

COMPLETE MONITORING SOLUTIONS & DIAGNOSTICS SERVICES

for the Hydro Industry



Table of Contents

ZOOMWatch C)1
Results Interpretation Service0)7
Phenomena requirements0	8
Parameters	
Magnetic flux	0
Stator bar absolute vibration	0
End winding absolute vibration	
Phase leads absolute vibration	
Iso-phase bus absolute vibration	
Shaft displacement 1	11
 Shaft displacement	11
 Shaft displacement	11 11
 Shaft displacement	11

Thrust bearing relative displacement
Stator bar relative vibration
 Stator core temperature
Turbine clearance
Improved design Air gap (rotor/stator)
 End-winding temperature
Rotor poles temperature
ZOOM monitoring cabinet & Acquisition units



Generator Diagnostics Asset Management Tool

By offering to its customers the first web based diagnostic platform ZOOMWatch, a revolutionary online machine management platform that meets a growing need in the industry.

Once again VibroSystM is the pioneer in machine diagnostic and management solutions.







- Mobile friendly, web-based diagnostic platform
- 24/7 on-demand support at your fingertips
- Analysis results displayed in easy to understand graphs



Cyber Security Map (CSM) Watch the video





Operability levels

These values represent the overall operability of any given section of the Unit, based on the severity levels of each phenomenon monitored associated to the section of the Unit.

Each value gives a good indication of the overall health of a section of the Unit and more importantly, an early detection tool to identify any deteriorating condition of the Unit.

Operability assessment of the various sections of the Unit accompanied by intervention recommendations







of results over time

					2	NOTCH-	24
100 J	VSM Operability	Chart					
Ĩ			75%	Good			
8	Considered as new	vly commissioned					
1		50%	Acceptable	75%	7		
'	Considered as acco	eptable for unrestrie	cted operation for lo	ng term operation			
	25%	Restricted	50%				
1	Considered as uns	atisfactory for long	term continuous op	eration		75	
1	Danger	25%					
ľ	Considered as uns	atisfactory for long	term continuous op	eration		•	•
S	Simplified ntuitive int	results dis terface:	played on a	an	OPERABILITY	50	
	■ Can b both e non-e	e used by engineers a engineers	plant mana and	agers,		25	
	Elimin exper	ates the n ts available	eed to hav	e		0 2015 02 03 04	05 06 07 08

Operability level based on current and previous results providing a trending





Severity levels

Represent the severity of any given phenomenon monitored on the Unit. Theses results are made much easier to understand by providing results per phenomenon, and displaying these results based on existing tolerances and standards, in an easy to understand graphical environment making it much easier to evaluate and react.

Severity results for all phenomenon monitored on the unit section will be used to assess the operability level of the Unit section.

Actual severity of each phenomenon on the asset









Demo Hydro 🔸							
et							
share 🥿							
ated over i critical							
tions be							Dem
	Station 1 → Unit 1 →	Stator + Circular	rity anomali	es > REPORTS 1			
		REPORTS	-				
	F	OTOR 5	TATOR	SHAFT & BEARING	5		
			6			. .	6
09 10 11 12							
						*	0
						¥	0
						1	•
			<u> </u>	<u> </u>		Im	
		0		۲		₽	0
						¥	0
						- i.	•
			<u>.</u>			≛	
		0	0			*	0
						. ↓ .	a
						<u></u>	Ü
			0			*	0
							1





RIS report

Results Interpretation Service

The specialists in our Tests & Diagnostics division provide clients with detailed reports on the general condition of their machines. They analyze and correlate all the information our systems collect and provide comprehensive training sessions on how to understand their machine behavior.

Analysis & Diagnostic reports

In combination with our powerful ZOOM software, VibroSystM's results interpretation service puts decades of experience at work, allowing our clients to extract the most out of their monitoring systems. The service helps users identify patterns and anomalies that are both meaningful and informative. Our RIS is among the many tools we put directly into the hands of our customers around the world empowering them to make informed business decisions that will have a direct impact on the bottom line of plant management.



VenoSeria

2.4.3 Relative Shaft Vibration

To monitor the shaft vibration, two (2) proximity probes are mounted 90° spart (x and y angle) in the apper guide hearing (UGB), the lower guide bearing (LGB) and the turbine guide bearing (DGB, he vibration readings were recorded with the ZOOM system, and the results can be seen in Tation I and U.L. was the case for the previous stator and rotor sections, the data from values operating codeins us and for this analysis.

