BRAZILIAN WIND FARM PROJECTS CERTIFICATION PROCESS

Vanessa Gonçalves Guedes
CEPEL – Electric Power Research Center
P.O. Box 68007 – Zip Code: 21944 – 970
Rio de Janeiro – RJ - Brazil
vanessag@cepel.br

Ricardo Marques Dutra
CEPEL – Electric Power Research Center
dutra@cepel.br

Ary Vaz Pinto Junior
CEPEL – Electric Power Research Center
ary@cepel.br

José João Garcia Couri
Padre Leonel Franca Foundation
225, Marquês de São Vicente Street– 9th to 13th floor
Gávea – Zip Code: 22451 – 900
Rio de Janeiro – RJ - Brazil
g.couri@uol.com.br

Abstract. *The certification process is a widely used instrument to assure the quality and the suitable operation of several services and products. Some international institutions have qualification to provide certification services in the wind energy area based on the IEC 61400 standards family, specifically for wind turbines. Some countries have developed or identified other specific standards related to surperficially mentioned topics in the IEC 61400 series. In order to reduce the costs of the certification services, stimulating knowledge spreading and development, an effort has been made by the European Community to harmonise the certification procedure of wind turbines through the IEC WT 01 standard. This standard defines a certification system for wind turbines. It specifies rules of procedure and management for carrying out conformity evaluation with respect to the mentioned standards and technical requirement for wind turbines.*

The Brazilian certification net is supported by internationally recognized organisms which are capable of certifying products, services or processes of several segments. Although, there are no national institutions accredited for services and processes certification related to wind power energy issues, like cup anemometers calibration, wind turbine safety, strengh and performance testing, measured power curve determination etc.

In the case of the Brazilian wind power plants, most of the wind turbines (and other equipments) will be installed near to the coast and will be submitted to corrosion, tropical abrasion and salinity severe conditions. Recently, the recommendations of the standards used and developed by the oil and gas offshore prospection industry have been being applyed on offshore wind plants. A careful analysis must be carried out in order to define the anticorrosive protections that must be applied to the Brazilian wind plants projects in order to guarantee suitable protection and equipment trustworthiness without increasing their cost.

Considering the Brazilian wind energy market expansion, encouraged by the beginning of the PROINFA (Alternative Energy Sources Incentive Program), Brazil must be prepared to indicate the standards that shoud be used in the certifications, in order to guarantee wind plant projects that fit our specific conditions during its lifetime. The objective of this article is to make an evaluation of the Brazilian Wind Farm Projects Certification Process taking the above topics into consideration.

Keywords*: Wind power, conformity evaluation, certification process, standards, corrosion*

1. INTRODUCTION

This article aims to evaluate the international experience and suggest the necessary steps for the establishment of a certification process technique of wind power plants in Brazil in order to guarantee the adequate performance of the same ones throughout its lifetime. The certification process of wind generation projects has great importance and its technical characteristics are not fully developed and applied by the Brazilian scientific community, differently from other sources of electric energy widely used in the country. And this process of certification is of special interest for ELETROBRÁS which assumes two roles of significant relevance and complexity in the PROINFA (Alternative Energy Sources Incentive Program).

The first one of them, aiming to assure the wind power projects economic-financial viability in PROINFA, consists in guaranteeing the acquisition of the electric power produced by those enterprises during a period of 20 (twenty) years.

With this commitment, ELETROBRÁS is responsible for any lack of electric energy that should be produced by the contracted wind power projects, and will have to buy the necessary energy shortage amount at thr spot market.

The second one is to promote the Brazilian electrical system diversification using renewal energy sources and to contribute to minimize the energy shortages possibility. For example, in Brazilian north-eastern, the highest wind speeds occur when the San Francisco's river level is the smallest along the year (Amarante *et al.,* 2001). In this way, it is possible to reduce the water consumption for electric power generation in the periods of drought using the wind energy. This characteristic is known as the wind / hydro complementarity.

The certification is one of the mechanisms to process Conformity Evaluation. The conformity evaluation has the objective to assure adequate degree of reliance of a product, process or service in order to be in agreement with the requirements of standards or regulations.

