ESTABLISHMENT OF THE NR10 REGULATORY
STANDARD FOR PROCESSES INVOLVING ACQUISITION
OF IMPORTED EQUIPMENT AND SERVICES PROVIDED BY
FOREIGN COMPANIES IN THE BRAZILIAN TERRITORY

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Establishment of the NR10 Regulatory Standard for Processes Involving Acquisition of Imported Equipment and Services Provided by Foreign Companies in the Brazilian Territory

Abstract. This article proposes the breakdown of NR 10 - Brazilian Regulatory Standard Number 10 - aiming at simplifying the understanding of its rules and training of those involved, by summarizing relevant concepts in a presentation form that is easy to understand. Usually, foreign companies and foreign technicians supplying designs, equipment, and services have difficulties understanding rules, standards, and guidelines during the installation of devices for the implementation of projects in Brazil. The performance of services in areas with electricity hazards requires preventive activities and compliance to Brazilian technical recommendations. This article presents an overview of the legislation hierarchy in Brazil according to the Federal Constitution and the Brazilian Regulatory Standards, including NR 10. In this study all items of NR 10 were presented in detail following the original document. In addition, interrelated issues displayed in a didactic manner in a set of Figures, and created requirements and guidelines are presented. All material was used to sensitize teams that developed the preliminary studies. We performed the project by planning and executing services for the installation of an automotive business of Chinese origin, contributed to the project’s direction, and planned the layout of facilities. All work was performed with surety and without complex necessary rework, up to the time of approved production lines.

Keywords: NR 10, Regulatory standards, Safety in electricity.

1. Introduction

In the Brazilian territory, all production equipment and accessories, and their installation and work environment involved must be designed, adapted, operated, maintained, audited, and inspected according to proper occupational health and safety conditions for workers that are determined by Regulatory Standards - NRs. All personnel working in areas of installations or places under their influence must also comply with the provisions of NRs in order to avoid accidents and risks to those involved.

Therefore, Brazilian teams who work in the development, assembly, operation, and maintenance stages of production lines must be qualified, trained, and capable to comply with the required procedures established by benchmarks with the best available techniques. Reaching this
goal is admittedly not a simple task when only the regular professional training, lacking additional specific training, is considered. When equipment is designed, manufactured, and built abroad and later transported, assembled, installed, and operated in Brazil by teams composed of Brazilian and foreign professionals, the difficulties in meeting the NRs’ requirements are greater than when a specific equipment is manufactured locally.

Thus, all professionals involved in each phase of the project must have knowledge on the standards adopted and the implications when the minimum requirements are not met, with possible undesirable consequences, such as: generation of risky conditions, project’s embargo, complex reworks, extra expenses with fines, modifications that were not predicted in original budgets, and breach of important deadlines.

In Brazil, the Regulatory Standards have the power of the law, in a strong hierarchical connection between legal references starting at the top with the Federal Constitution, with text promulgated on October 5 1988, through the Consolidation of the Labor Laws - CLT with text promulgated on May 1, 1943, and the Ordinances from Ministries, mainly from the Ministry of Labor and Employment - MTE; therefore, obligations towards occupational safety and health will always be bound to law enforcement.

A total of 36 Regulatory Standards refers, in a segmented fashion and by topics, to the rights and obligations of employees and employers governed by the CLT. NR1 describes the General Provisions for all Regulatory Standards and NR10 covers safety in electricity-related plants and services. NR10, announced by the Ministry of Labor and Employment in 2004, will be detailed in this article. The first ministerial decree on the subject, 3214/78, presents 28 Regulatory Standards that amounted to 36 after coverage studies. These standards are listed below:

- NR 1 - General Provisions.
- NR 2 - Preliminary Inspection.
- NR 3 - Embargo or Prohibition.
- NR 4 - Safety Engineering and occupational medicine Specialized Services.
- NR 5 - Accident Prevention Internal Commission.
- NR 6 - Personal Protective Equipment - PPE.
- NR 7 - Occupational Health Medical Control Program.
- NR 8 - Buildings.
- NR 9 - Environmental Risk Prevention Program.
- NR 10 - Safety in Plants and Services Related to Electricity.
- NR 11 - Transportation, Moving, Storing, and Handling of Materials.
- NR 12 - Machines and Equipment.
- NR 13 - Boilers and Pressure Vessels.
Relevant information in NR10 is generally fully known by graduated and specialized personnel working with issues that are closely related to this matter.

