cotton as specified in NR-10.

The conservation and preservation of the PPE must be done by the workers themselves; it was also verified the lack of care in handling and storing the equipment, causing it to deteriorate more quickly. And, in one specific case, the worker had the glove pierced on one of his fingers, and he did not notify the person responsible for the work, nor the outsourced company to exchange the same. It was found that workers do not pay attention to their skills and obedience.

To solve problems with PPE and tooling, registered when filling in the APR at the construction site, they can lead to the work stoppage,

according to the criterion adopted by the inspector, and the service provider company is subject to penalties provided for in the contract, with periodic inspections and with punishment for those who do not fit. The company does not have an updated and accurate record of accidents that occur with outsourced teams, it does not have an accident mapping policy, so the suggestion would be to create a way to map and monitor the incidence of accidents.

The finding of factors that corroborate the non-compliance with standards and other security mechanisms establishes that there is a need to implement criteria that help companies in the telecommunications segment to adopt more serious policies that guarantee the physical and mental health of workers and other people who perhaps they are in the installation and maintenance environments of fiber optic networks in the metropolitan region of Manaus.

#### 4. CONCLUSION

What can be seen from the study carried out is that the non-coherence on the part of the entities involved compromises the work and creates risky situations in activity that require a lot of care and attention. Many proposals for improvements were placed on legal aspects such as the application of contractual fines in cases where outsourced companies are not meeting the company's technical standards or the NRs that cover the work. But even with its degree of importance, it does not constitute a commitment, as the more fines are applied, the less there will be the participation of outsourced members as partners in the activities.

Workers working on the fiber optic network are of simple origin and many have never worked before. The charge for the activity to be performed safely depends on the lack of support from the company that hired it. Lack of support expressed in poor quality, damaged or expired PPE, apparently very old equipment and tools, as already seen, in the example of the broken ladder. Another important factor to note is the pressure for production, that is, for each activity performed there is a cost determined in the contract (examples: one merger, two mergers, the opening of splice boxes, installation of hardware supporting the optical cable on the pole, quantity in meters of cable launched, and others), so the more the worker does, the more the outsourced company will profit and the more he will also receive.

The use of baskets or lifting platforms would increase the safety and comfort of workers in various activities analyzed, for example, in cases of anchorages on super poles where the ladder does not reach the anchorage point of the cable, in cases where there is a need for access the optical splice

boxes located between the poles of the electrical network and in cases where the anchorage point is only accessible through the last step of the ladder. These workers usually do not have a vision of the importance of their work for both companies involved. Some company inspectors have an additional ability to monitor the works with outsourced workers, which goes beyond guidelines for the correct use of safety equipment in general, achieving a much more effective collaboration in a friendly and friendly manner.

The company's security team, together with the Internal Commission for the Prevention of Accidents at Work (CIPA) last year held lectures with the teams of outsourced companies, to address legal aspects, such as criminal civil liability in the event of the occurrence of a fatal accident. These lectures also addressed technical issues with guidance on safety and the importance of the work performed by these outsourced teams for the company was also highlighted.

Training is essential to ensure that work is carried out with quality and safety, so it must be constantly maintained to retrain already trained workers, as well as ensure that new employees receive training before starting work. effectively in the field. Outsourced companies have a high turnover of employees, a fact that supports the need for constant training.

In these training, the risks inherent to the activity must be highlighted, either causing a great impact or presenting serious cases of accidents that have already occurred. This usually has a certain result, but after some time, the worker starts to disregard the risks, finding them improbable. Therefore, the importance of recycling and the search for awareness of the worker has highlighted again, that he is a fundamental part for the work to be carried out safely.

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Renato dos Santos Rodrigueis, Aline dos Santos Pedraça, João Almeida Pedraça, Yonny Romaguera Barcelay, Francisco Lúcio Rodrigues de Araújo– **Modernization of the Data Transmission System: Assessment of Risks Arising from the Insertion and Maintenance of Fiber Optic Networks in Manaus-AM**

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