In Section 2, a summary of the certification processes in Europe is presented. The European Community has accomplished a process of standards harmonization (Nath *et al.*, 1999) in order to reduce technical and commercial barriers and thus, stimulate knowledge spreading and development.

The necessary documentation to be a PROINFA participant includes, amongst others, many certifications as presented in the Wind Energy Technical Guide (WETG). All enterprises need to present the certification requested to participate of the PROINFA first phase. Section 3 presents PROINFA and an evaluation of the Wind Energy Technical Guide, as well as some suggestions. It also presents the result of a research carried through the Brazilian institutions that act in activities related with wind energy which are potentially capable to carry out activities of certification in this area.

This article ends with conclusions and recommendations. In the recommendations, it's important to stand out the issues related to corrosion and climatic characteristics of Brazil, that may be considered in the wind turbines projects.

2. THE CERTIFICATION PROCESS OF WINDPOWER PLANTS IN EUROPE

Despite the publication of IEC 61400 family standards, during 1998/99, a workgroup, inside IEC scope, performed a survey aiming at establishing an unique wind power certification group of procedures due to the diversity of criteria and methodologies adopted at many European countries. This harmonization of the certification processes was carried out by the organisms responsible for this type of activity in each European country, and the preliminary conclusions are presented in Nath *et al.* (1999). This article shows that some countries such as Portugal, Spain, Belgium, Finland, France and Ireland do not make use of any specific national regulation on wind generation or any requirement about certifications. Germany, Holland Sweden and Greece accept the certifications carried through specialized institutions with international recognition in this area. In the case of Greece, the certifications are evaluated and approved by the Centre for Renewable Energy Sources (CRES).

3. THE CERTIFICATION PROCESS OF WINDPOWER PLANTS IN BRAZIL – THE WIND POWER GUIDE - PROINFA

PROINFA is one of the most important programs for promoting alternative energy sources in Brazil and worldwide, being designed to stimulate electricity generation based on renewable sources and the associated sales to the grid. Its aim is increasing electricity generation by three new renewable energy sources (wind, biomass and small scale hydroelectric power plants), preferably through projects implemented by independent power producers not controlled by a power utility, either directly or indirectly. PROINFA was enacted by Law 10.438 in 2002, being later revised and adjusted by Law 10.762 in November 2003 and Decree 5.025 in March 2004. The Program, in its first phase, projects long-term contracts for 3.300 MW, equally distributed among wind energy sources, biomass and SSH. Originally, the contracted plants would have to start their operation on December 2008[1]. PROINFA's participant projects have a contract guaranteeing generated energy payment for a period of 20 years. In the First phase of PROINFA a Technical Guide was published for each source.

The main objective of the Wind Energy Technical Guide (WETG) (MME, 2003) is to guide the interested parties in participating at PROINFA, informing and listing necessary documents to qualify wind projects, which had been presented to ELETROBRÁS in response to the Public Bid. The procedures and documents necessary to the qualification of wind generation enterprise are described at WETG, the focus of the present study. The analysis of the WETG presented throughout this section is focused in the basic requirements for technique qualification (section 4.4 of the WETG) and contract information (section 6 of the WETG). The studied points are related with international procedures standards such as wind measurement, energy generation forecast and certification of wind turbines used in the project.

[1] For further information see Ruiz *et al.* (2007); Cavaliero and Da Silva (2005); Wachsmann and Tolmasquim (2003); Filgueiras and Silva (2003); Dutra and Szklo (2004, 2006); Silva *et al.* (2005).

3.1. Technical Capability

T5. Presentation of the parameters associated to calculating the energy reference. In case of changing the specification of the equipment to be used and the data of the project, the entrepreneur will have to update to ANEEL and to ELETROBRÁS, the parameters of the reference energy calculation, up to 30 days before the beginning of the construction.

Comments: As suggestion for new WETG versions, companies should present certificated methodologies used for the annual energy production calculation, besides identifying the computational tools employed.