Professionals who design, carry out interventions, and operate electrical installations, or work in areas close to these working fields, not always have received specific NR10 training because it is extensive and not always possible or accessible to all. Major risks for projects and personnel can be prevented through actions to raise awareness about need for training and possible consequences from non-compliance.

Preventive actions that can be taken before the execution of services can possibly reduce expenses with additional payments over workers’ salaries, fines, and other unintended effects that could penalize projects’ budgets and deadlines, and especially jeopardize the safety of the involved
personnel.

Thus, this article proposes, in the form of a seminar, a theoretical review on Brazilian Regulatory Standards and their legal relations with other existing regulations with an emphasis on NR10. Moreover, this article presents the proposal of a methodology to raise awareness about this NR applied in practice to an enterprise of Chinese origin performing a project to be established in Brazil.

2. BRIEF STATEMENT OF OBJECTIVE

The objective of this article is to show the insertion of all current 36 NRs in the hierarchy of Brazilian laws and elaborate on the concepts of NR10 to prepare a training model for teams who will be assigned to work on a project executed by a foreign automaker in Brazil.

Considering the possible legal and financial implications arising from acts of malpractice, negligence, or recklessness in specialized services in electrical plants, the knowledge of rules to be followed by everyone involved becomes important.

3. BRIEF OVERVIEW OF SYSTEM MODEL

3.1. Theoretical Review

Brazilian Federal Constitution, with text promulgated on October 5, 1988, the Consolidation of Labor Laws – CLT, with text promulgated on May 1, 1943, Ministerial Ordinances, and the Brazilian Regulatory Standards, mainly NR10, which deals with safety in installations and services in electricity, published on December 17, 2004 through Ordinance N° 598 from the Ministry of Labor and Employment, the Brazilian Civil Code, published in 2002 and Technical Standards complements each other and contain texts that deal with specific issues of labor safety and occupational health, such as the Brazilian Standard for Electrical Installations of Medium Voltage – NBR 14039 and the Brazilian Standard for Electrical Installations of Low Voltage – NBR 5410 either directly or by means of quotes that require supplementary legislation.

3.2. Regulatory Standards and Brazilian Laws

The importance of occupational safety and health for workers is described from the top of the hierarchy of Brazilian laws, with reference to the Federal Constitution of 1988, more specifically in Chapter II, article 6 and article 7, subparagraphs XXII, XXIII, XXVIII, and XXXIII, which deals with social rights.

Right under the Federal Constitution, the Consolidation of Labor Laws – CLT deals with themes related to Safety and Occupational Medicine in its Chapter V, Title 2, articles 154 until 201,
mainly in article 200, which delegates the allocation of supplementary agreements necessary for accident prevention and occupational hygiene and health rules to the Minister of Labor.

Ministry of Labor has implemented specific and generic delegations for the Consolidation of Labor Laws, which are in line with the conventions of the International Labor Organization - ILO - which were ratified in Brazil and published in Ordinance 3214. The Regulatory Standards were created from this ordinance and according to a selection of similar themes using the tripartite equalitarian system recommended by ILO with the participation of government, employees, and employers.

One of the sources of information about the legislation was the book: Estrutura Normativa da Segurança e Saúde do Trabalhador no Brasil, published in 2007.

3.2.1. Regulatory standard 10 - NR10

NR 10 has been updated by Ordinance GM No. 598 in its publication from 12/7/2004 and is organized into 14 sections and 3 annexes (the glossary is considered as the first annex) by establishing new safety conditions for workers executing, directly or indirectly, projects or work in electrical plants and related areas.

In addition to the information in the Regulatory Standard, the Ministry of Labor and Employment - MTE published the Aid to the Interpretation and Application of NR 10 Guide, which is commented at the TEM website and was used in the elaboration of this article.

One of the most important characteristics relayed in NR10 is the characteristic of joint responsibility between contractors and workers. Contractors are those who execute specialized services in electricity by directly employing workers through the CLT or through other contractors.

Workers are the employees of a company itself, from a subcontractor, and the supervisors of these two categories. The responsibilities from each part are described in detail in the NR10 items with specific determinations to each item, therefore, the non-fulfillment of these determinations will be considered within the means of solidarity, without biased on either side, in any legal or administrative audit, and in cases of action or omission that results in an accident.

