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Pampa Energia: Detection of anomalies in gas turbine with PI AF

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AVEVA

Pampa Energía is the leading independent and energy integrated company in Argentina.

Power Generation

Hydro	938 MW
Thermal	4,093 MW
Co-Generation	14 MW
Wind Power	387 MW
+ Expansions	140 MW

Power Transmission

Transener	21,697 km of high voltaje lines

Oil and Gas

Blocks	11 porductive + 4 exploratory
Gas	10.6 million m3/d of production
Crude Oil	5.1 k bbl/d of production

Midstream

TGS	9,2220 km of gas pipelines NGL Capacity of 1 million ton/year

Downstream

Blocks	11 porductive + 4 exploratory
Gas	10.6 million m3/d of production
Crude Oil	5.1 k bbl/d of production

Our history with AVEVA

Pampa energía

2020

- Pampa Energia signs Enterprise Agreement with AVEVA™
- PI System™ Rollout @ CTLLL
- 27,000 data points

2021

- Creation of main assets models in Asset Framework

2022

- Started creating advanced predictive models for fault detection with AVEVA experts

2023

- Deploying cutting-edge predictive models for gas turbine commissioning
- Developing Operation predictive dashboards

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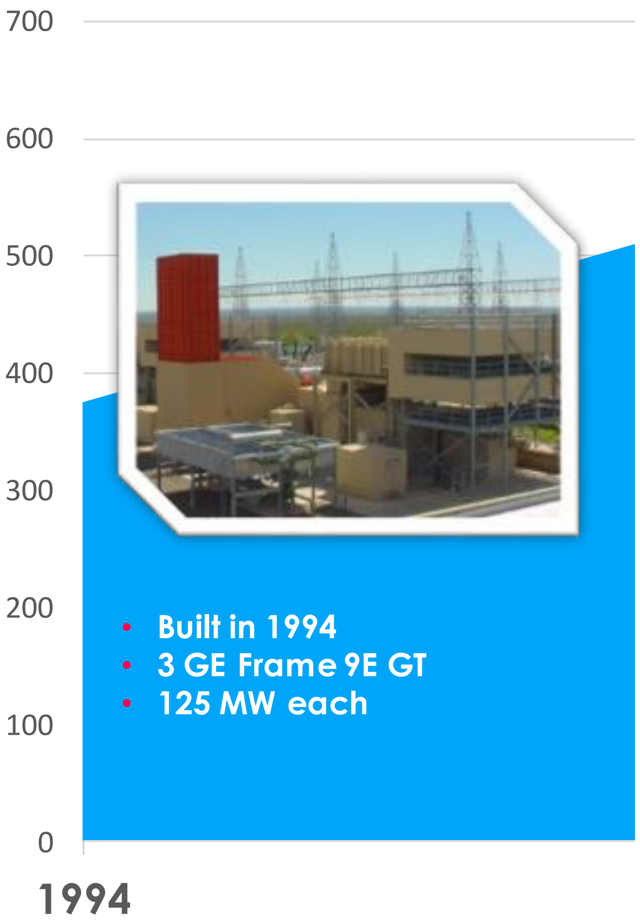
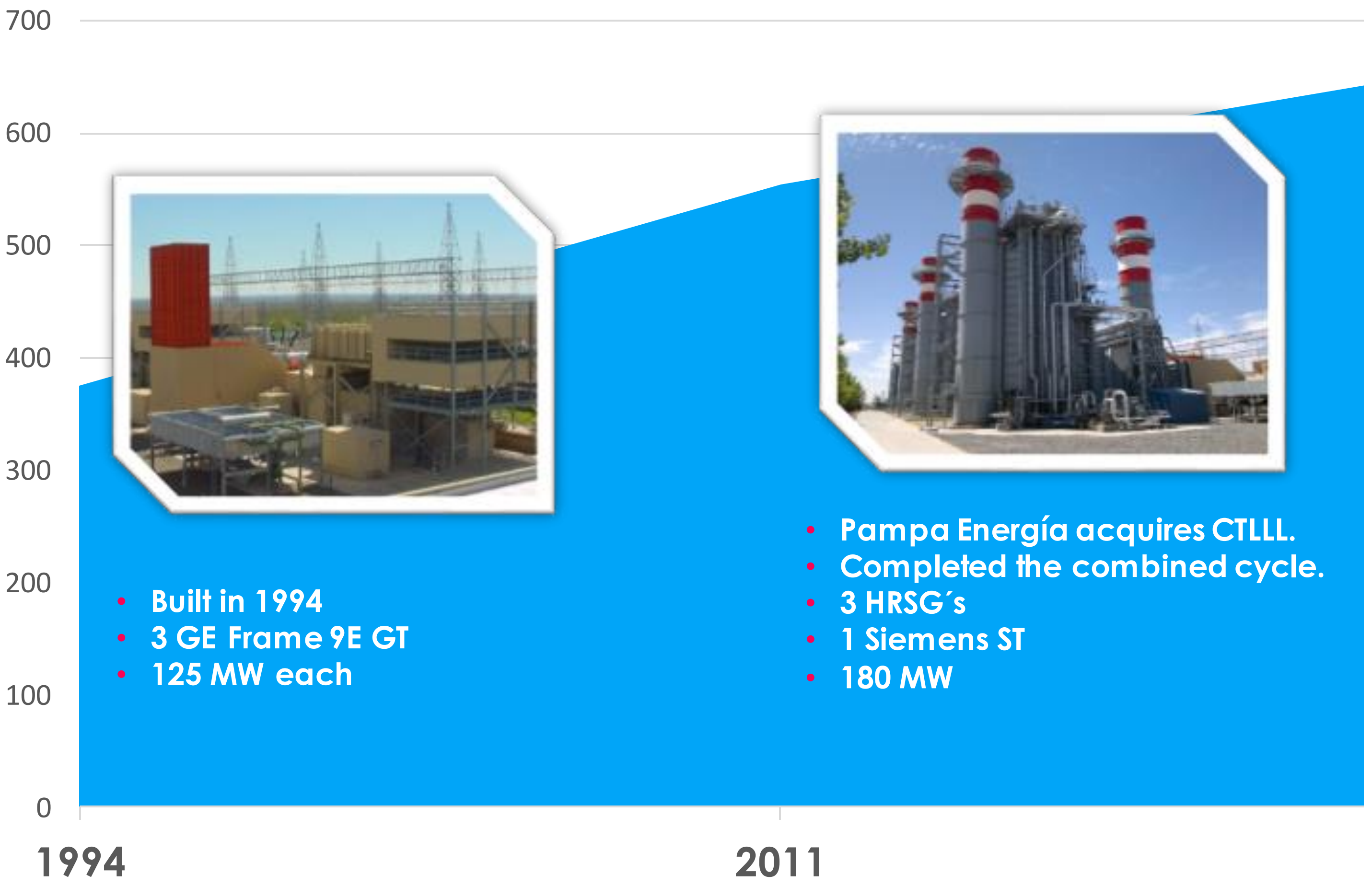
Loma de la Lata Thermal Power Plant