It is recommended that certified reports with correlating measured wind data and surrounding meteorological stations wind data (when available) be presented. The procedures for correlation have to be in compliance with IEC 61400-1. The surrounding meteorological stations wind data will be used for confirmation of the obtained historical series.

The annual energy production calculation - E_{annual} - and the monthly average energy production - E_i - besides considering micrositing characteristics, will also have to consider the wind turbine's Power x Wind Speed curve to be used in the project. This power curve has to be certified according to MEASNET procedures or IEC 61400-12-1, by companies or institutions will accredited in conformity with DIN EN 45011 (General requirements for bodies operating product certification systems).

As a consequence of not having a standard that defines methodologies for the energy calculation, it is important that ELETROBRÁS have at its disposal trustworthy methodologies in wind power generation forecast using the wind data supplied by the entrepreneurs. The generated power is proportional to the cube of wind speed of the wind and an error in the wind velocity field calculation results in a significant error in the wind power plant's generated power. For example, an error of 4% in the wind speed can generate an uncertainty of 12% in the energy forecast.

Currently several methodologies can be applied in the calculation of energy production of a wind power plant. The most popular are programs such as WAsP, WindFarmer and WindPro, for wind power plant optimization and calculation of the energy production, using information of orography, roughness, wind velocities historical series and others. However, there is some loss of information and precision if one chooses to use some of the available commercial softwares. In order to protect the developers' intellectual patrimony, the used methodologies are often not well divulged, as well as the approaches in the numerical calculations, making the analysis of the incurred error a hard work. An important question that must be considered is the fact that wind energy prediction commercial softwares have their own simulation models considering climatic characteristics of their native country. Consequently, significant errors can be incurred when using these softwares in Brazilian regions. WAsP presents problems in simulating wind flows through complex terrains (Bowen and Mortensen, 2004). Another necessary study to diminish the errors in the forecasts of energy production is the evaluation of the availability of winds in Brazil in the next decades, such as the work recently carried out in Europe by Pryor *et al.* (2006).

It means that, even internationally recognized companies or institutions, if using the available computational tools for the calculation of the electrical energy production, can obtain results that may not reflect the real ones under tropical climatic conditions.

T13. Term of commitment guaranteeing the delivery to the ELETROBRÁS of the certification of the wind turbines made by a credential institution as EN 45011, 30 days before the beginning of the construction.

Comments: It is recommended that, in the new versions of the WETG, T13 item, the standards that measurements and equipments must be in conformity have to be indicated by ELETROBRÁS. It is recommended that the certifications must be in conformity with the requirements of IEC WT 01 on Type Certification and that the accredited institutions must in agreement with DIN EN 45011standard. In the Brazilian case, a careful evaluation must be carried through in order to define if the wind turbines installed aong the Brazillian cost must be certificated in conformity with some specific, in order to avoid harmful effects of corrosion and other ambient agents that can damage the equipments physical integrity.

Conclusive Assessment of the Power Network Access will be emitted by ONS (National Operator of the Electrical System) or by distribution utilities companies, with participation of the transmission companies, in the stated period of 30 days after the beginning of the selected projects contract. These assessments will have to include the simultaneous connection of all the selected projects and its impact in the existing net, observing the defined rules of the Program at Law nº 10.438/2002, and its further alterations, as well as the specific ANEEL´s resolutions. Conclusive Assessment of the Power Network Access emitted by the suppliers will have to contain a specific topic about the impact of the accesses in to the Main Transmission Network made by ONS.

Comments: In regards to the stated periods for the access conditions defined by ONS (Basic Transmission Network[2]) or by transmission or distribution utilities (outside the Basic Transmission Network) it is suggested that the

[2] In Brazil, the Basic Transmission Network comprises all line above 230 kV.

available procedure in the ONS regulation (which is, MODULE 3 - Access to the Transmission System) and the GRID PROCEDURES authorized by ANEEL (Resolution nº 140/2002) must be followed.

