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Enabling the Extraordinary
To Fly To Power To Live

HYDRO AUXILIARY SYSTEMS MONITORING

NON-STANDARD APPLICATIONS

vibro-meter

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Sales Manager, Canada

May 2022

Hydro Power Plant Components

Drivers

- Hydro utilities have a need for long term monitoring not only limited to the turbine/generator units.
- Other non-rotating equipment like gates and valves can benefit from a continuous monitoring.
- Using the same hardware/software technology makes the solution very attractive.

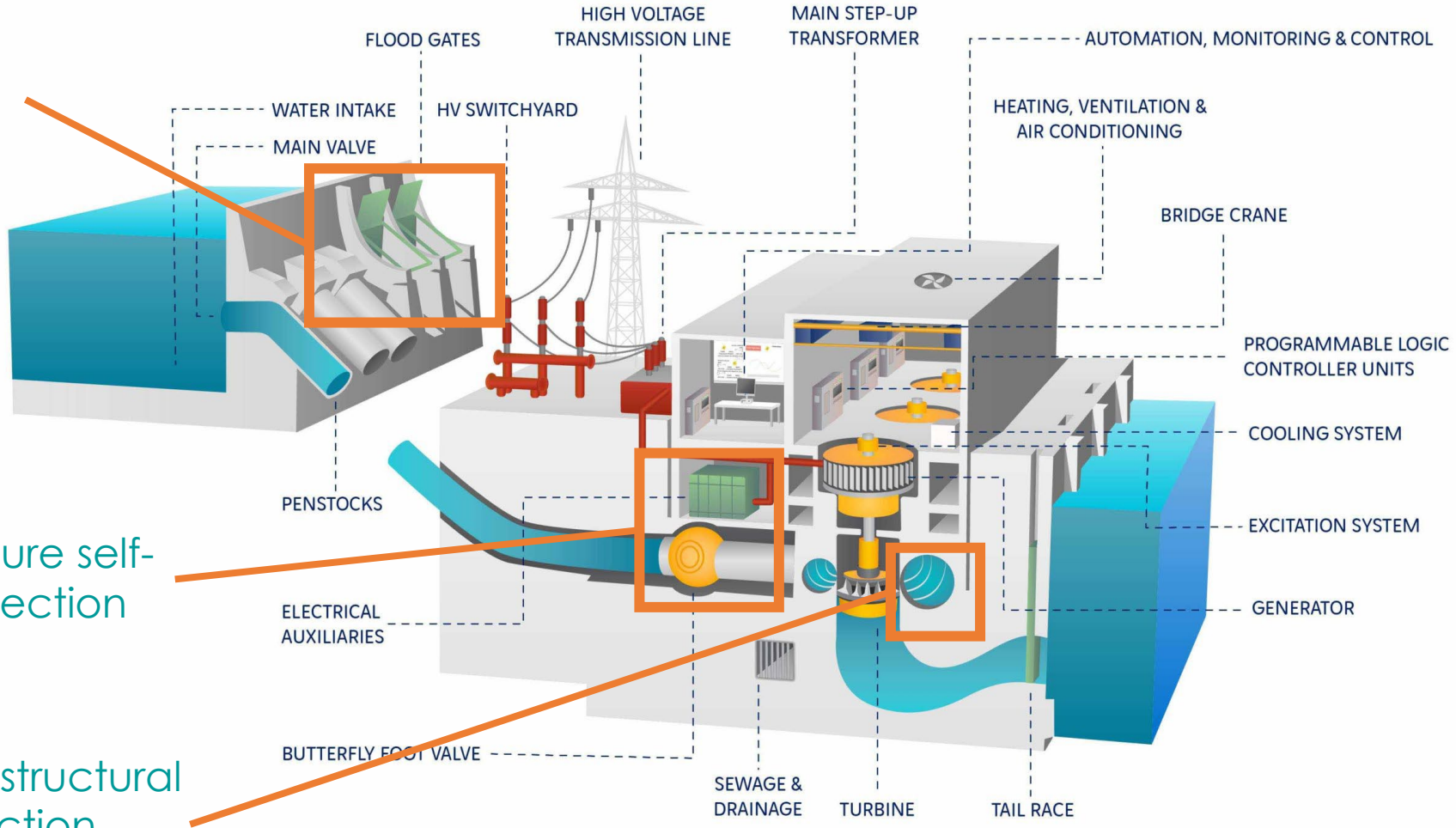
Hydro Power Plant Components

Overview

Spillway gates monitoring

Penstock pressure self-oscillation protection

Turbine casing structural vibration protection



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SPILLWAY GATES MONITORING

Spillway Gates Monitoring

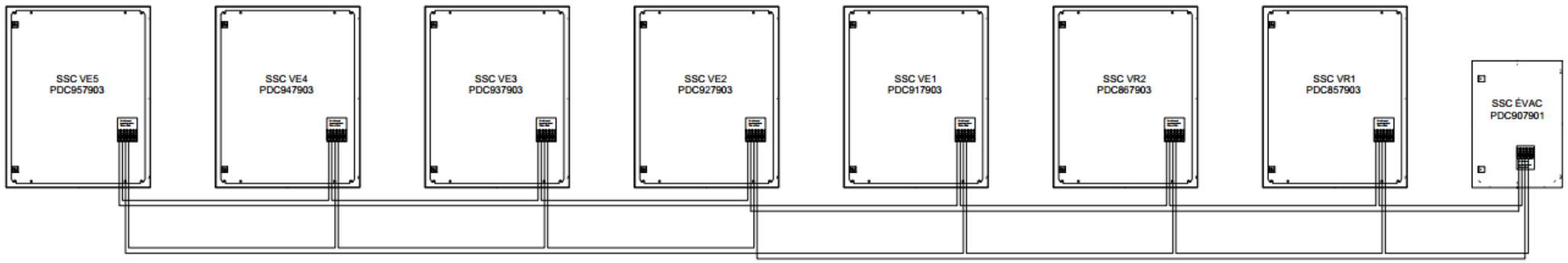
Situation

- Hydro-Québec – La Tuque dam
- 5 spillway gates and 2 control gates
- Vibration issues
- Continuous monitoring

