The Benefits of Witnessing Electrical Factory Acceptance Tests (FATS)

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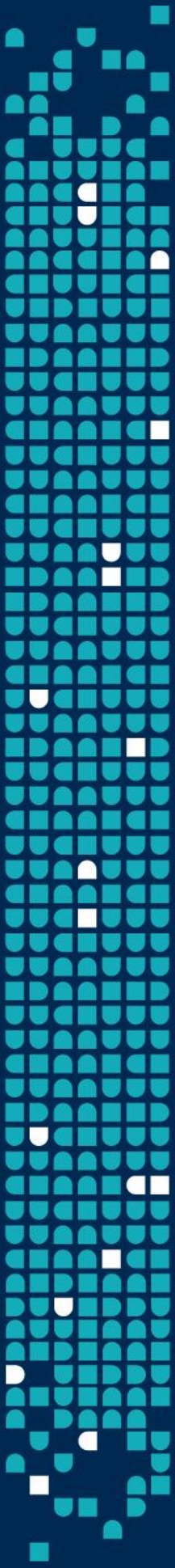

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Executive Summary

Today, rigorous witnessing of factory acceptance tests (FATs) performed by an expert who is directly involved in the project engineering process is proving to be key when carrying out detailed engineering projects. On the one hand, it prevents disruptions when completing an engineering project and, on the other hand, minimizes the risk of undue delays during plant commissioning and start-up. It also prevents significant production losses in case critical equipment is unexpectedly damaged in the initial years of operation.

Experience shows that, in general, intensifying FATs helps:

- Reduce the risk of litigation following project execution.
- Improve the insurability of a plant, knowing that the risks of premature damage are much lower when the FATs have been performed rigorously.

However, FATs are often sacrificed in favour of shortening the schedule and for financial considerations.

This document will demonstrate that properly following project steps to optimize nominal life expectancy is more beneficial than accelerating the process to save money or to shorten the schedule, which would negatively affect process operation.

Table of contents

Business Challenge

In the industrial sector, the acronym "FAT" is used to designate factory acceptance tests. These tests usually take place in the last construction phase of fully assembled equipment, before leaving the manufacturer's factory. Most FATs are designed to check not only that equipment meets specifications, but also that it is fully functional and safe before it is used. A comprehensive FAT program typically includes:

- An audit of equipment integrity
- An audit of contractual requirements
- Proof of functionality and a final inspection
- Witnessing specified tests as well as functional tests

Operational reliability of an industrial power grid is one of the most critical elements for project success. In fact, if one of its components fails, it usually results in commissioning delays, operational limitations or even partial or complete plant shutdowns, causing production losses that are often expensive. Additionally, the unexpected failure of such operating equipment generally results in periods of unavailability ranging from one to fifteen days, depending on whether there is spare equipment or if relief options were identified beforehand.

The business challenges encountered in the initial phases of a project are:

- To start the plant as quickly as possible.
- To ensure plant operations will not be subject to chronic problems that could have been identified and corrected prior to plant start-up or avoided by timely interventions, which is possible when FATs are properly witnessed.
- To ensure personnel safety when starting the plant and throughout its operation.

The administrative separation that exists between the end of plant start-up and its operation must not be used as an excuse to limit tests before and during its start-up, which would hinder productivity after the plant has started up. In fact, in attempting to limit factory testing, the overall start-up cost and initial months of production might be higher because of delays and production losses caused by previously undetected problems. Factory tests, pre-operational site verifications and commissioning must be performed in accordance with best practices. The goal is to avoid surprises that could prove to be costly and make it difficult to establish who is responsible if certain steps have been neglected.

Description of the Solution

An industrial power grid mainly consists of the following critical equipment:

- Power and ground transformers
- Low- and medium-voltage switchgear cabinets
- Motor control centres
- Distribution transformers and neutral point resistance
- Variable frequency drives

Electrical equipment is inseparable from other elements of an industrial process, hence it is critical. No industrial project is an exception to this rule and each requires well-constructed and carefully tested electrical equipment. This ensures reliable operation from the start and throughout equipment service life, which in turn calls for minimal maintenance that requires planned shutdowns.

It is important to carry out every project phase to prevent having to perform the phases during operation, where the financial consequences are often more harmful because of a lack of rigour during the engineering. Production losses, which are always very expensive, are added to the cost of repairing or replacing faulty or inadequate equipment for the task at hand. It is therefore recommended to follow these key steps:

- Equipment procurement
- Factory acceptance tests (FATs)
- Detailed engineering
- Pre-operational verifications and commissioning

Plants have often experienced financial difficulties that lead to their premature closure due to a lengthy running-in process and production shutdowns caused by critical equipment breakdowns.

In conjunction with design reviews, witnessing FATs is the last opportunity for the engineer to confirm that the major electrical equipment will fully meet all technical specification requirements as well as equipment performance expectations. Likewise, the test engineer will confirm that the test program is performed in accordance with the inspection test plan previously approved by all parties, and that the minimum requirements of applicable standards governing these tests are fully complied with.

Although FATs can be performed by a third party, there is a major advantage to awarding this mandate to a member of the group involved in performing the engineering for the relevant equipment. In fact, this allows you to benefit from the knowledge acquired by the expert throughout the tendering, procurement and manufacturer drawings approval processes. It is still necessary for the engineer to have the competencies and authority required to enforce a process that is often compressed and compromised by delivery requirements (awaiting boat, spring thaw, compliance with transport permits and any other economic considerations) as well as by inflexible managers with objectives other than plant start-up and operation. The decision on which group will perform the work must be made vigorously and, above all, must not only be guided by the budget. Most importantly, this mandate must not include the manufacturer supply mandate, as subsequent litigation is rarely in favour of the user who suffers production losses. Moreover, it prevents any break in the engineering process.

