REHABILITATION OF HYDROELECTRIC POWER PLANTS

ÍNDICE PÁG.

1 - OBJECTIVE

The objective of this document is to analyze specific critical aspects of the rehabilitation of hydroelectric power plants, focusing on contractual and regulatory gaps that may cause disputes between the parties.

The rehabilitation of hydroelectric power plants is a highly complex activity that requires the participation of professionals from various specialties, with extensive experience in their respective fields, to guarantee the success of the project.

2 - GENERAL CONSIDERATIONS

Rehabilitation includes refurbishment, replacement, modernization, recovery, and modification of equipment and installations. Therefore, for the purposes of this document, all major interventions are included in the concept of hydroelectric power plant rehabilitation. These concepts apply to any type of turbines and plants, including pumped-storage power plants.

Since hydroelectric power plants entered operation, wear and tear and obsolescence processes of systems and equipment lead to maintenance problems, which affect the operation of the facilities. This is due to the lack of replacement parts and components, caused by commercialization issues or the replacement of manufacturing lines by newer ones. Many manufacturers and suppliers also close their activities and/or no longer have the obligation to guarantee spare parts supply and/or technical assistance. The personnel responsible for facility maintenance do their best to keep systems in operation until costs and workload affect the performance of the facilities.

The operation of the facilities is performed to meet commercialization rules established by a regulatory framework, defined at the time of construction and commissioning of the plants. Due to changes and improvements in regulations, operating procedures have changed, including modifications to the facilities to meet the most urgent requirements. However, due to the difficulty of meeting legal regulations combined with maintenance problems, it becomes increasingly difficult to operate the facilities within the standards desired by the utility and the market requirements.

Costs arising from operation and maintenance problems at the plants lead to considering refurbishment, which requires specific studies to define its scope. Consequently, feasibility studies are required to estimate costs, benefits, and the return on investment for this type of project.

There are many refurbishment contracts that define commercial conditions, project management, execution and payment schedules, responsibilities, penalties, and warranties in detail, concluding with the final handover of the rehabilitated plant. These contracts can be used as a basis for drafting new agreements. Therefore, the complete drafting of these contracts is not the object of this work. The contractual points addressed herein focus strictly on the gaps that, in practice, usually generate cost overruns or conflicts of responsibility due to a lack of clarity.

The lack of certain definitions, which are even difficult to establish, remains outside the scope of contracted services and creates conflicts of responsibility. A lack of clarity about these matters generates an additional cost for the contractor or, when previously included without a clear definition, can generate an inflation of prices in the contract.

3 - REGULATORY AND INSTITUTIONAL FRAMEWORK

Refurbishments and modernizations of hydroelectric power plants occur within a complex institutional environment, formed by legal, regulatory, environmental, technical, and operational standards that have been built over time.

A large portion of the plants currently in operation were conceived, designed, and licensed under legal and technical frameworks significantly different from those in force today. Consequently, any relevant intervention, even when motivated by efficiency gains, increased reliability, or extension of equipment life, begins to interact with this set of regulatory framework requirements in an integrated manner.

3.1 - Power Sector and Regulation

Hydroelectric power plants are subject to the legal regime of the Brazilian power sector, whose core is formed, among others, by Laws No. 9,074/1995, No. 10,848/2004, and No. 12,783/2013. These standards define the model for concessions, permissions, and authorizations, as well as the general rules for the operation and commercialization of electric energy. The verification of the validity and enforceability of these standards must be performed at the time the decision to refurbish is made.

In Brazil, there are agents that define the procedures and requirements to be followed. Other countries also have their criteria and standards, like the Brazilian ones.

Within the Brazilian institutional scope, the following agents stand out:

3.1.1 - ANEEL - National Electric Energy Agency

The National Electric Energy Agency (ANEEL) is the regulatory body of the Brazilian power sector, with authority over the generation, transmission, and distribution segments of electric energy.

It is ANEEL's responsibility, among other duties, to:

- Regulate and inspect electric energy generation services;
- Establish technical, operational, and commercial requirements applicable to power plants;
- Administer concession, permission, and authorization contracts;
- Define criteria for quality, availability, and continuity of service.