Spillway Gates Monitoring

Challenges

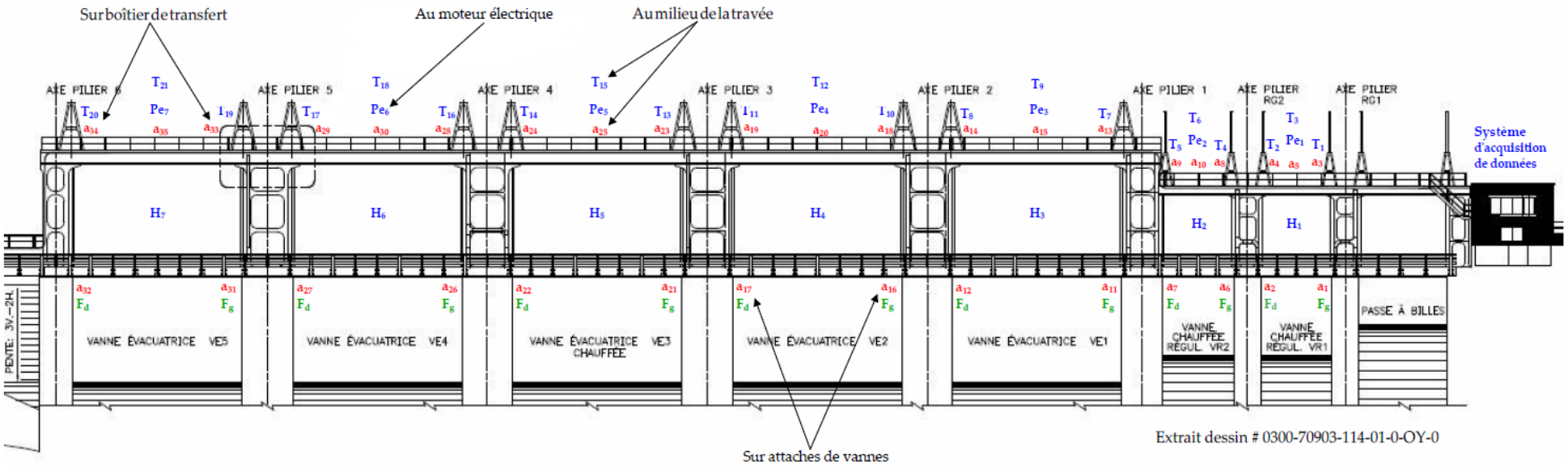
- Ethernet Cable length
- Operating temperatures ranging from -40°C up to +40°C
- The variety of sensor technologies/models



Spillway Gates Monitoring

Instrumentation

- Vibration (5 accelerometers per gate) – Meggitt scope
- Load (2 load cells per gate)
- Gate position
- Temperature (2 per gate)
- Motor Power



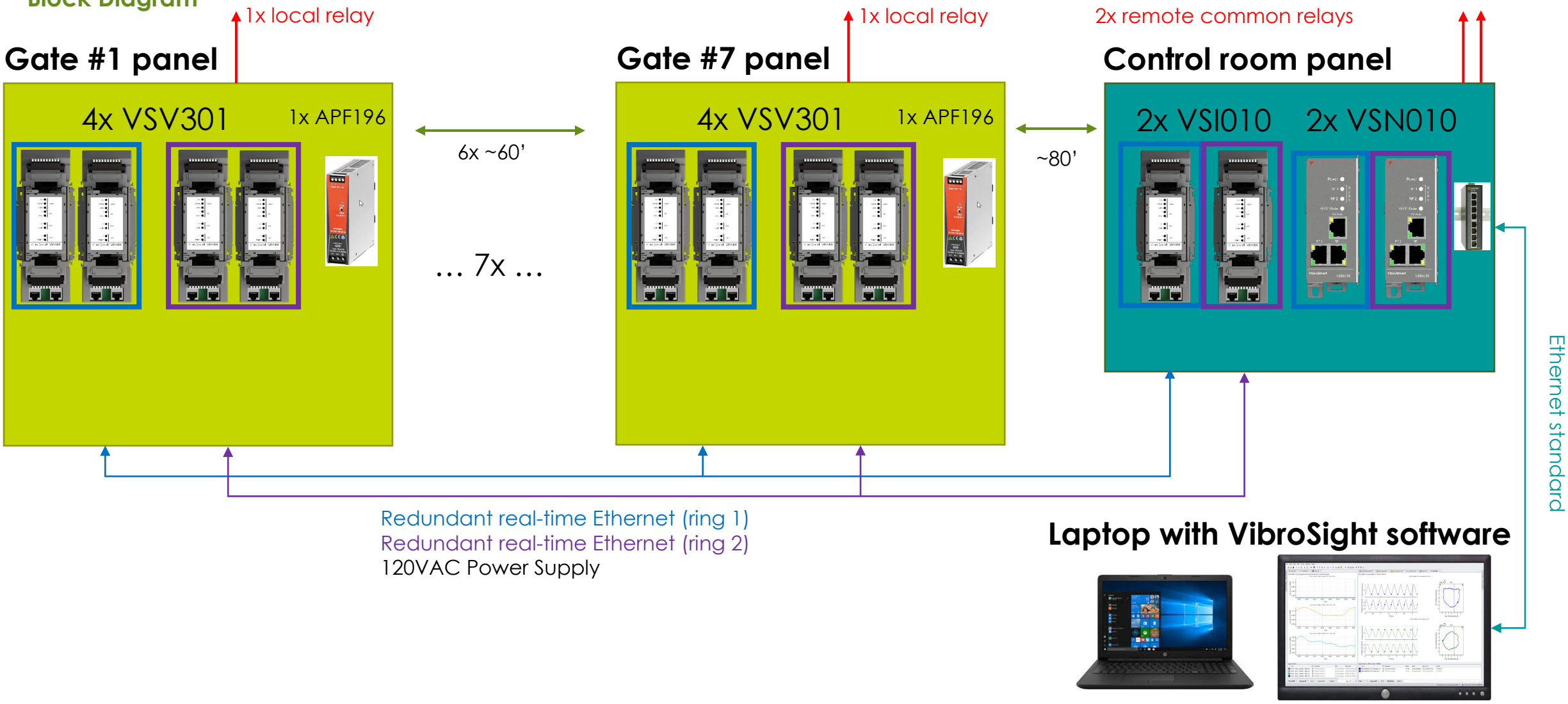
Spillway Gates Monitoring

Monitoring Hardware and Software

- 7 outdoor panels including:
  - 28x VSV301 / VSB300 (4 per panel)
- 1 indoor panel including:
  - 2x VSI010 / VSB010
  - 2x VSN010
  - 1x VibroSight Standard Software