The Ordinance GM No. 598 also created the National Standing Committee on Safety in Electricity - CPNSEE with the mission of overseeing the implementation and proposing developments or adaptations deemed necessary to improve the NR10 Regulatory Standard. Annex 4 was included in the publication of Ordinance GM No. 598 stipulating limits of up to 24 months for the fulfillment of specific obligations; this annex is no longer part of the current text. NR 10 indicates the control and preventive measures for electric plants, energized or not, in its 14 sections, expands on design, construction, maintenance, and operation, and includes the physical plant of spanning areas described in annex 1 and the necessary training of professionals described in annex
2 as shown below:

- 10.1 - Objectives and Field of Application.
- 10.2 - Control Provisions.
- 10.3 - Projects Safety.
- 10.4 - Construction, Assembling, Operation, and Maintenance Safety.
- 10.5 - De-energized Electrical Plants Safety.
- 10.6 - Energized Electrical Plants Safety.
- 10.7 - Work Involving High Voltage.
- 10.8 - Licensing, Qualification, Training, and Authorization for Employees Safety.
- 10.9 - Fire and Explosives Protection.
- 10.10 - Safety Signs.
- 10.11 - Working Procedures.
- 10.12 - Emergency Situation.
- 10.13 – Responsibilities.
- Glossary.
- Annex 1 – Risk Zone and Controlled Zone.

National Standing Committee of Safety in Electrical Energy - CPNSEE - works as a system with continuous improvement and keeps NR10 in accordance to the technological equipment and materials developments, changes in the workplace, and studies about accidents in electrical plants; the Ministry of Labor audits and oversees specific cases. These procedures update the NRs on any changes in materials and processes to reflect current needs in accident prevention in electrical installations.

Most of the issues addressed by NR10 are general or complement to the existing Technical Standards including: safety in energized and de-energized electrical plants; work in high-voltage circuits, safety in all stages of a project, and operation and qualification of workers. The Brazilian Technical Standards from the Brazilian Association of Technical Standards – ABNT - must be consulted if specific guidelines are required for an electrical plant.

Systematic model of this Regulatory Standard was prepared by a Tripartite Technical Group; it is NR10-specific and counted with the participation of specialists in electricity. This model contemplates complementarities between its elements in each chapter, glossary, or annexes seeking a simplification of terms and goals associated with a broad scope. NR10 assess the minimum requirements for maintaining an adequate level of safety for personnel involved with the work without citing how this condition should be fulfilled because of the specificity of each application.
Glossary has the main function of eliminating doubts concerning the understanding of the text in each chapter; the annexes 1 and 2 deal with themes that are somehow mentioned in a summarized form in all NR10 chapters. All actions for its preparation and its results led to credibility on its application.

4. RESULTS AND DISCUSSION

4.1. Development of Supporting Data for the Formation of the NR10 Regulatory Standard

Training support to all professionals who will work in the various stages of development and implementation of a project was developed based on the information cited above and will be shown in this chapter in the sequence of presentation.

These potential projects, whether in Brazil or in another country, considered the involvement of workers quoted as working in risky zones. Because this is a specific and technical material, the professional who will train others should be qualified as cited in Chapter 10.8 and annex 2 of NR10.

Many standards for electrical installation projects generally follow the same international pattern, however, the NR 10 guidelines for work on electrical systems may be new to many designers; the lack in the observation of its guidelines can lead to many adjustments in the premises. Therefore, the training of personnel in the precepts of NR10 is very important during project planning, from the initial stage, to avoid undesirable consequences. Throughout this article, the most relevant data and information that should be considered in the process of awareness - NR 10 - are presented.

The training should include instructional resources as a hardcopy of the presentation delivered at the beginning of the training session to each trainee. A media release for self-training is planned and will follow the same principles used in the face-to-face training.

The understanding of the Brazilian law on the part of leaders, and how NR 10 is included in this ordinance, shall occur in a sequential process that begins with the analysis of the Brazilian Constitution through the Consolidation of Labor Laws - CLT, Common Laws, Brazilian Association of Technical Standards - ABNT, and the Brazilian Regulatory Standards - NR. Figure 1 shows the hierarchy of Brazilian laws in reference to occupational safety and occupational medicine.
Brazilian Constitution, in Article 7 and clauses XXII, XXIII, XXVII, and XXXIII, referring to discipline related to Safety and Health in work issues says:

"Art 7: The rights of urban and rural workers, and others who seek to improve their social condition: XXII - Reduction of risks inherent with working through standards of health, hygiene, and safety; XXIII - Additional remuneration for strenuous, dangerous, and unhealthy activities as provided by the law; XXVIII - Insurance against accidents at work, the employer, without excluding the compensation to which it is obligated to incur when fraud or negligence are identified;

On a second level, Articles 154 – 201 from the Consolidation of Labor Laws – CLT, stipulate rights and obligations from the government, enterprises, and workers in relation to Occupational Health and Safety providing legal reasoning to the Regulatory Standards - NR. The CLT has delegated competence on issues related to job security to the Ministry of Labor.