I - In the installations of the Basic Transmission Network:

- up to 30 days, when it does not imply in or involve an enlargement or reinforcement of the Basic Transmission Network;
- up to 120 days, when it implies only in reinforcement of the Basic Transmission Network;
- up to 12 months, when it implies in an enlargement of the Basic Transmission Network. In this in case that, the technical evaluation of the access is carried through in the Enlargement and Reinforcements Cycle of the Basic Transmission Network. If it provokes change in the established strategy of planning, it must be compatible with the cycle of studies of the CCPE (Committee for Expansion Planning) will be made.

II - Installations outside the Basic Transmission Network:

Distribution concessions installations and transmission concessions installation available to the suppliers:

- up to 30 days, when it does not require an enlargement or reinforcement of the installations;
- up to 120 days, when it requires only reinforcement of the local transmission network;
- if an enlargement of the installations is required, it can be defined by direct negotiation with the involved utility distribution company and approved by the ANEEL. Otherwise, it will be established by the GRID PROCEDURES.

Another aspect to be considered is the dynamic analysis performance of the wind enterprises, also established by ONS and authenticated by the ANEEL, through the Communication nº 1961/2005, Studies of dynamic stability to analyze influences in the electric network induced by wind power plants focuses on the follow aspects:

- Dynamic Studies to identify the possibilities of several situations of wind power plant disconnection. In these situations, the necessity of transitory analysis of opening circuit breakers in phase opposition will be verified;
- Definitions of intrinsic protections of the wind power plants and the protections in the connection, aiming the coordination with systemic protections;
- Studies of energy quality produced by wind generation;
- Studies of quality in the point of wind power plant connection;
- Description of solutions to smooth or to by-pass eventual detected problems.

3.2. Brazilian qualified organizations for certification services accomplishment

Many Brazilian institutions have been working in several areas related to wind energy through research and services. Many of them have a wide experience in the development of projects initiated in the 90´s decade. The perspectives of a new market for renewable energy in the beginning of 2000 opened the discussion about the how specialized the institutions should be to give support to many different demands of this new market. Until the present moment, although the extensive acquired knowledge and experience, these institutions haven't developed enough skills and qualification to work performing certifications of products, processes or services related to the wind energy, being accredited by INMETRO or other accredited international agency.

The Table 1 show potentially capable institutions to work with wind energy certification.

Table 1. Research and development institution with potential to work with wind energy certification.

Institutions	Description
Instituto de Pesquisas Tecnológicas – IPT Laboratório de Vazão Gilder Nader Avenida Prof. Almeida Prado, 532.Cidade Universitária, Butantã – SP Tel.:(11) 3767 4756 (11)3767 4738 E-mail: gnader@ipt.br HP.: www.ipt.br	The laboratory works in anemometers calibration and the process of accreditation for anemometric services is in progress. Working in others certifications services, the IPT have a important potential to be able to provide others certifications services at wind energy.
CATÓLICA DO RIO GRANDE DO SUL - PUCRS NUTEMA – Núcleo Tecnológico de Energia e Meio Ambiente Jorge Antônio Villar Ale – Coord. Av. Ipiranga, 6681 - Prédio 30 - Bloco F - Sala 272 90619-900 - Porto Alegre - RS Tel.: (51) 3320-3500 R.4438 Fax: (51) 3320-3540 E-mail: villar@pucrs.br HP.: www.em.pucrs.br/nutema	NUTEMA was created in the College of Engineering of PUCRS in 1996. It presents a team of professionals in wind energy, solar energy, hidroeletricity, biomass and ambient impact. The Renewable Energy Laboratory (LAER) has an excellent infrastructure and equipments for engineering works, searches and development in renewable energy areas. The main activities related with wind energy include anemometers verification at wind tunnel, wind power curve of small wind turbines and simulation of wind farms in Rio Grande do Sul.
CENTRO BRASILEIRO DE ENERGIA EÓLICA – CBEE Everaldo Feitosa – Coord.CT - UFPE Cidade Universitária50740-530 - Recife – PE Tel.: (81) 3453-4662 Fax: (81) 3453-2975 E-mail: eolica@eolica.com.br HP.: http://www.eolica.com.br	The CBEE office in the Federal University of Pernambuco - UFPE have a area for wind turbine test located in the coast, next to the city to Olinda/PE. Working since 1990, the CBEE have a staff of specialists: doctors, masters, engineers and trainees acting in wind measurement areas, small and big hybrid project with wind turbines, evaluation of the quality of energy, etc.
CEPEL Centro de Pesquisas de Energia Elétrica Av. Horácio Macedo, 354 - Cidade Universitária Rio de Janeiro - RJ – Brasil Tel.: (21) 2598-6000 HP.: http://www.cepel.br.br	CEPEL works in many areas of research and development in the area of renewable energy and, specifically in wind energy, CEPEL works with site prospecting and evaluation for wind generation, project of measurement systems and supervision, wind power plant projects, etc. Moreover, CEPEL have a large experience as certifier agency of many electronic/electric products, and already being qualified to certificate asynchronous generators up to 500 CV.

