Rotor circularity calculation for hydro turbines

Many machinery monitoring systems provide rotor circularity measurements for hydro turbines, but only a few calculate rotor circularity correctly, in accordance with the industry-standard guides and reports produced by CEATI International.
Incorrect calculation of rotor circularity can have serious and costly implications for operators of hydroelectric stations, which is why Meggitt is CEATI compliant.

Figure 1: A hydro-generator rotor being lowered into its stator

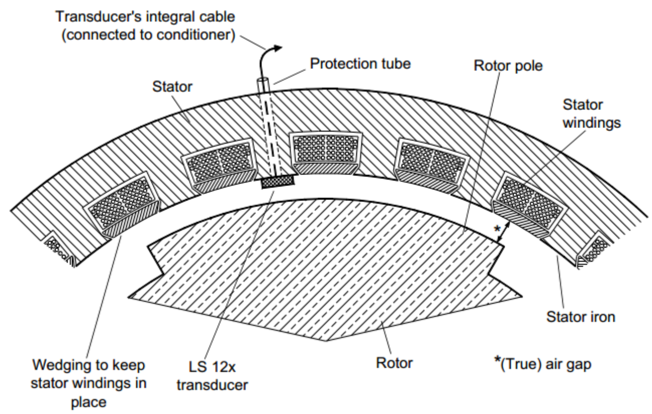

Figure 2: Cross-section of a hydro generator showing an LS 12x transducer mounted on the stator

Hydro air-gap monitoring

Large hydro generators, such as the one shown in Figure 1, are typically equipped with capacitive air-gap sensors such as the LS 12x on the stator in order to determine the distance to the rotor (see Figure 2). Dedicated monitoring systems process these air-gap sensor signals to provide corresponding measurements such as minimum gap, rotor eccentricity, circularity and ellipticity, and stator eccentricity, circularity and ellipticity.

The trending and correlation of these important hydro-generator health indicators with vibration indicators can provide a complete picture of a machine's condition that can be used by machinery diagnostic experts.

CEATI International (the Centre for Energy Advancement through Technological Innovation) is a Canadian-based solutions exchange and development program for utility companies with a special interest in hydro. Among the many guides and reports it publishes, *Hydroelectric Turbine-Generator Units Guide for Erection Tolerances and Shaft System Alignment* is the way hydro generators should be installed. More specifically, this guide defines important measurements for hydro turbines, such as rotor circularity, and how they should be calculated.

Accordingly, Meggitt Sensing Systems has designed and developed a monitoring system dedicated to hydroelectric generators that provides true rotor and stator circularity and eccentricity calculations in accordance with CEATI. This solution consists of LS 12x / ILS 73x measurement chains, a VM600 rack with XMV16/XIO16T extended monitoring card pairs and the VibroSight® software with the hydro air-gap monitoring package.

Compliance with CEATI

Measurements performed on hydroelectric generators using Meggitt's monitoring system were compared with the system of a major player in this market. An analysis of the results confirmed that the competitor's system calculated rotor circularity incorrectly, even though CEATI compliance was claimed.

Meggitt Sensing Systems
Rte de Moncor 4
1701 Fribourg, Switzerland
Tel: +41 26 407 11 11
energy@ch.meggitt.com

5650 Thimens Boulevard
Ville Saint-Laurent, QC H4R 2K9
Canada
Tel: +1 514 956 0918
mss.canada@meggitt.com

www.meggittsensingsystems.com
www.meggitt.com

As illustrated in Figures 3 and 4, the key factor in an accurate rotor circularity measurement is whether the circularity calculation compensates for eccentricity or not.

Error! Reference source not found. shows a rotor circularity calculation (green) that is centred on the rotor best centre, that is, rotor eccentricity(red) is taken into account. This is a CEATI compliant calculation, as implemented by Meggitt's monitoring system.

Error! Reference source not found. shows a rotor circularity calculation (orange) that is centred on the stator best centre, that is, rotor eccentricity (red) is not taken into account. This is not a CEATI compliant calculation.