Generation Mode

User Name + :

Shere at

1.00

Power Station / Unit 1 - UNIT SECTIONS

OPERABILITY

20102

STATOR

SHAFT/BEARINGS

25 50 75 100

Operating	111110	- Debala	called), stops	whether the de-	phone 1	
sourcestore -	A STATE IN CO.	 COB 3001 	ECH Dr	19402-940	NOR OF	THE R.
New printing	1.28	1.0.0	100 B 100 B	100.00		
Blasting to \$52.	10.00	12. 10. 10	COLUMN DE LE D	Contraction of the local division of the loc		
Field applied	1.2.5	10.5	10.0	STREET, STREET		
Want to grid .	1.1.1.1	24.8	1000	100		
WPE lossed WE MPE'	- 1	1.00				
BOTH Road D'S MONT		1.00	10.0			
1078, hand \$28, 545W	10.0	1.10	1.1		100	10000
Full load is host in the	10 B C	1.4	1. 1.4	Contraction of the second		1.11

Table 4: Relative shaft displacement - Generation mode

avia recorded at the upper guide hearing were high during the Unit station absumes and after synchronization to the grid. When the mult began producing pose, the size mane good to acceptable, when compared to existing tolerance buck (26) 2004 file a levels were found after application of the rotor field, where reads of 04.5mh plot on This result is uncommon as the vibration levels usually decrease when the aspectrum

wels recorded at the lower guide bearing were critically high during the Uni nation des field and after synchronization to the grid. Values only because good due the full solution of nominal power. The highest vibration levels were found over applicational factors ts of 24.2 mils ph-ph were recorded at 15". This result is naccensus as for cluster with when the magnetic forces appear in the air gap-

cells recorded at the turbine guide bearing were acceptable to high during the lat star tion of the field and after synchronization to the grid. When the sol bepapolety are derivered and became good to acceptable, when compared to existing theme into et highest subration levels were found after application of the rotor feld, when makes ere recorded at 15". This result is uncompton as the vibration levels uside decar the a appear in the air gap.

THERE'S MANNE

TOOTA	- A Contract
market and the second s	Ed Viewers
The state of the s	Andrew Water State
Table & Robertson al	
and periodical at the support proch-	in complementered - Pomp stocke

arised waves moving too according consider of the state o and put movied at the lower gride bearing were high during operation in pump mode. The analysis being movies after start-up in pump mode, where reaches of tabula.

ag josh received at the source proces bearping were high during operations in proop mode. The source level three (2) branes after start-up in pump mode, where results of 14.9 mile provide the second of the testing scale bracking were fixed throughout operation in pump mode and about the second times (3) hours also start-up, and then during reaching in some and low mercine in the terms to be forming were good throughout operation in pump mode are cluster brind black pipt were recorded at 15°.



Builts I as its sam pope show the veloc and FFT of each guide bearing for all measurements maxing president made. The JYT place use the angular choicealin to better allow whall effections in terms.

21



Phenomena requirements

SEVERITY

ROTOR

Rim expansion anomalies

Circularity anomalies

Pole radial position anomalies

Concentricity anomalies

Pole overheating

Stiffness anomalies

Pole shorted turns

STATOR

Stator core & frame attachment system anomalies

Stator bar wedging system loosening

End windings & support system anomalies

Stator core deterioration

Circularity anomalies

Concentricity anomalies

Stiffness anomalies

Stator bar deterioration

SHAFT & BEARINGS

Shaft & bearing anomalies

Thrust bearing anomalies

SENSORS REQUIRED

AIR GAP	MAGNETIC FLUX	VIBRATION & DISPLACEMENT			TEMPERATURE				
VM	MFP	FOA	PCS	PES	SBV	VSM797S	FOT	TWR	TWS
x	0		х	0					
x	0		x	0					
x	0		x	0					
x	0		x	0					
x	0							x	
x	0		x	0					
x	x								

	0			0		x		0
		0			x			0
	0	x					0	
			-			x		x
x	0		x	0				
x	0		x	0				
x	0		x	0				
		x			x			x

x	x	0
x	x	
		X mandatory O ontion

8





Damage caused by pole inter-connection overheating







Sensors Precision & Reliability

In order to give our customers a precise prognosis on the condition of their machine, data accuracy is essential. VibroSystM sensors were all designed to withstand the harsh and robust variety of environments they are to be installed in, without compromising the accuracy needed to correctly monitor and protect your machine.