Article 200 cites: it is for the Ministry of Labor to establish additional provisions to the rules of this Chapter, in view of the peculiarities of each activity or job sector especially about:

Accident prevention measures and personal protective equipment in construction, demolition, or repairs; depots, storage, and handling of fuels, flammable, and explosive, as well as transit and stay in their respective areas; working in excavations, tunnels, galleries, mines, and quarries especially for the prevention of explosions, fires, landslides, and burials,
elimination of dust, gases, etc... facilities and rapid exit for employees; in general, fire protection and appropriate preventive measures with the special coating requirements of doors and walls, fire wall, dams, and other installations construction, as well as general secured easy dislocation with access to wide corridors and protected outputs with sufficient signage; protection against sunlight, heat, cold, humidity, and winds, especially for outside work with provision of drinking water, housing, and prophylaxis to endemic diseases; protection of workers exposed to harmful chemicals, ionizing, and non-ionizing substances, noise, vibrations, or abnormal pressures in the work environment, specifying the appropriate measures to eliminate or mitigate such effects including maximum limits of exposure time, intensity of activities and its effects on the human body, compulsory medical examinations, age limits, ongoing monitoring of workplaces and other requirements that may be necessary; hygiene in the workplace including a breakdown of requirements, sanitary facilities, showers, lavatories, changing rooms, and lockers with gender separation, cafeterias or comfort conditions during meals, drinking water supply, cleaning conditions of the workplace and mode of implementation, treatment of industrial waste; use of color in the workplace including warning signs.

In the case of ionizing radiation and explosives, the standards referred to this article shall be issued in accordance with the resolutions adopted regarding the technical body.

Ministry of Labor has adopted and systematized the Regulatory Standards by dedicated themes through Ordinance no. 3214 from June 8, 1978.

This decision facilitates revision and updating as the result from changes in procedures and technological advances.

These revision and updates are designed in a tripartite and joint ILO-driven system, with representation from employees, employers, and government.

Brazilian Association of Technical Standards - ABNT, with the corresponding Technical Standards and Regulatory Standards, comprehend a series of procedures directed by the Ministry of Labor with legal efficacy compared to the common law, where the employer must pay attention to compliance to both general standards and rules that are specific for certain activities.

Conventions of the International Labor Organization - ILO can be reviewed and ratified by Brazilian authorities, including actions to prevent risks, which are incomplete or even nonexistent in the Brazilian Regulation.

Some examples of ILO conventions already ratified by the Brazilian government are:
- Convention n. 115 - Ionizing Radiation;
- Convention n. 136 - benzene;
- Convention n. 139 - Carcinogenic Substances or Products;
- Convention n. 148 - Risks related to air pollution, noise, and vibration in the workplace;
- Convention n. 155 - Safety and Workers and Work Environment Health;
- Convention n 161 - Health Services in the Workplace;
- Convention n. 162 - Asbestos;
- Convention n. 170 - Chemicals;
- Convention n. 171 - Night shifts.

Figure 2 shows the main channels used as reference in the publication and dissemination of NR10, including the publication in the Diário Oficial da União (Union Official Diary).

![Figure 2 – Channels used for Publication of Reference Documents and NR10 (Oliveira, 2007)](image)

NR 10, approved by Ordinance No. 598 from 07.12.2004 from the Ministry of Labor and Employment, published in the Union Official Diary - DOU from 08.12.2004 is structured in a
systematic way and consists of 14 items, 99 items under 2 Annexes, and one glossary.

Figure 3 shows the systematic structure of NR10, with its chapters, glossary, and annexes displaying its completeness. The scope and key questions addressed by NR 10 such as objectives, control provisions, specific security topics to work on electrical installations, procedures in emergency situations, responsibilities, and training model among others are presented.