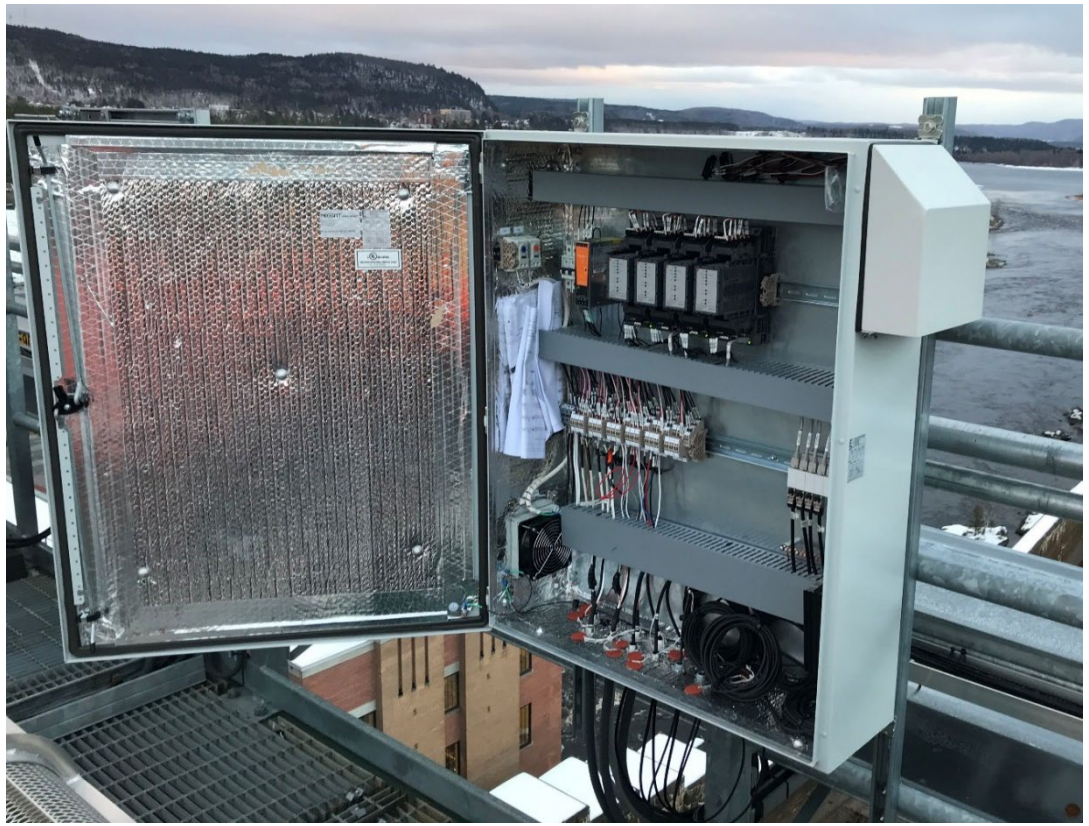
Spillway Gates Monitoring

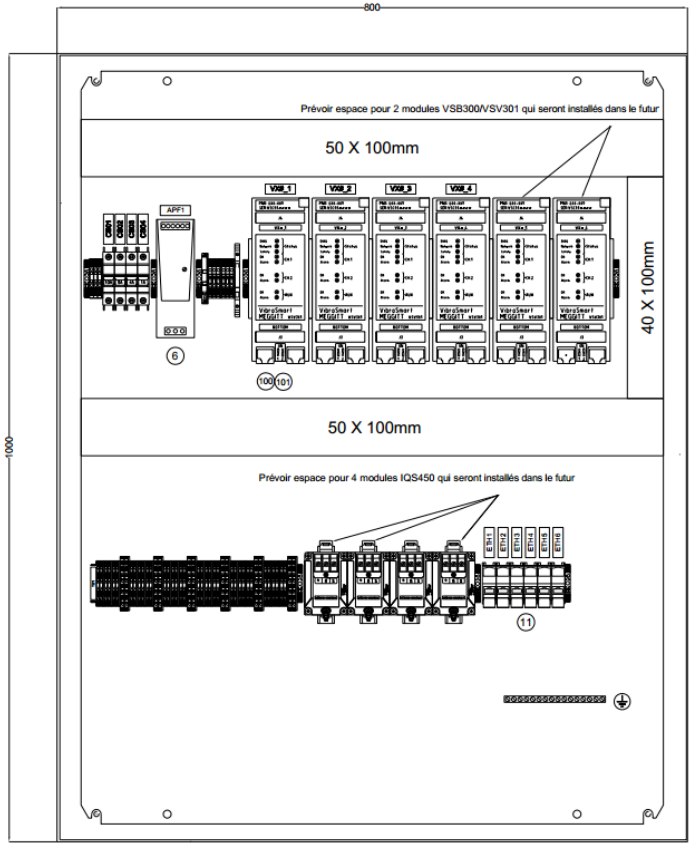
Block Diagram



Spillway Gates Monitoring

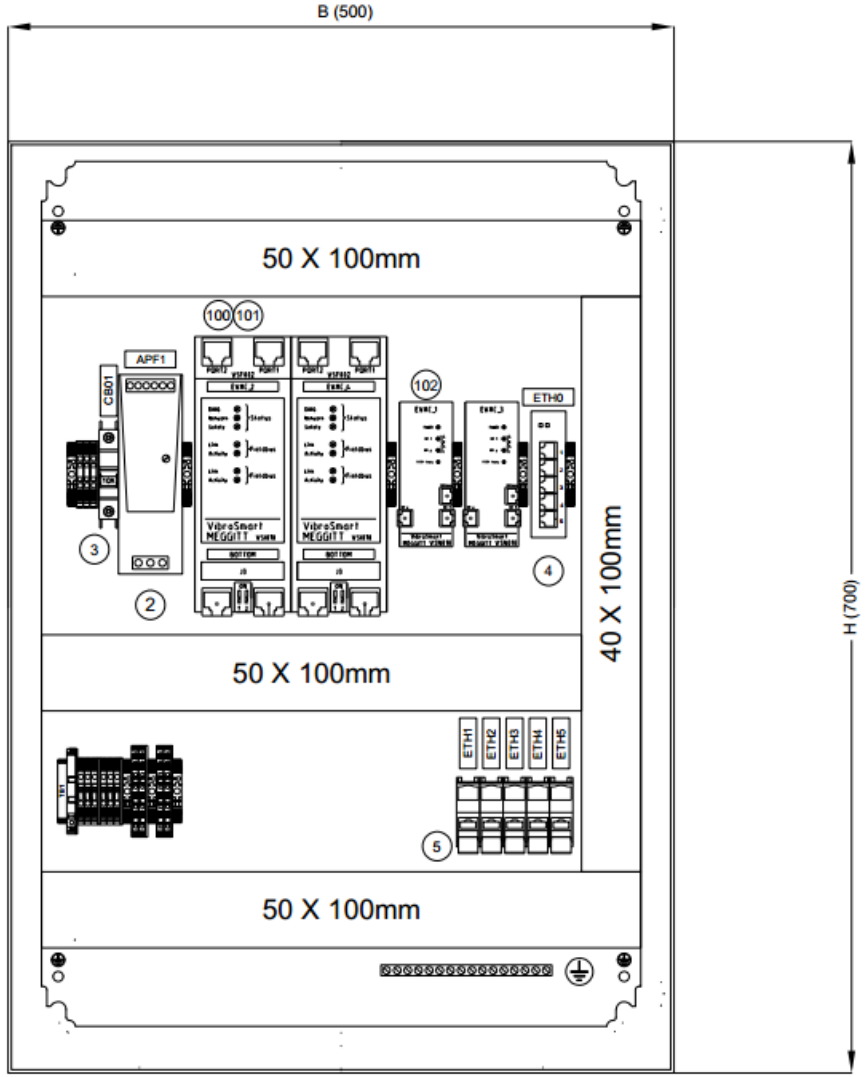
7 outdoor panels





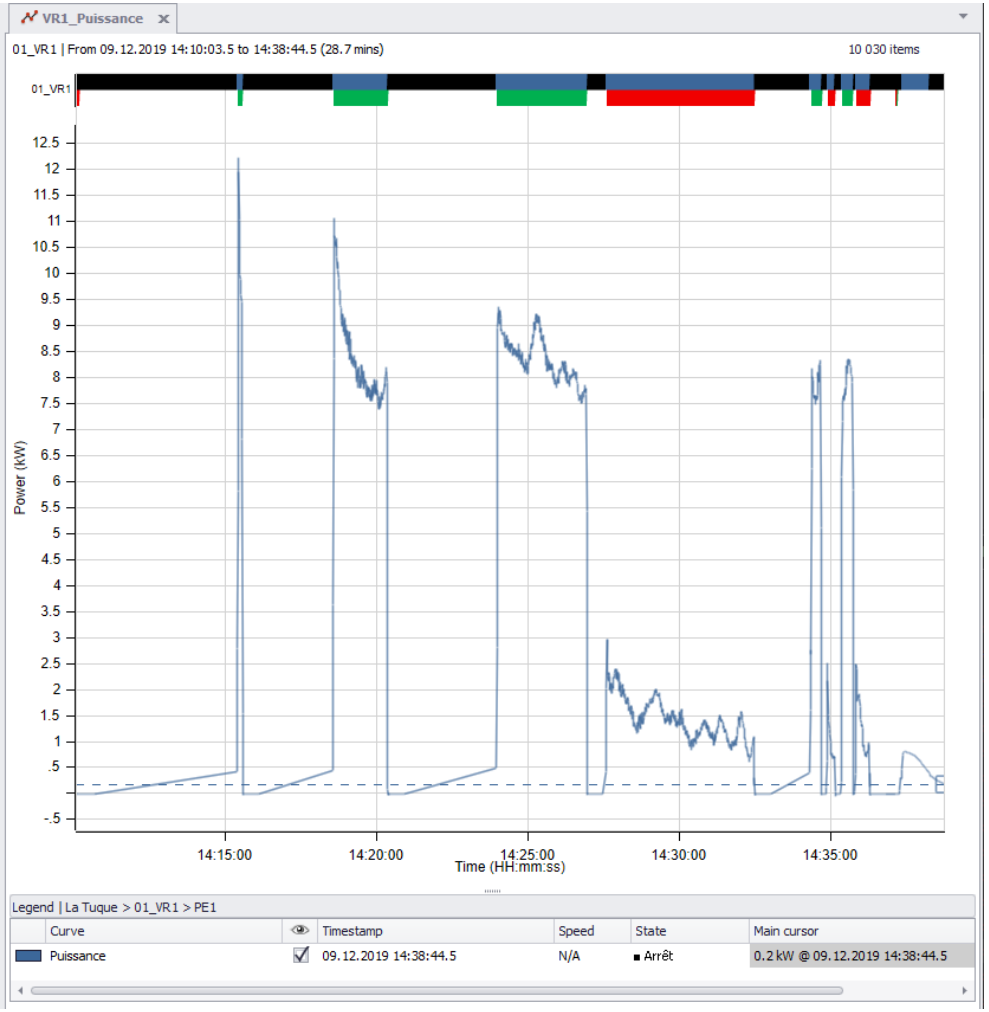
Spillway Gates Monitoring

1 indoor panel



Spillway Gates Monitoring

Data visualisation



Spillway Gates Monitoring

Highlights/Benefits

- Possibility to interface with sensors of any type / brand
- Network redundancy
- Post-processing calculations
- Remote access to support commissioning / diagnostic in operation

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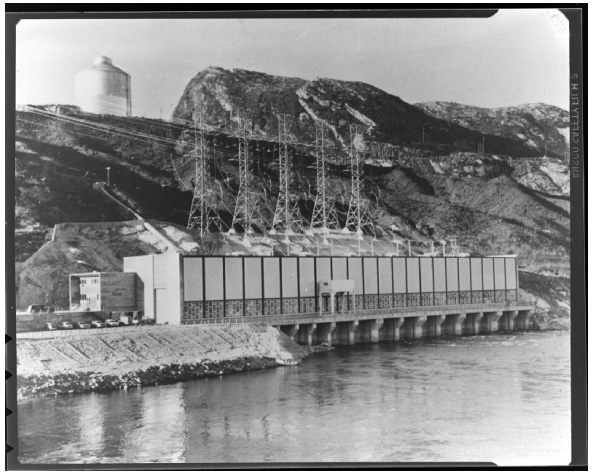
PENSTOCK PRESSURE SELF-OSCILLATION PROTECTION