In the context of refurbishments and modernizations, ANEEL is the main body responsible for framing interventions from a regulatory perspective, especially regarding the maintenance of grant conditions, declared technical parameters of the plant, and associated contractual obligations.

3.1.2 - ONS - National Electric System Operator

The National Electric System Operator (ONS) is the entity responsible for coordinating and controlling the operation of the National Interconnected System (SIN).

Even though they are privately owned assets, power plants connected to the SIN operate in a centralized manner, in accordance with the Grid Procedures established by the ONS. These procedures define technical and operational criteria related, among other aspects, to:

- Generation dispatch;
- Operational limits;
- Voltage and frequency control;
- Provision of ancillary services.

Changes in control, protection, regulation, or supervision systems resulting from refurbishments and modernizations must generally be compatible with the operational requirements established by the Operator.

3.1.3 - CCEE - Electric Energy Commercialization Chamber

The Electric Energy Commercialization Chamber (CCEE) is the entity responsible for the accounting and settlement of electric energy transactions in the Brazilian market.

Regarding hydroelectric power plants, CCEE is mainly associated with aspects of measurement and accounting of generated energy, as well as compliance with contractual obligations assumed by agents within the commercialization environment.

3.2 - Water Resources

3.2.1 - ANA - National Water and Basic Sanitation Agency

At the federal level, the National Water and Basic Sanitation Agency (ANA) is responsible for managing water resources under the federal domain, while state bodies are responsible for managing waters under their respective state domains.

The water rights grant establishes the general conditions for water use by the power plants, including flow limits and reservoir operational rules.

3.3 - Environment and Licensing

3.3.1 - IBAMA - Brazilian Institute of Environment and Renewable Natural Resources

Hydroelectric projects are subject to environmental licensing, conducted by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) or by state environmental bodies, according to legal jurisdiction.

Environmental licensing generally consists of the following licenses:

- **Preliminary License (LP)**, which certifies environmental feasibility;
- **Installation License (LI)**, which authorizes the implementation of approved interventions;
- **Operation License (LO)**, which authorizes the operation of the project.

Depending on the characteristics of the project and the proposed interventions, specific environmental studies may be required, such as EIA/RIMA, Environmental Control Plans, and monitoring programs.

3.4 - Dam Safety

Law No. 12,334/2010 institutes the National Dam Safety Policy (PNSB). This legislation establishes criteria for dam classification, obligations for developers, and the need to draft and maintain technical documents such as the Dam Safety Plan (PSB)—a technical

document compiling safety information, procedures, and controls—and the Emergency Action Plan (PAE), a document defining actions in case of risk situations or dam failure.

3.5 - Historical Heritage and Communities

Interventions in hydroelectric power plants may involve aspects related to the protection of historical, cultural, and archaeological heritage, as well as impacts on local communities. In this context, notable entities include the National Historical and Artistic Heritage Institute (IPHAN), the body responsible for protecting cultural and archaeological heritage; the National Foundation for Indigenous Peoples (FUNAI), the body responsible for indigenous policy in Brazil; and the Palmares Cultural Foundation, depending on the nature and location of the project.

3.6 - Technical Standards

In addition to legal and regulatory requirements, refurbishments and modernizations of hydroelectric power plants must comply with technical standards applicable to various systems and engineering disciplines.

- **ABNT (Brazilian Association of Technical Standards)** - Entity responsible for technical standardization in Brazil.
- **IEC (International Electrotechnical Commission)** - International standards commission for electrotechnical systems and equipment.
- **IEEE (Institute of Electrical and Electronics Engineers)** - International organization for standards and best practices in electrical and electronics engineering.
- **ICOLD (International Commission on Large Dams)** - International reference organization for dam engineering.

3.7 - Occupational Safety

Rehabilitation and modernization activities are subject to Regulatory Standards (NR) for occupational safety and health established by the Ministry of Labor. Among the most relevant standards for hydroelectric power plants are those related to electrical installations, machinery and equipment, confined spaces, and working at heights.