4. CORROSION, ABRASIVENESS AND SALINITY IN WIND POWER PLANT PROJECTS IN BRAZIL

Metallic structures exposed to atmospheric conditions are frequently damaged by corrosion. Some simple proceedings during the project as, for example, avoiding the existence of water stagnation areas, are indispensable in order to prevent areas of corrosion attack. The contact between different metals surfaces can give rise to corrosion in the less noble one, starting the so-called galvanic corrosion. The presence of small gaps in aerial structures can result in the formation of areas with different oxygen concentrations, in which the area with less oxygen will be anodic, in relation the area with more oxygen and a process of differential aeration corrosion is established. Besides, an inadequate anticorrosive protection specification and an inefficient application of the same are causes of corrosion. If the structure is mechanically requested, the question becomes more critical, and then it is observed in the fracture mechanism due to corrosion associated to mechanical efforts. In a structure submitted to the cyclical efforts, the fatigue limit disappears when an aggressive environment exists and causes a premature fracture. Encouraged by the facts mentioned before and by several observations made in recent inspections accomplished in some northeast Brazilian Wind Power Plants, a Good Practice Guide in Corrosion Issues is being developed in CEPEL.

Aiming at avoiding corrosion problems in aerial structures, as the wind turbine towers, it is necessary to specify the system of anticorrosive protection correctly. Also it is known that, the cost of the protection painting is smaller than the cost of repairing an structure that collapses (Thick, 2006). The anticorrosive protection specification depends on the materials that compose the tower, the conditions of exposition and work and the environment where the same one is

installed. In relation to the environment, some factors influence its aggressiveness and can turn sufficiently intense the corrosion of aerial structures. It can be mentioned, as example, the solar incidence, the high relative air humidity, the chloride presence in the atmosphere (surrounding marine), winds, particles and pollution. Regarding to the materials that compose the tower, IEC 61400 standards is not clear, mentioning that the blades can be of strengthened plastic material with fibreglass. In a case like that, when an anticorrosive protection is not demanded, such material must be resistant to the abrasion because it is subject to constant shocks of dust and sand brought by wind.

The IEC 61400 - 1 standard makes reference to the necessity of considering the ambient conditions (the IEC 60721-2-1 is mentioned) and the ground characteristics into a Wind Power Plant project (it does not mention any reference). However the subject is very superficially treated and anticorrosive protection methods of the wind turbines materials and the deterioration effect due to the environment are not discussed.

In IEC 60721 standards family, some ambient parameters are classified and are degrees of severity are attributed to each one of them. Standards IEC 60721-2-1 and 60721-2-5 are more specific and deal with the temperature /humidity and dust/sand/salt mist conditions, respectively. Some definitions and classifications are given and maps indicating the regions of the planet where these ambient conditions are presented and classified.