Penstock Pressure Self-Oscillation Protection

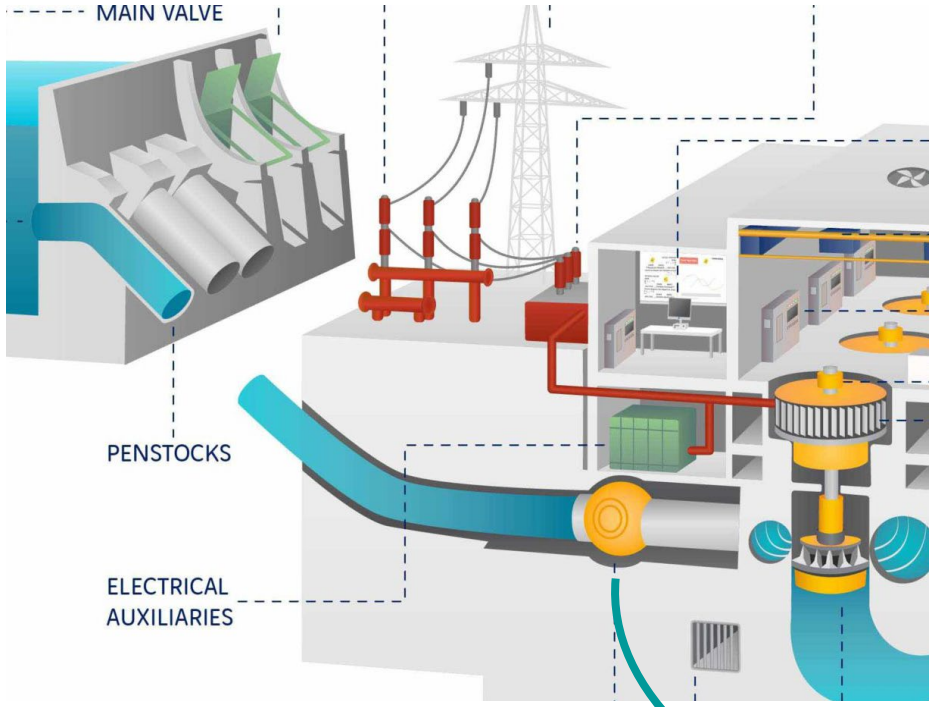
Background

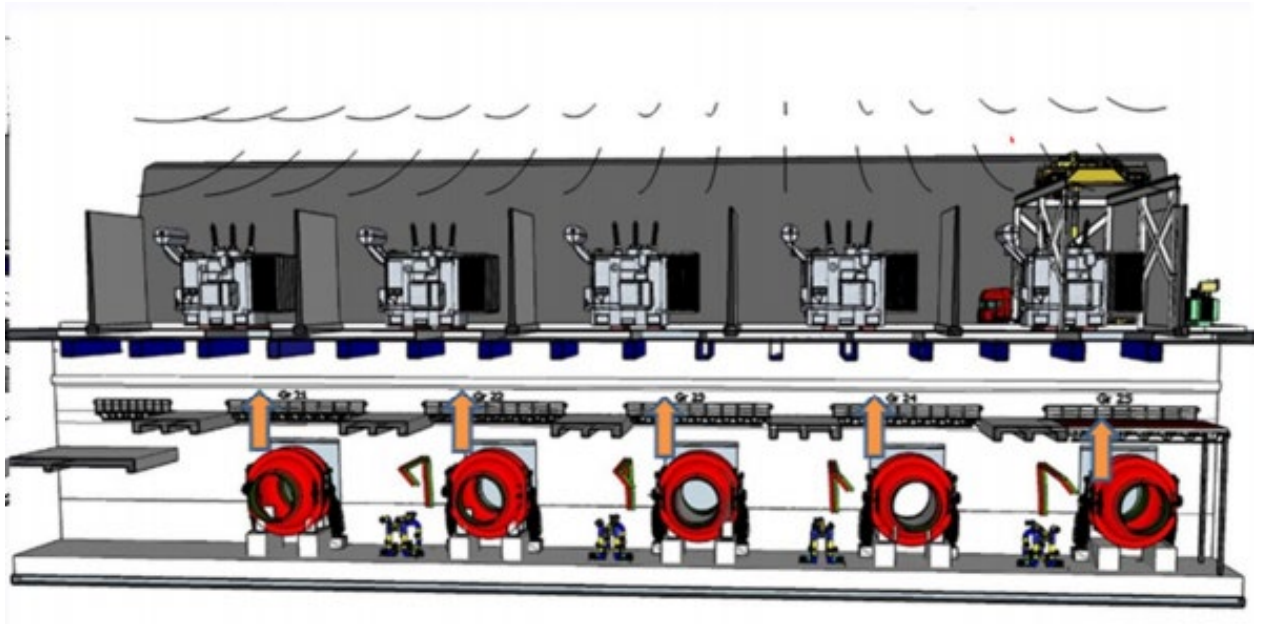
- Hydro-Québec – Bersimis-2 HPP – 845 MW
- Protect 5 penstocks from over-pressure conditions



Penstock Pressure Self-Oscillation Protection

Location

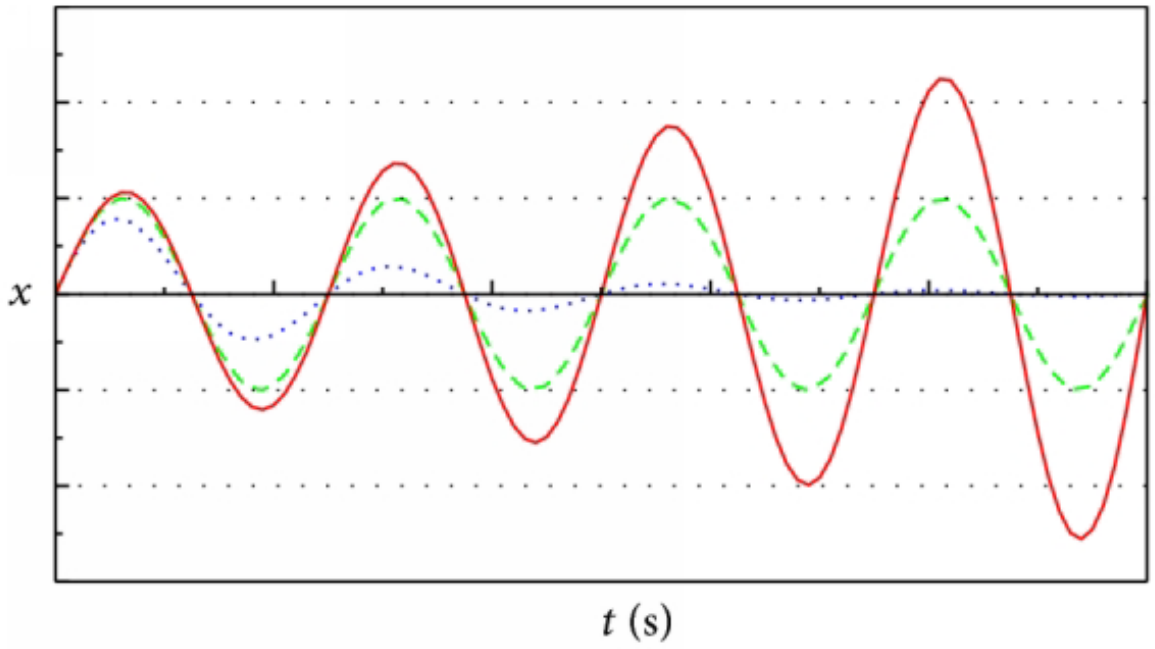




Penstock Pressure Self-Oscillation Protection

Problem

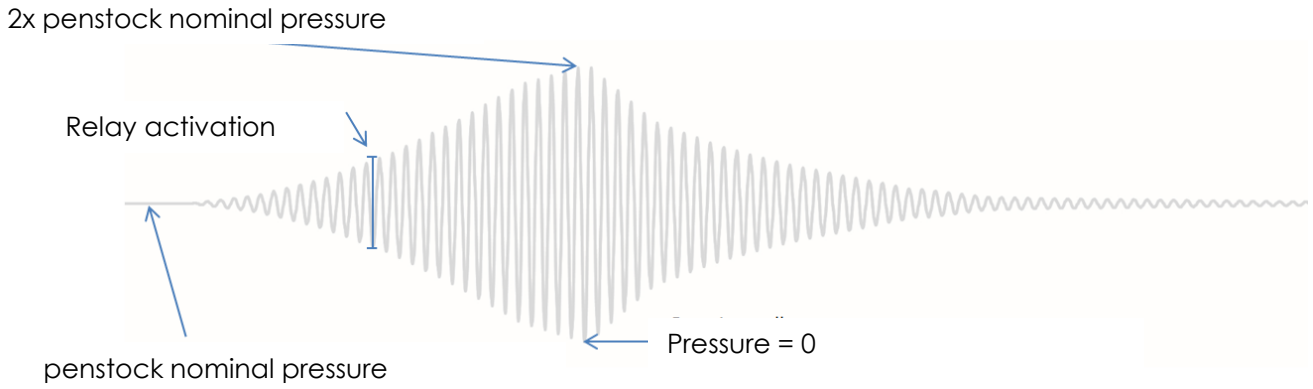
- Spherical valve pressure starts self-oscillating at low frequencies and can create an over-pressure of the order of 2 times the nominal pressure