Figure 3 - Systematic Structure of NR10 (Regulatory Standard NR-10)

Figure 4 lists the objectives and scopes of NR10 in accordance with other applicable standards. Audits to verify compliance to NR10 must be performed by companies on services to be executed according to the minimal conditions for working in electric networks, including specificities cited and covered in detailed in NR 10.
10.1 – Objectives and Field Applications

- 10.1.1 – Establishes the minimum required conditions for the implementation of control measures and preventive systems to ensure safety and health for workers.
- 10.1.2 – It applies to the generation, transmission, distribution and consumption, including the project, construction, assembly, operation and maintenance of electrical plants and proximities, observing the official technical norms and in their absence or omission in the international standards.

Figure 4 - Objectives and Field of Application (NR-10 Regulatory Standard)

Item 10.2 in NR 10 cites control provisions corresponding to the set of strategic actions that should be put into practice by organizations to formalize technical and methodological analyses to reduce or eliminate risks during electrical services.

These actions emerged out of concerns in the perimeter or their influence to control uncertainties and undesirable events with the potential ability to cause accidents, injuries, damage to health, or death of workers by mapping the obvious difficulties to achieve the expected results. Figure 5 shows the breakdown of these control provisions.
Figure 5 - Lists the main control provisions contained in Chapter 10.2 in NR10 (Regulatory Standard NR-10)

Control provisions are associated with preventive measures by anticipating the possibility of very serious accidents and should be integrated with other corporate actions, such as safety and occupational health, including the management of medical records for all personnel involved in the entire installation, operating procedures, intervention, emergency, related records, reports of tests, modifications of individual profiles, and prevention of events considered abnormal, especially in areas classified as high-risk areas.

All interventions should be made based on updated and standardized diagrams developed by skilled professionals, followed by technical documentation. All electrical equipment, safety devices, signs, for network sectioning, security against reclosing systems, grounding systems, collective protection equipment, personal protective equipment, and tools should be approved.

Companies must rely on documentation systems for the qualification and training of personnel working in areas considered of risk. A special attention is given to companies with oversized installation of 75 kW with higher apparent risks.

In the design phase, NR 10 recommends a series of actions and recommendations for the use of devices that allow for simultaneous sectioning, signaling locking procedures against accidental or unauthorized re-energizing, which ensure adequate services for the construction and intervention of facilities.

These actions should always be performed by authorized professionals. Furthermore, the use of multi-pole circuits that reduce the risk of wrongful shut-down operations and consequent
understanding of accidents should be recommended.

Spaces in rooms and electrical panels should be ergonomically designed to provide safety during installation and intervention; channels shall provide temporary grounds, whether automatic or manual, allowing the condition of equivalent potentiation in divided parts and avoiding sharing circuits with different purposes.

Diagrams and other technical design information should be provided by qualified personnel working in the installation of equipments and interventions. According to NR 10, projects must conform to the law and all other safety regulations, occupational health, and ergonomics applied to electrical systems; all documentation should have the signature of authorized personnel.

The establishment of a specific descriptive history of the installation project is part of the NR 10 requirements. In addition, minimum illumination levels of premises should be met according to another Specific Regulatory Standard (NR 17). Figure 6 shows the procedures to be followed by projects.

![Figure 6 – Safety Items in a project applying the NR10 (Regulatory Standard NR-10)](image)

Construction, installation, maintenance, and operation of electrical plants should ensure the safety of personnel involved; all requirements are established in NR 10. The supervision of work must be performed by qualified professionals to develop plans for regular and high-risk tasks such as: within confined spaces, in elevated, humid, and explosive areas, and in areas under other adverse conditions.
Proper signage and corresponding preventive actions should be established, always applying the best techniques, tools, instrumentation, and equipment according to the requirements and recommendations of manufacturers, and without removing existing protections.

Materials cannot be stored in electric fields and electrical panels; the associated access should be performed with special keys. Ergonomics and lighting conditions should be preserved as a regulatory standard. Figure 7 shows important safety aspects in construction, assembling, operation, and maintenance in electrical plants according to NR10.

Figure 7 – Construction, assembling, operation, and maintenance safety in electrical plants (NR-10 Regulatory Standard)

According to NR 10, electrical installations may only be considered released from work when they are being de-energized through a sequential and documented process including circuit isolation, absence of voltage, installation of temporary grounding with equalizing potential of circuit conductors, protection of energized elements, and installation of signage to prevent reenergizing.

A similar procedure should be established for reenergizing the circuit, which was sectioned and blocked, to release the facility for operation. If there is a risk of energizing circuits, the working
model does not fit to that described in Figure 8, which shows detailed guidelines to ensure proper de-energizing processes in electrical plants. The possibility of accidental energization in electrical circuits should always be considered.