4 - DEFINITION OF INTERVENTIONS

The utility must, based on operation and maintenance problems and difficulties, preliminarily define, either through its own professionals or experienced consultants, what should be the object of the rehabilitation. This definition must consider the Regulatory and Institutional Framework.

The rehabilitation of hydroelectric power plants is normally carried out by a large company or group of companies, depending on the definitions in the Bidding Documents. This company or group of companies is responsible for the entire project until the power plant enters operation, and the final handover of the rehabilitated plant is completed.

Since the rehabilitation of a hydroelectric power plant is not a fast process, the scope of services must consider the final date of the rehabilitation and not just the current or short-term situation. Often, services are defined as unnecessary now; for example, a system considered "new" might be obsolete by the end of the rehabilitation process, which includes

feasibility study, basic design, bidding documentation drafting, proposal analysis, contract signing, execution of works, and conclusion of the rehabilitation, taking years.

4.1 - Civil Works

Preliminary assessment of the condition of civil structures of the Dam, Powerhouse, Water Intake, Spillway, Substation, and other important installations, based on records and information provided by the plant personnel.

4.2 - Generating Units

Evaluate the possibility of changes in operating conditions and capacity increases of the units. When the replacement of the units is not planned, the most common and important interventions are:

4.2.1 - Generators

- Replacement of excitation systems.
- Recovery of the stator and rotor windings.
- Recovery of bearings, including the addition of an oil injection system to the thrust bearings in older units.
- Replacement of the protection system.
- Replacement of the monitoring system, with the inclusion of corresponding sensors.

4.2.2 - Turbines

- Replacement of turbine speed governors.
- Recovery of the turbine runner.
- Recovery of the distributor mechanisms.
- Recovery of bearings.
- Inclusion of a water level depressing system in the turbine draft tube for operation as a synchronous condenser.

4.3 - Step-up Transformers

Evaluate the condition of step-up transformers and associated facilities, including the insulation oil treatment and drainage system, and fire suppression systems.

4.4 - Supervision and Control System

Due to the continuous emergence of new technologies, these systems are replaced by more modern ones, especially in older plants.

4.5 - Electrical Auxiliary Systems

Due to obsolescence, all components of the electrical auxiliary systems are normally replaced.

4.6 - Mechanical Auxiliary Systems

Mechanical auxiliary systems are partially replaced, especially the drive, supervision, and control systems.

In older facilities, where the plant drainage systems and turbine spiral case dewatering systems are shared between both systems, and due to environmental requirements, it is necessary to separate the systems to prevent contamination of the water discharged into

the river with oil residues from the powerhouse drainage system. This rehabilitation sometimes implies creating an oil-water separation system for the powerhouse drainage system specifically for this purpose, similar to the oil-water separation system for transformer insulating oil.

4.7 - Overhead Crane

The drive system of overhead cranes is replaced by a new one featuring precise speed control utilizing frequency inverters.

It is observed in older plants, from the era when the power system frequency in Brazil was 50Hz, that the capacity of overhead cranes was reduced to 80% of their former capacity due to the frequency increase to 60Hz, to compensate for the speed increase caused by the higher frequency. The indication of the new capacity on the crane structures was often altered, which may give the wrong impression that the crane's capacity is lower than its actual capacity. In these older facilities, original crane documents must be researched to maintain the original capacity, given that the speed of the refurbished crane can be reduced to the original speed (i.e., when the frequency was 50Hz).

In cases where units are replaced by larger ones, static and dynamic capacity evaluations of the crane must be conducted to meet the new conditions.

Another issue that is sometimes raised is the requirement for the rehabilitation contractor to perform load tests on the refurbished crane before using it for the assembly or disassembly of generating units. This requirement makes no sense, as the crane, having been used for many years, proved that its structure has already been properly tested. Therefore, the only doubt that could arise would be whether the replacement motors and drive system were correctly selected. This can be verified during the plant rehabilitation services. Remember that during the plant's original construction, tests are not performed on the crane prior to assembly.

According to standards, cranes are sized to lift loads greater than nominal capacity, which is not possible to prove in tests, as such large loads would be very difficult to obtain and prepare. In the absence of documents containing this information, calculations must be made, if necessary, to determine the actual capacity of the crane.