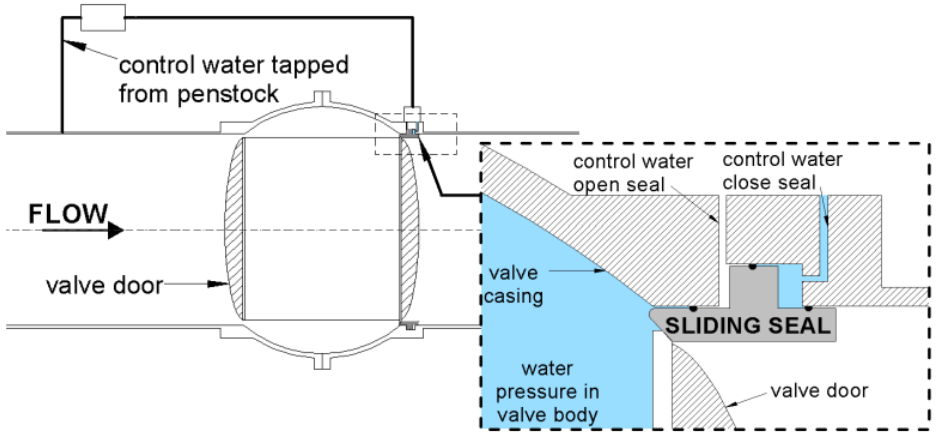


Penstock Pressure Self-Oscillation Protection

Phenomenon

- Due to leaks on the downstream seal
- Leaks create a delta P which then amplifies to finally reach critical amplitudes.





The spherical valve has two seals, an upstream seal and a downstream seal.

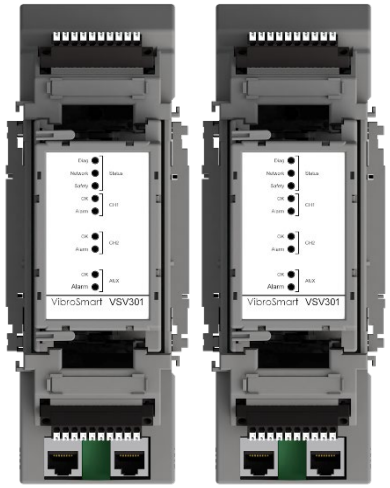
The upstream seal is only used during maintenance or to stop leaks.

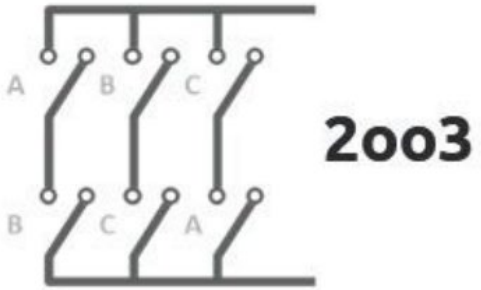
Penstock Pressure Self-Oscillation Protection

Solution

- Dynamic pressure sensors to detect the pressure amplitudes
- 3 sensors for triple redundancy
- 2oo3 logic with instantaneous activation of a protection relay
- Application of the upstream seal to stabilize the phenomenon

3x





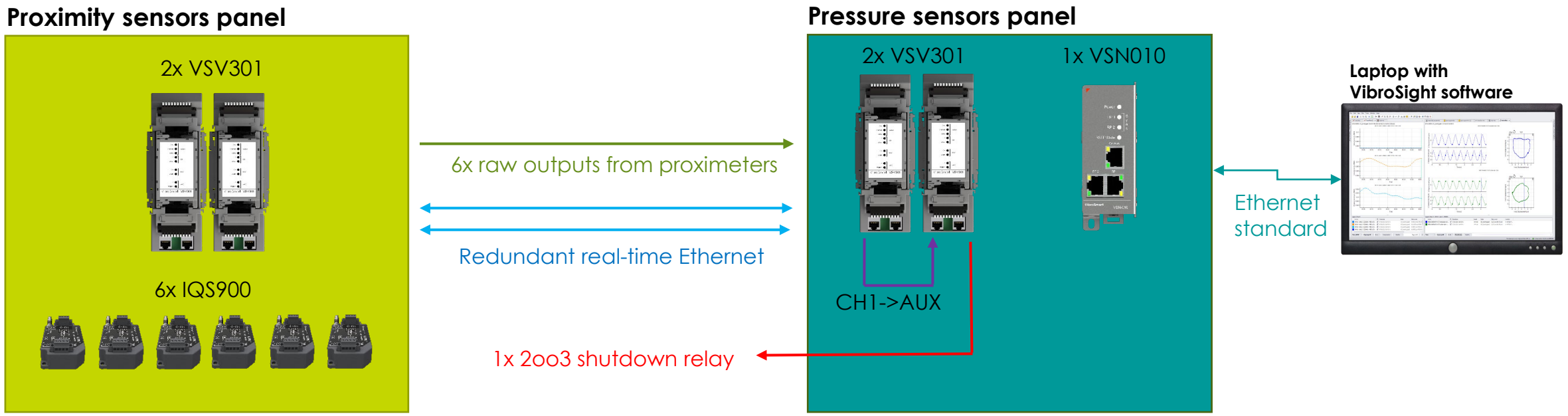
Penstock Pressure Self-Oscillation Protection

Instrumentation and Monitoring Hardware (per valve)

- Penstock pressure:
  - 3x 350300 Pressure sensors from Bently Nevada – GE Renewable scope
  - 2x VSV301 / VSB300
  - 1x VSN010
- Valve position:
  - 6x TQ403 (12mm range) sensor chains to measure valve position
  - 2x VSV301 / VSB300

Penstock Pressure Self-Oscillation Protection

Schematic



Penstock Pressure Self-Oscillation Protection

Highlights/Benefits

- Possibility to interface with sensors of any type / brand
- Network redundancy
- Signal processing adapted to dynamic pressure sensors
- Use of the AUX channel to allow for a 2oo3 logic without using a VSI010