Loma de la Lata Thermal Power Plant



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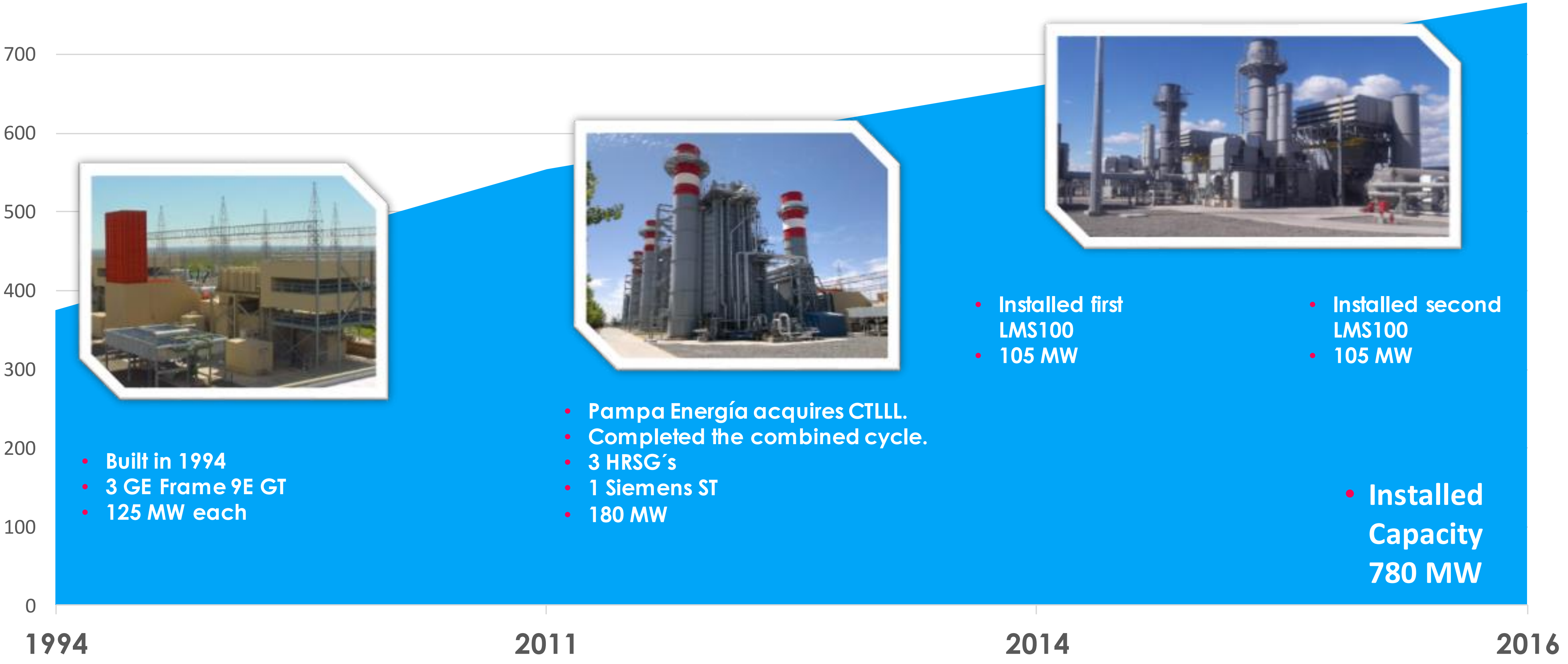
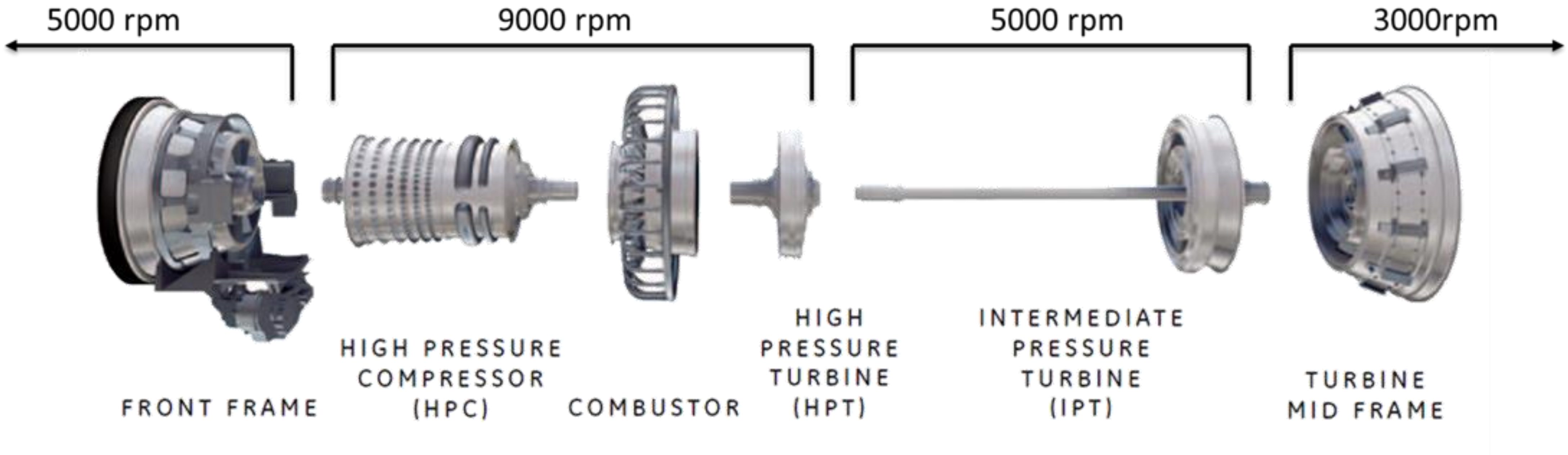
Loma de la Lata Thermal Power Plant