4.8 - Spillway

Evaluate the structures of gates, seals, and stop logs; drive, supervision, and control systems of the gates; gantry crane; and the need for an emergency generator set.

4.9 - Water Intake

Evaluate the structures and seals of gates and stop logs; drive, supervision, and control systems of the gates; evaluation of the gantry crane and trash rack cleaning machines.

4.10 - Draft Tube

Evaluate the structures and seals of gates and stop logs; evaluate the gantry crane.

4.11 - Substation

Evaluate the condition of equipment such as circuit breakers, disconnect switches, protection, supervision, and control systems; necessity of replacement; compliance with ONS requirements.

5 - FEASIBILITY STUDY

The feasibility study aims, among other aspects, to verify whether the requirements of the institutional regulatory framework can be met, estimate the costs of possible alternatives, and determine the return on investment. This study is conducted by experienced companies and professionals.

6 - BASIC DESIGN

The basic design is a subsequent stage to the feasibility study and aims to define what must be done and how the project development should proceed. This basic design can be executed with a greater or lesser level of detail and serves to meet the institutional regulatory framework, define more detailed costs, schedules, and important technical information.

The basic design will comprise the set of documents that will allow the definition of the scope of rehabilitation services to be contracted, enabling the standardization of proposals from companies interested in executing the project.

This design is prepared based on the results of the feasibility study, existing documents of the plant to be rehabilitated, field surveys, and complementary services. These complementary services may include conducting tests and trials on the facilities and equipment, aiming to provide more data for a more precise definition of the rehabilitation scope of services.

7 - BIDDING DOCUMENTS

The bidding documents aim to establish, among other conditions, the requirements for contracting the company, the contracting regime, the definition of the supply of equipment, components, materials, and systems; services for civil works execution, disassembly, assembly; decommissioning, equipment testing, and facility commissioning; execution of the detailed design; training of operation and maintenance personnel, assisted operation, and warranties until the end of the project with the final handover of the facilities to the client.

All information necessary to define the project scope must be included in these bidding documents

7.1 - General Information

The bidding documents must state the conditions for participation, qualification of interested parties, proposal presentation formats, evaluation criteria, taxation, guarantees, obligations of the contractor and contracting party, subcontracting, responsibilities, penalties, and others deemed relevant. If the bidding process is for a public enterprise, the reference price or estimated value must be included in the documents.

7.2 - Detailed Description of Scope

The bidding documents must contain a detailed description of the supplies and services that must be met by the bidders.

7.3 - Documentation

Detailed specifications of all services and supplies, defining all characteristics and activities that must be the object of the project, must be included in the bidding documents.

7.4 - Schedules and Payment Milestones

The execution periods of the project and payment milestones must be defined in the bidding documents.

8 - CONTRACT

8.1 - Selection of Bidders

Participants in the bidding process must meet the requirements established in the bidding documents and must be companies with experience in the field, whether associated with others or not, that meet the conditions of the bidding documents.

8.2 - Contractor Invoicing

Depending on the contract, the invoicing of equipment and services can be done directly with the contracting party or, through a contract, as a sub-supplier of the contractor. The form of invoicing is defined in the contract based on the role of the supplier involved, as a contractor or sub-supplier. The problem is that the client, most of the time, limits the direct invoicing of sub-suppliers, which can make the supply unfeasible if the tax rates of the operations are not very well defined and considered in the costs of supplying services and materials.

8.2.1 - Invoicing Split in Consortiums

In the case of a consortium formation, the companies must define in detail how the invoicing split for each of them will be carried out based on the contractual payment milestones. A practical solution is for each consortium member to invoice an amount proportional to its share in the project over each completed milestone, regardless of who the direct executor of that specific milestone is. For example, if a participant has a 20% share in the total contract value, and a milestone completed by another consortium member generates a payment of 0.05% of the overall value, they will receive 0.01% of the total contract value (i.e., 20% of 0.05%).

To financially enable this flow, consortium members issue proforma invoices to record the contributions and amounts received, which accumulate and are offset as final tax invoices for services and supplies are issued.