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TURBINE CASING STRUCTURAL VIBRATION PROTECTION

Turbine Casing Structural Vibration Protection

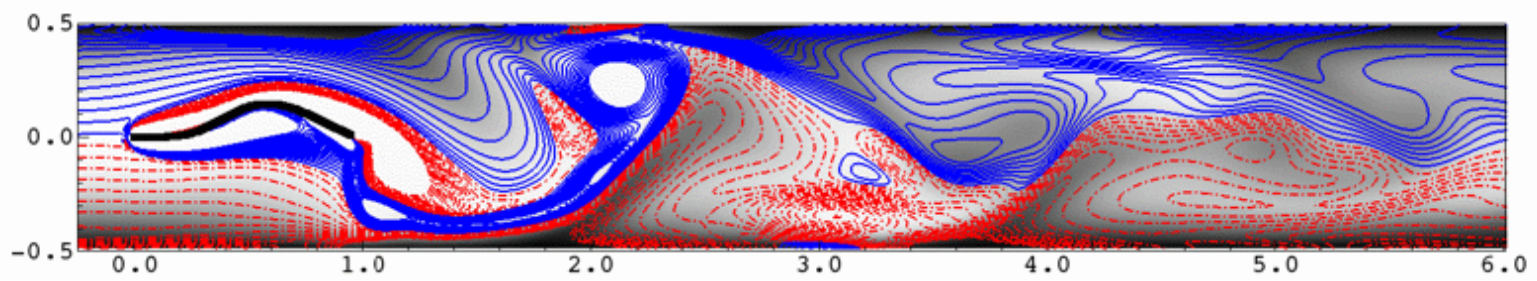
Background

- Hydro-Québec – Hull-2 HPP – 27 MW
- The plant includes three horizontal Francis-type turbine-generator units and a horizontal Kaplan-type bulb unit.

Turbine Casing Structural Vibration Protection

Problem

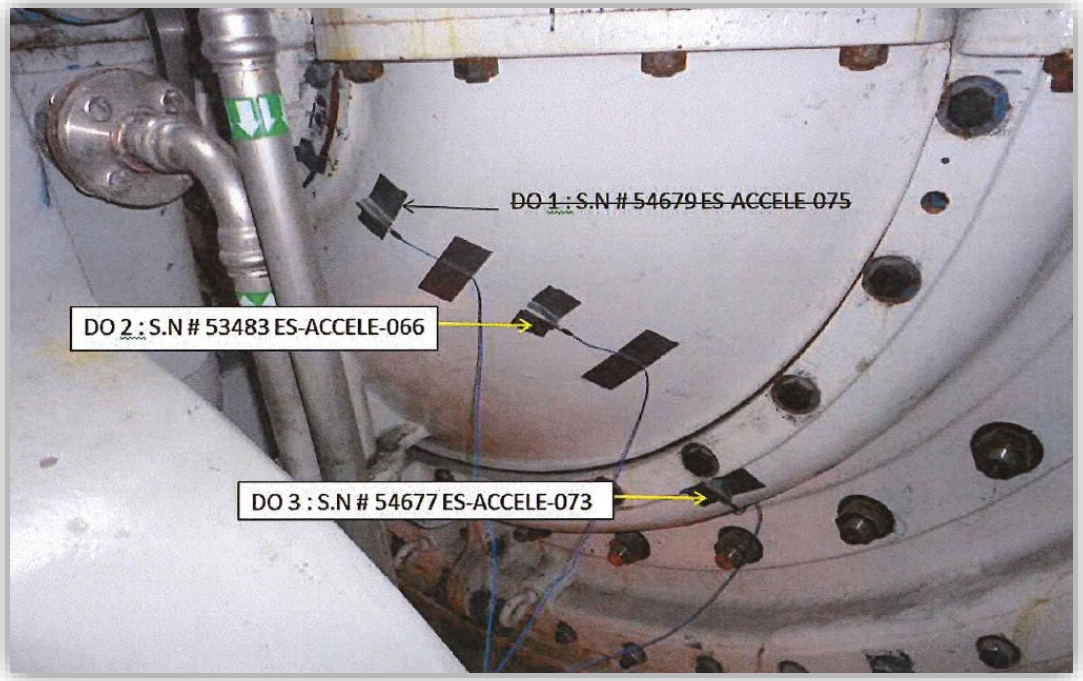
- High vibration/noise heard during specific operating conditions
- Suspected Von Karman vortices at the outlet
- How to detect this phenomenon?
- Warn the operators to modify the operating conditions and stay away from this unstable zone



Turbine Casing Structural Vibration Protection

Instrumentation

- 2x Accelerometers (GE Renewable scope)
  - Sensitivity 100mV/g
  - Glued on the upper flange of wheel B



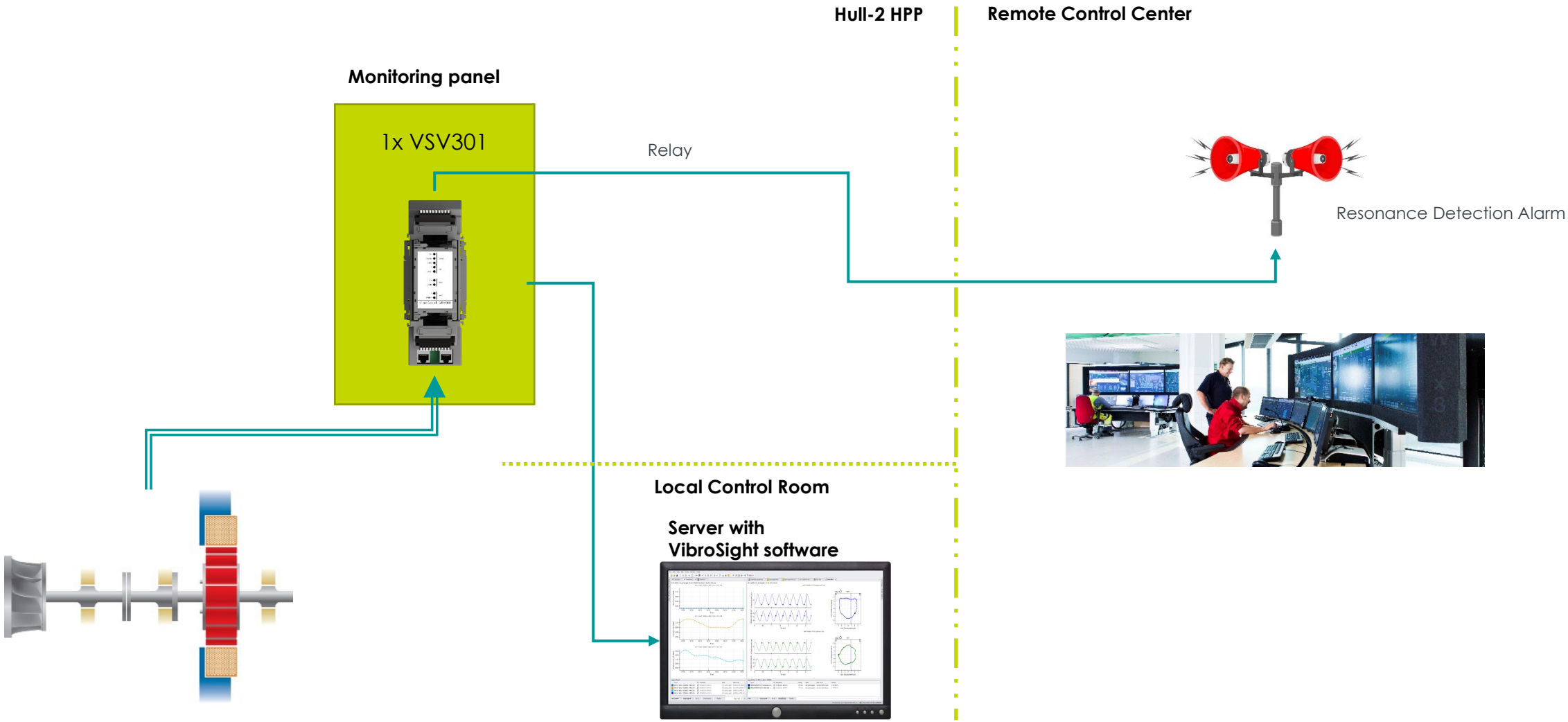
Turbine Casing Structural Vibration Protection