Magnetic flux **MFP[™]-100**

The MFM magnetic flux measuring system monitors magnetic field density and detects imbalances that contribute to machine vibration, overheating and excessive stress on the rotor and stator. The sensor can be installed without removing the rotor or the poles.

FOA[™]-100/200

The FOA fiber optic accelerometer was designed to measure vibration amplitudes of high voltage components that are exposed to electrodynamic and mechanical stress, such as stator end-windings. Its robust design, made of non-metallic and electrically non-conducting materials, makes it suitable for hostile environments. No field calibration is required.

Stator bar absolute vibration End winding absolute vibration Phase leads absolute vibration Iso-phase bus absolute vibration









Shaft displacement Shaft relative vibration **PCS[™]-302**

The PCS capacitive proximity probe was designed for non-contact measurements of relative vibration, displacement and radial positioning. Its exclusive capacitive measuring technology makes it unaffected by conductive or semi-conductive target material types, therefore requiring no field calibration.

- Stator frame absolute vibration
- Stator core absolute vibration
- Pressure plates absolute vibration
- Bearing absolute vibration
- Turbine head cover absolute vibration
- Nose absolute vibration

VSM797S[™]

The VSM797S is a piezoelectric accelerometer designed to measure absolute vibration in harsh industrial environments. This sensor was developed to ensure accurate results throughout the entire operating temperature range.



■ Stator frame relative displacement **PES[™]-110**

The PES-110 eddy current proximity sensor is designed for non-contact measurements of relative vibration, displacement, and axial positioning. The sensor is equipped with built-in conditioning circuitry allowing it to be directly connected to processing instrumentation.





■ Thrust bearing relative displacement PES[™]-300 Serie

The PES eddy current proximity probe is designed for non-contact measurements of relative vibration, displacement and axial positioning. The probe is equipped with built-in conditioning circuitry and protected to be fully operational in oil. Since it requires no field probe drivers, it can be directly connected to processing instrumentation.





■ Stator bar relative vibration SBV[™]-202

The SBV stator bar vibration capacitive sensor was designed for non-contact in-slot measurements of stator winding vibration. Built to be immune to strong magnetic fields, this sensor provides reliable and accurate information on bar vibration and displacement.



■ Stator bar relative vibration DCS[™]-400

The DCS capacitive sensor is designed for non-contact in-slot measurements of stator winding vibration (i.e. bar relative to core). The sensor is embedded in a stator slot facing the bar and replacing a wedge or a part of it.





- Stator core temperature Stator bars temperature
- TWS™

The TWS ThermaWatch stator sensor is a real-time multipoint temperature sensor for the stator core and windings. It provides valuable information about the thermal behavior of a stator core, especially the hot spots or shorted laminations.

Turbine clearance **SPES**[™]

The SPES proximity sensor is designed to measure the relative distance of an underwater metallic target surface. It is usually used to measure blade tip clearance in Kaplan turbines as well as runner band clearance in Francis turbines. The sensor can sustain high levels of underwater pressure and is equipped with built-in conditioning circuitry allowing it to be directly connected to processing instrumentation.



Pressure plates temperature (end core)



Improved Design





U.S. Patent No. 11125795

The VM[™] AIRFLOW sensors are non-contact capacitive sensors that measure the distance between the rotor and the stator. These sensors are designed with apertures, thus limiting obstruction of the ventilation holes on the stator. They are specifically designed to continuously provide reliable information about the machine air gap

End-winding temperature Phase leads temperature Iso-phase bus temperature FOT™-200

The FOT fiber optic temperature sensor was developed to monitor temperature of high voltage components, such as generator end-windings, isophase bus bars, exciter brushes and knife switches. Its robust design, made of non-metallic and electrically non conductive materials, makes it suitable for hostile environments. No field calibration is required

Rotor poles **TWR[™]-200**

The TWR ThermaWatch rotor sensor is a fast-response, non-contact sensor that measures rotor pole and rotor pole joint temperature. Although small in size, this high speed temperature sensor allows for a comprehensive analysis of the rotor's condition



Acquisition Units Protection, Monitoring & Analysis Unit

Combine all your quality control data acquisition units in one single space, and simultaneously monitor all the critical parameters on your machine.