As the monitoring system comparison performed by Meggitt Sensing Systems demonstrated, an incorrectly calculated rotor circularity can be much higher than the true ("actual") circularity if rotor eccentricity is not considered. In fact, Meggitt has seen examples that show discrepancies up to a factor of three. This has significant implications for the management of hydroelectric stations, since rotor circularity is one of the key health indicators: no one should make costly decisions, such as unplanned rotor refurbishment, based on inaccurate data.

Therefore, it is very important to talk to your monitoring system supplier about how their rotor circularity calculations are performed in order to be able to trust the system and have confidence in your plant asset management decisions.

CEATI definitions

Concentricity / Eccentricity

A zone limited by a circle, the centre of which is established by the junction of the reference axes. The deviation in this case is always measured to the actual component's best centre. The deviation is the square root of the sum of the squares of the "x" and "y" components. The deviation is sometimes referred to as "eccentricity". If the angle of the line joining the junction of the reference axes to the best centre of the component is measured from a reference axis, eccentricity can also be used as a vectorial quantity.

Best centre

The best centre of a generally circular component is the location that gives the minimum deviation in circularity for any given set of equally-spaced readings of radius.

Circularity

A zone limited by two separate concentric circles where the common centre is the best centre of the component being verified. The deviation in circularity is the difference between the maximum and minimum radii as measured, or measured and calculated, from the best centre. It should be noted that, by this definition, the circularity of a component does not change if its error in concentricity (deviation between the best centre and the axis of rotation, for instance) changes.

Rotor circularity calculations

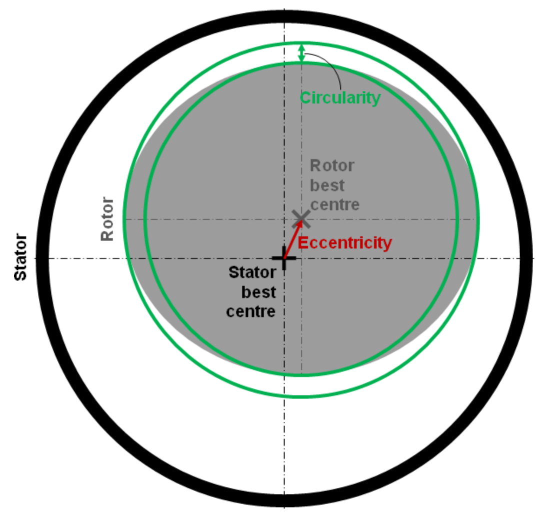

Figure 3: Rotor circularity calculation using the rotor best centre (CEATI compliant

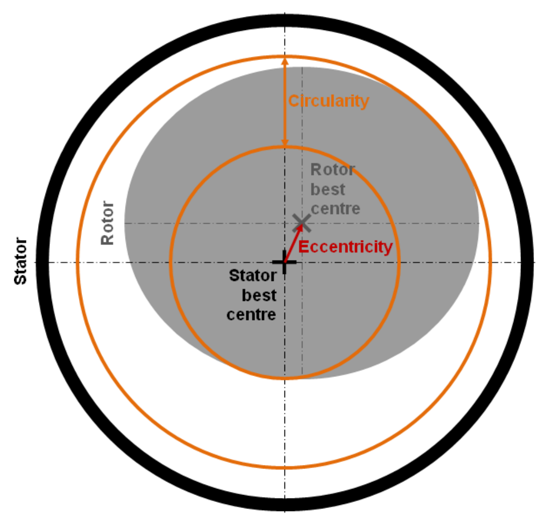

Figure 4: Rotor circularity calculation using the stator best centre (not CEATI compliant)

Meggitt Sensing Systems
Rte de Moncor 4
1701 Fribourg, Switzerland
Tel: +41 26 407 11 11
energy@ch.meggitt.com

5650 Thimens Boulevard
Ville Saint-Laurent, QC H4R 2K9
Canada
Tel: +1 514 956 0918
mss.canada@meggitt.com

www.meggittsensingsystems.com
www.meggitt.com