![Figure 8 – De-energized electrical plants safety (Regulatory Standard NR-10)](image)

When working on energized circuits or any possibility of energizing conditions, the procedures established by NR 10 are adapted to the levels of voltage and must be performed by skilled, qualified, trained, and authorized professionals in accordance with the requirements addressing risk and workload areas, following the training curriculum shown in item 10.8 and annexes in this regulatory provision. Services should be suspended if risks to personnel are still identified.

Risk assessment must be conducted with de-energized circuits in new installations or electrical installations undergoing modifications to identify all hazards related to work on energized circuits and create safety procedures for these tasks. Figure 9 describes the tasks related to item 10.6 in NR10.
### 10.6 - ENERGIZED ELECTRICAL PLANTS

**SAFETY**

| 10.6.1  | Intervention for voltage ≥ 50 VCA or > 120 VCC, performed by qualified personnel according to 10.8 |
| 10.6.2  | Procedures for work in Controlled Zones according to Annex I |
| 10.6.3  | Immediate stop; procedures that might put personnel at risk of hazard |
| 10.6.4  | Risk Assessment in new Plants |
| 10.6.5  | Stop work if the risk condition cannot be eliminated or neutralized |

**Figure 9 - Guidelines for working in de-energized electrical plants (NR-10 Regulatory Standard)**

Specific parts of electrical work present more danger than others. They relate to those performed on high voltage or interfaced with electric power systems (EPS) defined as above 1000 volts for alternating current and above 1500 volts for continuous current circuits between phases or between phase and ground.

People must be empowered and trained in subsidiaries, in areas of risk and electric power system (EPS) zones, according to item 10.8 and annexes 1 and 2 of this regulatory provision, which makes the performance of team work to prevent individual risk mandatory.

All work on high voltage or work with electric power system (EPS) interaction should be preceded by a specific work order, signed by the qualified professional in charge of the work area.

Staff designated to implement these areas should make an assessment before starting to work, following specific procedures established by a qualified professional.

For work on energized high voltage circuits or circuits interfaced with EPS, all existing systems of automatic reclosing must be disconnected, disabled, or blocked and all circuits must be marked according to each procedure; all equipment, tools, and insulating devices must pass electrical and laboratory tests periodically as specified by the manufacturer or on a yearly basis.

All workers assigned for these tasks must always rely on communication equipments. Figure 10 presents the criteria adopted for working with high voltage circuits.
10.7 - WORK INVOLVING HIGH VOLTAGE (AT)

- 10.7.1 – Only qualified workers in the Controlled and Risk Zones. According to Annex I
- 10.7.2 – Workers in the Controlled and Risk Zones must receive Safety Training on the Electric Power System (SEP). According to Annex II
- 10.7.3 – Work in Energized Electrical Plants with High Voltage in the Electric Power System cannot be performed individually
- 10.7.4 – Work in Energized Electrical Plants with High Voltage and those that interact with the SEP. Performed under Work Order Signed by the Responsible Manager
- 10.7.5 – Previous evaluation before the work starts in Energized Circuits with High Voltage
- 10.7.6 – Signed Procedures for work in Energized Electrical Plants with High Voltage
- 10.7.7 – Deactivation of Automatic Re-opening in interventions in Energized Electrical Plants with High Voltage in the Risk Zone
- 10.7.8 – Periodic Tests in isolating Equipments, Tools, and Devices for work with High Voltage
- 10.7.9 – Communication Equipment during Work in Energized Electrical Plants with High Voltage or in Activities in the SEP

Figure 10 – Work Involving High Voltage (AT) (NR-10 Regulatory Standard)

Figure 11 shows the licensing requirements for workers, including qualification, training and specific authorization for electrical plants.
NR 10 deals with fire and explosives protections in areas with electrical equipment and installations and cites another regulatory Standard, NR 32.

Conformity of all materials, systems, and devices in areas that are classified as potentially explosive shall be certified by an agency accredited by the Brazilian Certification System. In addition, devices and equipment that can generate or accumulate static electricity should be safely stored to prevent the dissipation of accumulated energy, discharges on people, or explosions.