Tax Risk Alert: In the Brazilian legal and tax system, a proforma invoice has an exclusively commercial character (as a quote or intent) and possesses no tax validity. Receiving financial advances without the immediate counterpart of a Tax Invoice (*Nota Fiscal*) or a collection document formalized by the consortium (such as a Debit Note, when applicable) can be interpreted by the Tax Authorities as revenue omission or tax deferral. Therefore, the accounting control of these advances must be rigorous to avoid tax contingencies and liabilities.

8.2.2 - Cost Alerts

In practice, no company, even large ones, manufactures all the equipment and materials it must supply. The procurement and sales logistics of these supplies must be carefully evaluated before entering the business, especially in public procurement or with large clients who exercise strong bargaining power and frequently establish extremely reduced BDI (*Indirect Costs and Profit*) limits, or limits at the threshold of feasibility. This is an extremely important item and must consider updated tax legislation and the rules defined in the contract with the client.

Many supplies are conducted through Triangulation (Drop Shipping / Bill-to-Ship-to), an operation in which the contractor supplies equipment from third parties without the merchandise needing to physically pass through its company. In this dynamic, the supplier delivers the material directly to the end client for the account and by order of the contractor.

Although it optimizes logistics, this operation requires attention to the costs involved and rigorous control of tax legislation involving ICMS, IPI, ISS, IRPJ, CSLL, PIS, COFINS, etc., which must be correctly considered in the shipping and sales invoices, under the risk of double taxation or tax penalties if the documentation flow does not exactly mirror the current state and federal legislation.

For example, in the case of a consortium member (A) that supplies equipment, materials, and services from third parties (B) to an end client (C): consortium member (A) signs a supply contract that includes equipment, materials, and services (design, inspection, assembly supervision, training, etc.). Consortium member (A) issues the invoices for the equipment, materials, and services to the client (C). Supplier (B) fulfills what is defined in its contract, leaving consortium members (A) responsible for client (C) and the other consortium members for:

- Preparing specifications and documents for hiring supplier (B) to meet the bidding documents;
- Assuming the supply of any item not provided for in its contract with (B);
- Managing the supply with the other consortium members and clients (C);
- Arranging the approval of supply documents with Client (C);
- Inspecting equipment and materials at supplier (B)'s facilities, accompanied by client (C);
- Accompanying the assembly supervision performed by supplier (B) and resolving eventual problems with the other consortium members and client (C).

The tax legislation to be considered is that in force at the time of signing the contract with the client. Changes in tax legislation occurring after the signing of the contract with the client may be considered by either party.

8.3 - Interface Matrix

This is a very important and necessary document when the contractor is formed by a consortium of companies. In it, the limits and responsibilities of each company are defined and must be studied exhaustively in detail, down to the smallest detail, to meet the contract with the client. If a consortium member assumes responsibility for a certain supply provided for in the consortium's contract with the client, any additional cost not foreseen by the consortium member responsible for that supply will be of its sole responsibility and burden, and this cost shall not be prorated among the others. When relevant, interfaces with the client must be included in this matrix.

8.4 - Coordination and Management of the Project

The coordination and management of the project must be carried out by the contractor and the contracting party, each within its duties and responsibilities. A general coordinator from the contractor will be responsible for dealings with the client, who in turn will have a person responsible for coordinating the contracting party's activities. The contractor and the client, in turn, will define their own coordination structures to interact internally and externally.

Common consortium expenses (insurance, coordination costs, contractual guarantees, licenses, etc.) are normally prorated among the consortium members proportionally to their percentage share in the business.

8.5 - Detailed Design

The design of a plant, prior to rehabilitation, can have thousands of documents (including detailed design, manufacturers' documents, reports, and others). Many documents, due to replacements of components, equipment, and maintenance interventions, may no longer correspond to the current reality. However, much information will remain valid for what has not been modified or replaced. The detailed design must provide for the survey of valid documents to be considered in the rehabilitation and, if necessary, conduct a survey of the respective information. Surveys of information must be conducted by those responsible for supplying the equipment and/or systems, to include them in their respective sets of documents for the refurbished and/or modernized systems. All specialties and project activities are involved in this activity, including representatives of the contracting party and contractor, coordinated by the contractor company or by whomever it designates for this purpose. Thus, the final detailed design of the project must consist of a set of documents containing all information on all rehabilitated facilities. The detailed design will consist of:

- The set of documents produced by the contractor. This set includes design drawings, manufacturers' documents, calculation memories, descriptive memorials, specifications, reports, certificates, etc.
- Old documents, whether revised or not by the contractor, are necessary for any activity involving the rehabilitated facilities.
- Dead storage, consisting of documents of installations and equipment that were discarded and/or replaced by new ones. This archive may be maintained or not, at the client's discretion.