Description of the issue with the LMS100



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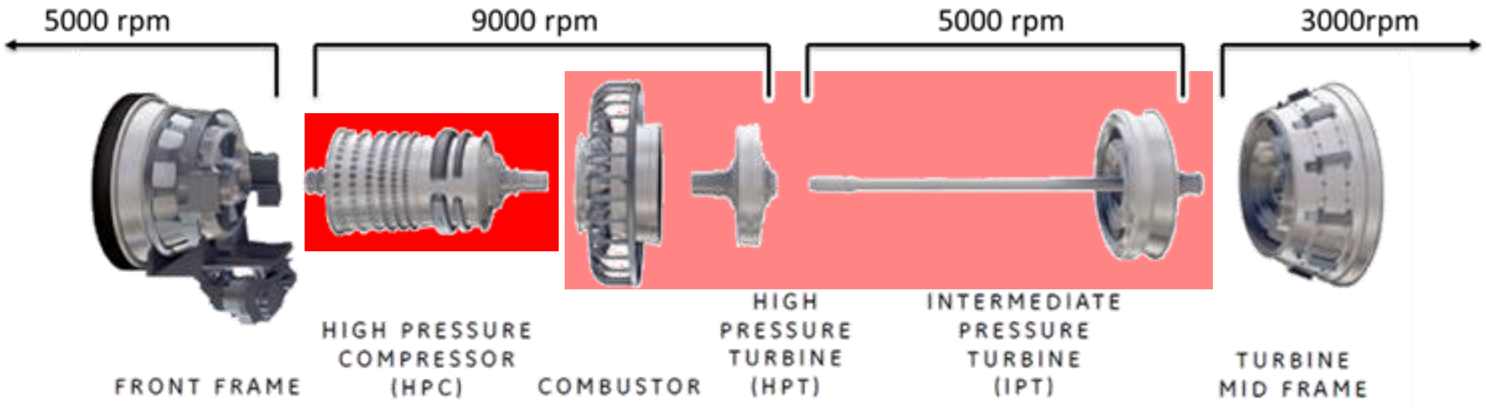
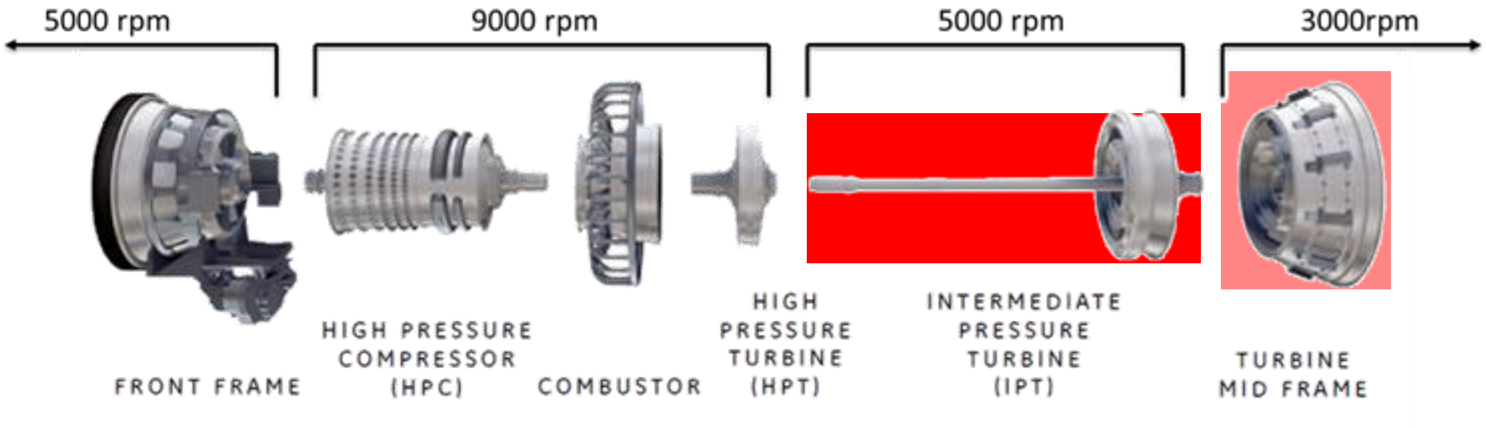


TG5: HPC Stall / 4B Bearing Failure

- Jan 9,2017 4:00hrs
- Catastrophic failure of 4B bearing causing a stall in the HPC
- HPC, Combustor, HPT, IPT and PT hardware go to scrap.
- 1 year later, they are installed again.