Monitoring hardware

- 1x VSV301/VSB300
  - Installed and pre-wired in a water tight enclosure

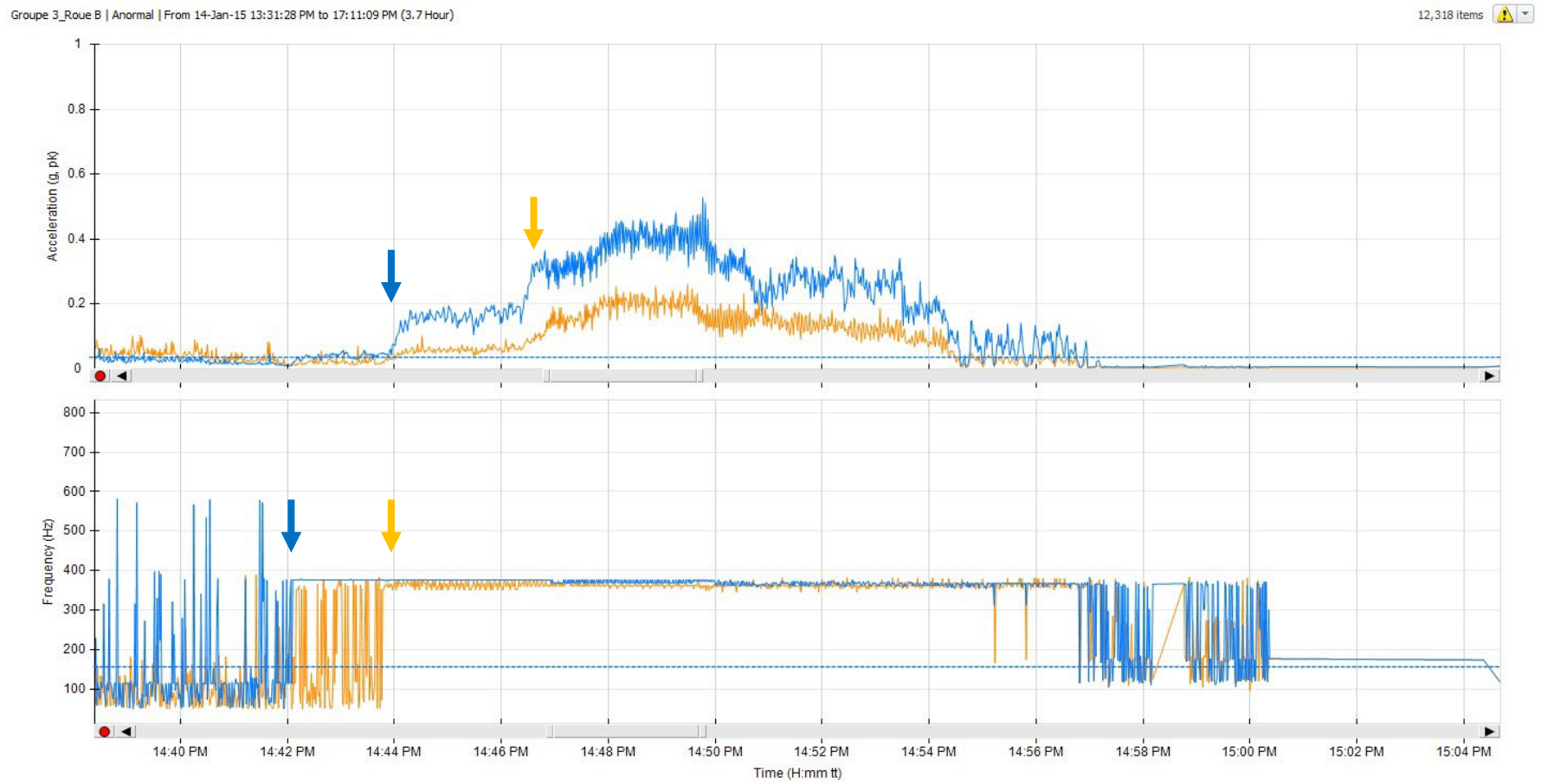
Turbine Casing Structural Vibration Protection

Schematic



Turbine Casing Structural Vibration Protection

Band Peak processing – resonance detection



Legend | VibroSmart Measurement Block 1 > VibroSmart VSV300

Curve	Visible	Timestamp	Speed	State	Main cursor	Location
DO2 > Band Peak	☑	14-Jan-15 17:11:09 PM	N/A		0.04 g b_pk | 155 Hz @ 14-Jan-15 17:11:09 PM	0° EU
DO3 > Band Peak	☑	14-Jan-15 17:11:09 PM	N/A		0.11 g b_pk | 77 Hz @ 14-Jan-15 17:11:09 PM	0° EU

Time/APHT | Group all | Compensation | Baseline

Turbine Casing Structural Vibration Protection

Highlights/Benefits

- Possibility to interface with sensors of any type / brand
- Signal processing adapted for peak frequency line tracking
- Detection of fluid induced instabilities though the interaction with the structure
- Ability to warn the operator to change the operating conditions

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Q&A

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THANK YOU

presented by Gregory Zurbriggen,
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May 2022

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