The detailed design of the installations for the rehabilitation of hydroelectric power plants must have its scope clearly defined to avoid problems of interpretation regarding the objective involving existing documentation.

8.6 - Definition of Rehabilitation Sequence

The definition of the sequence of supplies and services is normally defined in the bidding documents and the contract. This sequence is part of the project's master schedule and is linked to payment milestones.

The definition of the rehabilitation sequence of the generating units is particularly important because it also defines the construction execution logistics. The detailed design of all involved parties is developed considering this sequence. The party responsible for the detailed design must, at the beginning of the contract, prepare a design showing the step-by-step equipment arrangement of the facilities for each stage of the modernization. This design is normally made for the rehabilitation of each unit; that is, the design is a set of equipment arrangement drawings showing the beginning and end of the rehabilitation stage of each unit, up to the configuration of the fully rehabilitated plant. For the execution of this activity, all parties involved must provide the person responsible for the detailed design with information regarding their equipment. This phase of the detailed design allows the planning of all activities involving the supply of equipment and materials, as well as the design of temporary facilities that must be made to allow the rehabilitation to be carried out with the least interference to the operating facilities.

Altering the rehabilitation sequence implies redesigning from the point where the sequence is changed; altering designs prepared considering that sequence; replanning temporary facilities; rescheduling and/or anticipating the ongoing supply of equipment and materials that are customized for each unit; renegotiating equipment warranty periods; reviewing contracted insurance policies; altering the construction schedule; reorganizing the warehouse; reviewing contracts with third parties affected by the alteration of the assembly sequence, etc.

The alteration of the assembly sequence must be very well evaluated before being finalized, as it implies the reworking and rescheduling of a series of activities and increased project costs. This alteration may occur, for example, because of serious damage to another unit, implying the anticipation of its rehabilitation.

8.7 - Inspection of Equipment and Materials

The inspection and testing of equipment and materials must be performed in accordance with contractual conditions. These activities are carried out at factories and suppliers, accompanied by the contractor and the contracting party through their professionals responsible for drafting and approving specifications and documents. In final inspections, the professionals responsible for facility maintenance should participate in this activity, and in some cases, operations personnel as well.

8.8 - Spare Parts

Spare pieces and materials must be inspected together with the main supplies and must be identical to those supplied. In case of the need for configurations or adjustments for use, the spare parts must be parameterized so that, if their replacement is necessary, it can be done without the need for on-site adjustments.

Contractors must consider that often, during the rehabilitation process, components of their supply may become obsolete due to the replacement of the manufacturing line by more modern ones or the termination of the obligation to maintain products on the market. This occurs in power plant rehabilitations with many units, where the project schedule forecasts deliveries over time as the rehabilitation develops. These schedules provide equipment deliveries according to the progress of the assembly; that is, deliveries are also split so as not to overburden construction warehouses. As contracts also provide for the supply of spare parts, due to the above, it may be necessary to supply additional spare parts, different from those already supplied, to accommodate component changes often not foreseen in the supplier's costs. The solution of acquiring all components at the beginning of the work has the disadvantage of storage issues and manufacturers' warranties, which have an expiration date, leaving the supplier responsible for the warranty without the backing of the manufacturer.

8.9 - Storage and Preservation of Equipment and Materials

The contractor must be responsible for the handling, storage, and preservation of equipment and materials, strictly following the manufacturers' recommendations to prevent their deterioration or the loss of manufacturers' and suppliers' warranties. Many equipment and materials require special care that is often disregarded by those responsible for their custody.