The benefits of entrusting such a mandate to the project engineering group are as follows:

It allows the engineer to inspect specific elements that were agreed upon with the manufacturer during the project, but do not necessarily appear in the drawings and documents. It is information that obviously cannot be known by a third party, because several components are visible only during final equipment installation at the project site.

It allows the engineer to detect minor defects that, although not critical, must be corrected to optimize equipment performance. These corrections are much easier to make at the equipment manufacturer's factory than at the project site, after delivery. Certain corrections cannot be performed after delivery because of the significant cost associated with performing them at the project site. The client therefore has virtually no choice after delivery than to accept the equipment as is, despite the problems observed at start-up. Often enough, it is the clients who must correct these defects themselves, at great expense, to prevent production losses and the risk of accidents during operation.

It ensures continuity of project monitoring throughout the engineering work.

Nowadays, more and more insurers view FATs as being a very important part of a quality assurance plan. For example, a transformer that does not operate properly due to premature failure will have a major impact when considering repair costs, production losses and the reduced reliability of a now weakened distribution network. The cost of

rewinding a transformer can typically reach 70% or more of the cost of a new transformer. Repairs, where possible and financially feasible, can easily be spread over almost six months. Additionally, equipment removal, return transport and relocation to the manufacturer's factory can cost anywhere from $200,000 to $350,000, not to mention the additional repair time when the repair is to be performed overseas.

Despite the arrival of switchgear on the market that is resistant to internal arcs, protecting personnel against the risk of injury is not fully assured, since arc resistance was demonstrated only on a prototype and several years ago. That is why it is equally important, if not more important, to perform comprehensive FATs, which include lightning shock tests, induced voltage with partial discharge measurement tests and applied voltage and temperature rise tests. These make it possible to at least minimize the risk of damage to internal arc switchgear. Engineers who affix very low-level safety data sheets to such critical equipment must be aware that the equipment might not be as safe as expected, since it is all an aspect of:

- Successful standard tests
- Integral compliance with the reference design used in certifying the internal arc resistant test
- The quality of factory assembly, which does not tolerate variation from the prototype used to obtain the certification

Also, experience demonstrates that the repair time is often excessive in the event of unexpected failure of equipment that must withstand the internal arc. In fact, to maintain the arc-resistant certification, it is imperative to use the original parts and, ideally, entrust the repair to the original manufacturer, while the latter is rarely in the region where the equipment is used and, often, even on another continent. This situation must strongly encourage owners to systematically demand standard tests (of lightning shock, induced voltage with partial discharge measurement and applied voltage and temperature rise) on switchgear that is resistant to internal arc to avoid transferring costs to operations that are significantly higher than the expected savings. Since partitioning is very important, ventilation and respectable isolation distances are much more critical than before and often very difficult to assess by simple visual inspection. The internal arc resistance design in no way reduces the rigour and importance of FATs and cannot be a cure-all for the frequency of switchgear malfunctions. A significant reduction in personnel risk results in much longer repair time after an incident as well as a much more complex design than before, hence the importance of performing all FATs with this type of equipment.

Benefits of the Solution

Witnessing FATs by an expert who was ideally involved in preparing the equipment specifications and in carrying out the detailed engineering for the project, including the approval of the manufacturer's drawings, is now essential for the following reasons:

- Equipment that is not subject to rigorous FATs are at risk of premature damage in the first years of operation.
- FATs help minimize the risk of serious injury to personnel exposed to severe failure of this type of equipment.
- FATs can prevent downtime in a very important and expensive plant or manufacturing process.
- FATs also help prevent costs and lost time during arduous disputes with the manufacturer following equipment failure.

Conclusion

To ensure project success, rigorous FAT witnessing of any major electrical equipment is essential. Additionally, this work must be carried out exclusively by specialists, preferably members of the engineering group involved in the project and not by a third party consisting of non-specialists who generally do not hold the knowledge of the critical equipment elements and, above all, their use at the site. This is essential for any project where personnel and installation safety is paramount, even if the project is to be carried out in a ridiculously short timeframe. Otherwise, the burden of problem-solving is shifted to the operator, with financial consequences that insurers are increasingly concerned about.

About the Author

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Maurice Brisson is a natural leader with a bachelor's degree (1971) and master's degree (1973) in electrical engineering from Polytechnique Montréal. He is recognized today for his high-level expertise, particularly in medium- and high-voltage power grids.

- Main contractor of studies for protection and reactive compensation, design and optimization of high-power harmonic filters for electrolysis processes and arc furnaces, short-circuit and power flow calculations, transient phenomena and voltage flickering.
- Participates as an expert in seeking causes of damage and problems with power transformers as well as for special transformers for large power rectifiers, power for large variable frequency drives and arc furnaces.Performs numerous techno-economic studies for reliability, sustainability and rehabilitation of electrical substations of up to 230 kV as well as for industrial distribution networks of up to 52 kV, overhead lines and underground cables.
- Participates as a technical expert in settling legal disputes, either by direct negotiation between the parties or through the courts.
- Leads and participates in numerous industrial power quality studies for large power consumers, with recommendations for appropriate mitigation, including specification, detailed engineering and performance testing (over 100 studies).
- Participates in various detailed engineering phases and in the specification of major equipment as well as in technical support of groups of engineers and technicians responsible for the detailed engineering of projects.

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