Authorized and formally documented systems and services, such as alarms and automatic isolation of electrical circuits, must be installed in areas with risks of fire and explosion. Figure 12 indicates compulsory actions for fire and explosives protection in electrical plants.
In order to formalize a model of safety signage and services for electrical installations considered as an additional measure of risk control, NR 10 uses the same criteria of NR 26. NR 26 deals with safety signage, including plate symbols, designs of electrical circuits patterns, identification models for detection and locking devices, exercises of restrictions and impediments to access systems, determination of delineation areas, signaling personnel, vehicles, and machinery dislocation, signaling the stopping of re-energizing circuits, and identifying stopped circuits. Figure 13 gives the guidelines of safety signage for work in electrical plants.
The implementation of working procedures is necessary to guaranteed workers’ safety, which beyond the specific assigned service, must contain information about material and human resources, instructions, and specific technical safety guidelines with the analysis of possible circumstances that could prevent their execution.

Therefore, all electrical services involving risk should be performed based on detailed standardized procedures formally approved and signed by an authorized professional taking into account the recommendations for training, in addition to having the order of specific services and if you decline, approvingly taken by medical service and security of their company.

An appointed official should be in charge of the supervision of tasks in each group of workers encompassing risk analysis and work initiation; every task should be analyzed by all. Figure 14 presents the guidelines for working procedures.
10.11 - WORKING PROCEDURES

10.11.1 – Procedures for Planning Work in Electrical Plants Signed by a Qualified Professional

10.11.2 – Work Order Approved by a Qualified Professional Before the Execution of Work in Electrical Plants

10.11.3 - Procedures for work include: Objective, Application Field, Technical Base, Competencies and Responsibilities, General Provisions, Control Measures, and Final Orientation

10.11.4 – The SESMT Must Participate in the Elaboration of all Work, Training, Safety and Health, and Authorization procedures in Item 10.8

10.11.5 – The Authorization from Item 10.8 Must Conform with the Training Provided. Predicted in Annex II

10.11.6 – All Teams must have a designated worker prepared to Supervize the Work.

10.11.7 – The responsible worker must execute preliminary evaluations in the team before the work start, aiming at safety

10.11.8 – Alternating Activities Must consider the risk assessment of Tasks and the competence of the workers involved

Figure 14 – Working procedures (NR-10 Regulatory Standard)

Companies are obliged to draw up an emergency plan with specific emergency procedures for electrical installations and services, integrated in the overall plan of the company, always based on failure analysis performed by experts, and including resources available to service the established procedures with training materials and resources.

All employees authorized to work in hazardous areas shall be trained in a theoretical and practical way to rescue injured personnel and perform basic first aid procedures. Companies should examine the possibility of special situations outside the ground level (above or below), in distant locations, or with resources that are difficult to access providing procedures and resources, in case of an accident.

Considering the risk of fires caused by electrical work, workers must be able to efficiently identify and operate firefighting equipment. Figure 15 shows the rules for emergency situations in electrical plants.
### 10.12 - EMERGENCY SITUATION

<table>
<thead>
<tr>
<th>10.12.1</th>
<th>The Emergency actions in Electrical Plants and Services must be in the Company’s Emergency Plan</th>
</tr>
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<tbody>
<tr>
<td>10.12.2</td>
<td>Authorized workers must be ready to rescue and provide First aid to personnel involved in accidents. especially through CPR</td>
</tr>
<tr>
<td>10.12.3</td>
<td>The company must have Standardized Rescue methods that are adequate to its activities and means</td>
</tr>
<tr>
<td>10.12.4</td>
<td>Authorized workers must be prepared to manipulate and operate equipment to prevent and fight fires in the Electrical Plant</td>
</tr>
</tbody>
</table>

Figure 15 – Emergency situations (NR-10 Regulatory Standard)

Contractors performing services should be held liable to the enforcement of Regulatory Standards and must inform workers about the risks involved in performing their tasks. Both companies, contracting and contractor, must develop a plan with corrective and preventive measures in the case of accidents.

In addition, workers must assume civil and criminal responsibilities on the security and health of other people working in electrical areas without omission, negligence, recklessness behavior, or malpractice in relation to technical procedures and legal provisions. Figure 16 gives the responsibilities of each involved party in compliance to NR10.
There are references within the final provisions of NR-10, that follow the ILO guidelines, stating that work should be stopped if the satisfactory working conditions are not met or could be endangering to others. Companies should have actions in place against the risk of accidents caused by other people or companies to report to public bodies when they are identified and eliminate hazardous conditions.