8.10 - Commissioning

Commissioning must be planned and executed in a sequence and manner compatible with the progress of the rehabilitation, in accordance with contractual conditions. The following must be defined as applicable:

- Program and detailed schedule of commissioning;
- Activities, necessary maneuvers, and personnel involved;
- Eventually interdictions required;
- Limits (what is inside and outside of commissioning);
- Responsibilities for tests (contractor, suppliers, contracting party);
- Supply of necessary instruments and materials;
- Prerequisites (completed assembly, documentation, energization);
- Definition of expected results;
- Acceptance criteria and evidence (reports, records, checklists);
- Treatment of non-conformities and retesting;
- Integration with operational requirements (including protection, control, and supervision systems).

8.11 - Interaction with Operations and Maintenance

As operation and maintenance routines continue to be performed during the rehabilitation process, those involved in the plant rehabilitation must coexist with local operators and other collaborators to reconcile their activities.

The sharing of equipment, facilities, and responsibilities for uses such as overhead cranes, gantries, oil treatment systems, assembly areas, warehouses, offices, storage, restrooms, locker rooms, etc.—must be defined and agreed upon in the contract or with those responsible on the client's side.

The performance of assembly services and interventions in the facilities must be detailed and communicated to the client, who must authorize, accompany, and inspect these activities, and eventually participate when planned.

Due to the characteristics of the services, modifications to facilities under rehabilitation or in operation occur continuously. In turn, the operation of a plant is done in shifts and by different operators who have no knowledge of the modifications carried out in the previous shift, which alter their operating routine. Therefore, there must be constant updating of relevant operational routine information, guidance, and training of operators for the correct execution of maneuvers to avoid any problem or accident. Assisted operation cannot, by itself, be considered sufficient to waive compliance with operator guidance procedures. The client must designate its representatives, who will be responsible for the contractor's interface with the plant personnel, to monitor all stages of the modernization.

Plant maintenance personnel do not work in shifts but are permanently available. The same principle adopted for operator guidance and training must be adopted for maintenance personnel.

The documents normally used to keep information on modifications updated are single-line diagrams, process flowcharts, and operating instructions, which must be continuously updated.

Operations and maintenance professionals, principally, should participate in equipment inspections to familiarize themselves with the equipment they will have to maintain under their care.

8.12 - Assisted Operation

Assisted operations must be conducted by professionals from the contractor with extensive experience in this activity, and who continuously participate in assembly services, testing, and commissioning of the facilities.

During assisted operation, all plant operators must be trained to maintain the rehabilitated and not yet rehabilitated facilities in satisfactory operation.

The professionals responsible for assisted operation must not perform operational activities which must be carried out by the plant operators.

In cases where operating procedures are not well defined or present flaws in their execution, they must be altered by the contractor's professionals and subsequently communicated to those responsible for preparing instructions and operating documents so that the proper corrections can be made.

Those responsible for assisted operations cannot operate equipment and facilities delivered to operations. Any intervention, even if extraordinary, involving risks to people and facilities, must be conducted with the participation of the operators and a knowledge of higher management.

8.13 - Resolution of Outstanding Issues

Throughout the project, outstanding issues may arise regarding the supply of equipment and materials, execution of services, drafting/updating of documents, etc. The resolution of these outstanding issues may provide for:

- Definition and classification of outstanding issues (critical, operational, documentation);
- Responsible parties and resolution deadlines;
- Criteria for closing (evidence and acceptance);
- Rules for partial and conditional acceptances;

8.14 - Warranty

Equipment and facility warranties, depending on the rehabilitation execution schedule, expire during the progress of the plant rehabilitation. Until commissioning and handover to operations, the maintenance of these installations remains the responsibility of the contractor, who must arrange for warranty service through appropriate means. After the warranty period, the contracting party becomes responsible for contacting the respective manufacturer or supplier.

8.15 - Final Handover

The final handover must be conducted as provided for in the contract and scope, with eventual restrictions and/or observations:

- Consolidated final documentation (as-built, manuals, test reports);
- List of closed outstanding issues and remaining outstanding issues (if accepted);
- Completed training (operation and maintenance);

- Delivered spare parts and tools;
- Final acceptance/handover certificate.