Another family of standards, the IEC 60068 standards, is available and it defines the tests to be carried through in electronic equipment components subjected to adverse ambient conditions, simulating working conditions and ambient variations. The conditions of solar incidence (IEC 60068-2-5), exposition to the salt mist (IEC 6068-2-11 and IEC 6068-2-52), exposition to dust and sand (abrasion - IEC 60068-2-68), variations of temperature (being able to generate humidity for condensation - IEC 6068-2-14, IEC 6068-2-33, IEC 6068-2-61) are covered by this family of standards. In all the tests present in the standards, procedures are suggested with several aggressiveness degrees, leaving the definition of the conditions simulate the real condition as a user responsibility. As criterion of acceptance or rejection in the tests, the standards establish that after each test, the equipment must be visually evaluated and verified if its mechanical and electric functions remain as initially. Particularly on anticorrosive protection, the subject is not treated in these standards. The cited standards can guide for an evaluation of electronic components resistance (IEC 60068 standards) and in the identification of ambient parameters (norms IEC 60721).

The NORSOK M-501 standard was developed by the Norway offshore oil and gas prospecting industry and is based on other ISO standards that present requirements for preparation, application and evaluation of anticorrosive painting performance (part 5 of ISO 12944 and ISO 20340). In Wind Power Plant Offshore projects, the acquired experience by the offshore oil and gas prospecting industry has been used due to the similarities between the two applications. Related to these areas, ISO 12944: 1998 standard have been indicated as a general guide for anticorrosive painting of steel structures and ISO 20340: 2003 has been used to improve the requirements of anticorrosive protection of offshore structures, concerning aerial structures subjected to the marine environment action and submerged structures in water of the sea.

In function of the recent electric power generation park expansion using, among others, the Wind Power energy, Brazil must be prepared to indicate the standards which the certifications must consider. A careful analysis must be carried through in order to know the necessary anticorrosive protections to be applied to the wind turbines that will be installed in Brazil, in order to not to increase the cost of the same ones, but making possible adjusted protection and trustworthiness of the equipment. It's worthy to remember that, in the Brazilian case, most of the Wind Power plants will be located at the coast and will be submitted to the severe conditions of corrosion, tropical abrasion and salinity, mainly throughout the northeastern coast.

4. CONCLUSION AND RECOMENDATION

Taking into account the experience achieved from the wind power enterprises certification process harmonization carried out by the European community, it is recommended to coordinate efforts in order to establish an uniform process in Brazil, where the standard IEC - WT 01 must be the main guide.

The lack of accredited national organizations capable to perform activities related to the certification process results in higher costs for the Brazilian projects due to the necessity of hiring these services for foreign institutions. Moreover, the high equipment index of nationalization demanded by PROINFA will encourage the implementation of entities national certifiers and will have as an important result the absorption of technology on the part of the Brazilian technician-scientific community. Thus, considering the fact of that the magnifying of the presence of wind generation in the Brazilian Energy Matrix is a strategic decision of government, ELETROBRÁS, face to its sector coordination function, that establishes one programs aiming at, in average stated period sends regards to it, to endow national entities with technological capacity and accreditation to exert the activities of certification of wind enterprises according to international norms in vigor.

The methodologies and tools used for the calculation of the produced electric energy from the wind, based on the measured anemometric data in the wind farm installation area had been developed for the climatic conditions of the north hemisphere. A methodology developed concerning the climatic conditions of this hemisphere will certainly present better results. It is recommended to stimulate the development of a methodology for the calculation of the produced electric energy from the wind considering the typical climatic conditions of the south hemisphere.

In regards to the corrosion aspects, abrasion and salinity, which can affect the Brazilian enterprises located at the coast, it was verified the inexistence of specific standards about it. For this reason, it is recommended a special analysis of the standards used by the offshore industry.

For futures version of the Wind Energy Qualification Guide, same modifications are suggested for a better adaptation of the certification process. Same modifications for wind generation contract are proposed, such as: presentation of the methodology and the softwares used to forecast the wind energy generation; Definition of the standards requested for certification by ELETROBRÁS; Compatibility of the projects and ONS´s schedule to provide authorization for electric net access. The presented elements, throughout this article, strengthened by the fact of the new stages of the expansion of the wind generation will become reality (the continuation of the PROINFA) indicate that the steps recommended here must be implemented.

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