The Ministry of Labor has the authority to monitor compliance towards NR-10 and embargo when no risks of accidents are identified. For all work on electricity, excluding work with extra low voltage, relevant documentation should always be available and accessible to employee representatives of supervisory authorities. Figure 17 lists the final provisions, which are not classified in the previous figures.
NR-10 includes a glossary defining technical forms and conceptualization used in 31 items, which leaves no doubts about key terms used in its text. Figure 18 shows the words with specific meaning applied to electrical plants that are detailed in the NR10 glossary.
Risk influenced geographic areas are defined from an energized point (PE) in an electric installation, located in the center of two concentric circles according to annex 1 from NR-10, with special requirements for any type of work according to voltage ranges in kV.

Three specific areas were determined: a "risk zone" area associated with lightning risks (Rr), restricted to authorized personnel, and equipped with appropriate procedures and tools; a "controlled" area associated with a radius of control (Rc) and restricted to licensed professionals; and a "free zone" area where there are no specific definitions related to the PE.

If necessary, areas of risk and control can be reduced through the implementation of physical separation surfaces that eliminate risks. Figure 19 and 20 shows a summary of annex I, which deals with risk zones.
Figure 19 – Annex I – PART 1 – Risk Zones (NR-10 Regulatory Standard)

ZL = Free Zone
ZC = Controlled Zone restricted to authorized workers
ZR = Risk Zone restricted to authorized workers adopting techniques, instruments, and equipment appropriate for work
PE = Energizing installation site
SI = Insulated surface built with resistant material containing all safety devices
Workers who are authorized to perform activities in areas of electrical hazard must be trained according to the model described in Annex II from NR10 through two specific modules of 40 hours each. This training does not replace the need for technical training and offers guidance to workers on normative questions about safety and accident prevention.

Training in Module 1 should be developed in 40 hours for authorized workers. Figure 210 shows the minimum program in the basic safety course for working in electrical plants that correspond to Module 1.
Workers who perform services in the Electric Power System are obliged to undergo training through Module 2 following training through Module 1.

These trainings cover topics that should be developed and targeted specifically to the characteristics of the working conditions in each branch, including standard operating procedures, voltage level, and other specific types of activities or special condition peculiarities. Hierarchy must be followed by technical development workers.

Participation in Module 2 requires employee technical training and approval in Module 1. Figure 212 shows the program of a supplementary safety course in electric power systems and vicinities - SEP - and for Module 2 training.
5. CONCLUSIONS AND LESSONS LEARNED

The strategy of applying a complete training on NR10 for all workers involved in the launching of an Asian factory in Brazil is complex. In addition, this strategy is time consuming, expensive, and may not be suitable for everyone. A strategy without training, features important risks such as possible negative consequences on the financial, time-related, and workers’ safety and health aspects. An intermediate solution was developed throughout this article proposing the creation of a training support as an instructional resource based on NR10; this solution replaces a 40-hour course with a 4-hour presentation.

NR10 and its validating laws were studied to provide a didactic synthesis and robust form of presentation without losing the main content of its concepts. Questions can be answered during the presentations based on the reference documents. One of the difficulties in the course of drafting this article was setting the ideal level of information synthesis; some tests were performed and validated.
the full understanding of this proposition. As a result, the didactic proposal contains 21 slides associated with each item in NR10 that can be animated according to the group of trainees. This presentation has been presented to a group of foreign managers who understood the content, supported the decision of using it as a tool, and believed in its importance during the current phase of a macro project.

All Figures presented throughout this paper are in the same order of the original document and directly related to each NR 10 topic, maintaining the consistency of conceptual and didactic standards. Reading of this article for a complete understanding and for the raise of awareness of foreign personnel and companies working on projects and electrical installations in Brazil is recommended. Figures from this article can be used in slides for presentations; the discussion on these topics could prevent events that can penalize projects in terms of time, budgets, and intangible problems such as personnel injury, equipment damage, and loss of positive reputation.

In the case of the Chinese company that is currently in the design phase of the construction of a truck manufacturing facility in Brazil, the elements of this article have been effectively used for training personnel, which eliminated questions and concerns related to risk prevention and elements that must be adopted from the early stages of any project.

Future studies could develop similar materials for other Brazilian Regulatory Standards, as NR12 dealing with - Safety in Workplace for Machinery and Equipment. Others NR should be prioritized for foreign teams. The dissemination of relevant information could follow the same principle proposed in this article.

REFERENCES


______. NBR 14039: Instalações elétricas de média tensão de 1,0kV a 36,2kV. Rio de Janeiro, 2003.