ZPU[™]-5000 Protection, Monitoring & Analysis Unit

The ZPU-5000 is a multi-channel acquisition instrument designed for monitoring and protecting large rotating machines. Available in a network (with a ZOOM server), the ZPU-5000 can simultaneously monitor multiple parameters and communicate with the ZOOM software.

ZOOM® Monitoring Cabinet 19" Rackmount Freestanding Cabinet (42 U)

Our ZOOM cabinet comes pre-wired, fully tested and complemented with as-built drawings for a fast and effective on-site installation. Its robust design keeps VibroSystM's monitoring hardware protected, extending its longevity.



To SCADA/PLC



ZOOM Software can be complemented by Modbus® and OPC® bi-directional communication services that collect and send data to and from the **plant's control system**.

ZOOM® Software

Zero Outage **Online Monitoring**

VibroSystM's ZOOM software provides its users with a clear, real-time picture on the condition of their machine in any operating mode. The ZOOM software suite is the only one on the market that can be tailored to a user's specific needs. It is composed of various acquisition services, which gives its users the possibility of choosing the parameters to be monitored on their machines.

communication





ZOOM[®] Software



VM + ZPU + ZOOM

Generator Shapes & Clearance, Rotor shape and position inside stator shape. Quickly identify critical air gap locations and associate its values to industry standards



MFM + VM + ZPU + ZOOM

Magnetic flux intensity is inversely proportional to air
gap. Therefore, a small air gap produces higherEnd-Winding Vibration during Load Increase,
End-winding vibration behavior during load increasemagnetic flux results and vice-versaon a hydroelectric generator



PCS + ZPU + ZOOM

Shaft Orbit & Displacement

Shaft orbit relative to rotor pole position. Indicates that the pole position confirms the imbalance



PCS + VM + ZPU + ZOOM

Machine Behavior Over Multiple Rotations Shaft displacement and air gap variation vs. turn/pole number. Extend measurements over many turns to see parameter dynamic behavior, especially during transient operating modes

FOA + ZPU + ZOOM

FOA + ZPU + ZOOM

12-hour trend of end-winding vibration (radial) with a peak of ~9 g (~310 μ m, pk-pk, at 120 Hz) for end-winding #35 during temperature increase

PES + ZPU + ZOOM Example of oil film thickness results

SBV + ZPU + ZOOM

Trend Graph Correlating Bar Position and Active Power (MW), This graph shows that the bar is magnetically pulled inward into the slot as the load is increased





VSM797S + ZPU + ZOOM

High frequency stator core oscillation is clearly noticeable. The results at 0 Mvars are somewhat lower than at 16 Mvars



VSM797S + ZPU + ZOOM Example of absolute guide bearing vibration at full load - cold



TWR + MFM + VM + ZPU + ZOOM

Machine Condition Over One Rotation Pole temperature, magnetic flux and air gap vs. pole number. Compare results with our exclusive pole-reference method for easy correlation and accurate diagnosis



TWS + ZPU + ZOOM Bar graph Graph showing temperature measurements of multiple stator bars

ZOOM[®] Software

FOT + ZPU + ZOOM

Example of coil temperature in trending format during a short period of time

TWR + ZPU + ZOOM

Online rotor pole and interpole temperature measurements



TWS + ZPU + ZOOM

Stator thermal mapping

Provides valuable information about the thermal behavior of a stator core, especially hot spots or shorted laminations

SPES + ZPU + ZOOM Turbine blade tip clearance Turbine position inside discharge ring. View of blade gap and discharge ring shape

VibroSystM reserves the right to, due to improvements, make technical changes or modify the contents of this document without prior notice. Modbus® is a registered trademark of Schneider Electric and/or such related companies. OPC® is a registered trademark of the OPC Foundation. © 2019 VibroSystM Inc. All rights reserved.





FOLLOW US fin D ()

www.vibrosystm.com