Description of the issue with the LMS100



TG4: Creep Failure IPT Stage 2 Nozzel

- Oct 22, 2019 17900 h

- Catastrophic failure in IPT 2nd Stage nozzle partition.
- IPT and PT hardware go to scrap.
- Serious damage on the TRF.

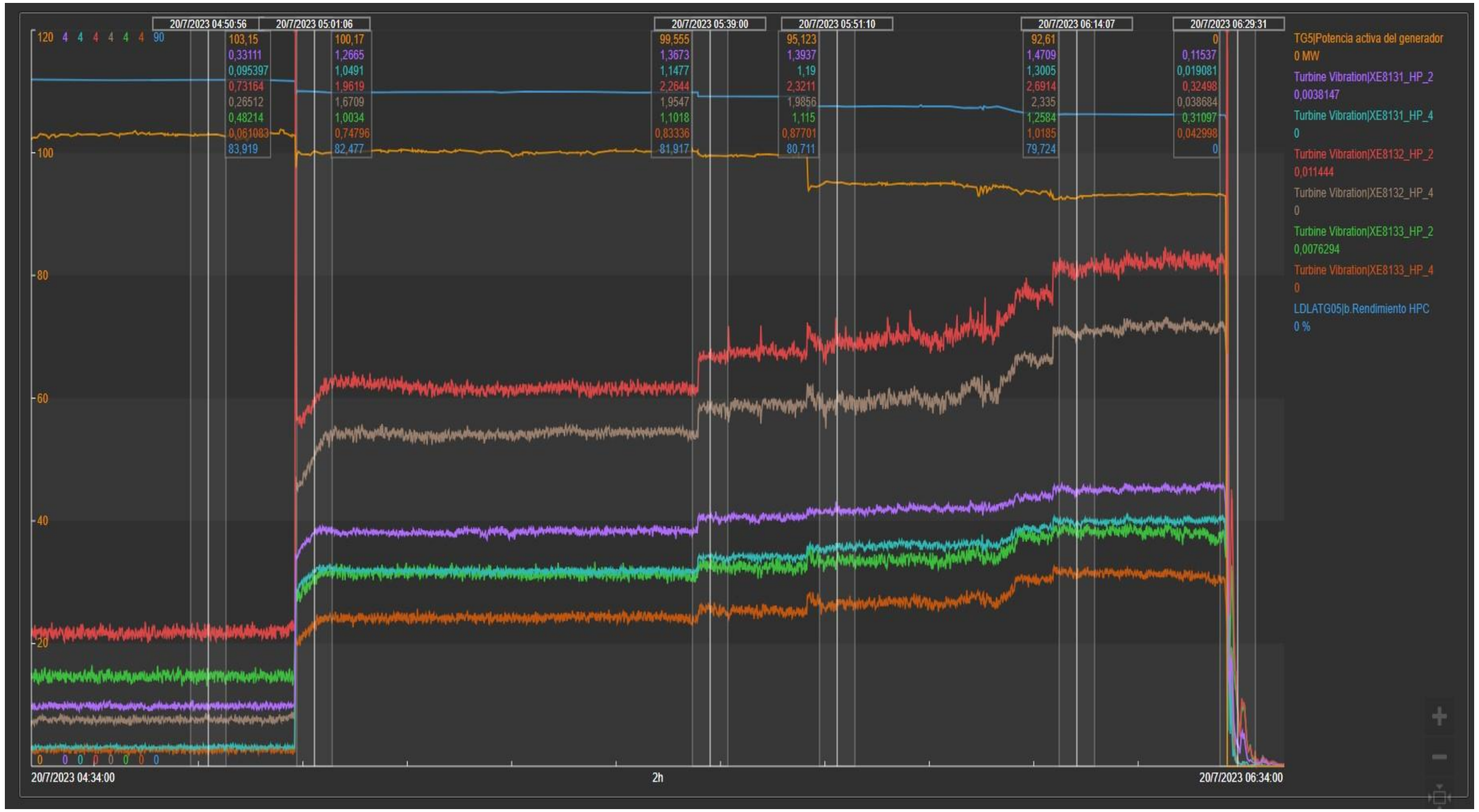
Solution

1. Analyzing LMS100 behavior through historical data

Analyzed historical data to understand the machine behavior across various downtime scenarios.

The critical variables selected to insight in a LMS100 downtime were:

- Vibrations
- Power
- Performance metrics

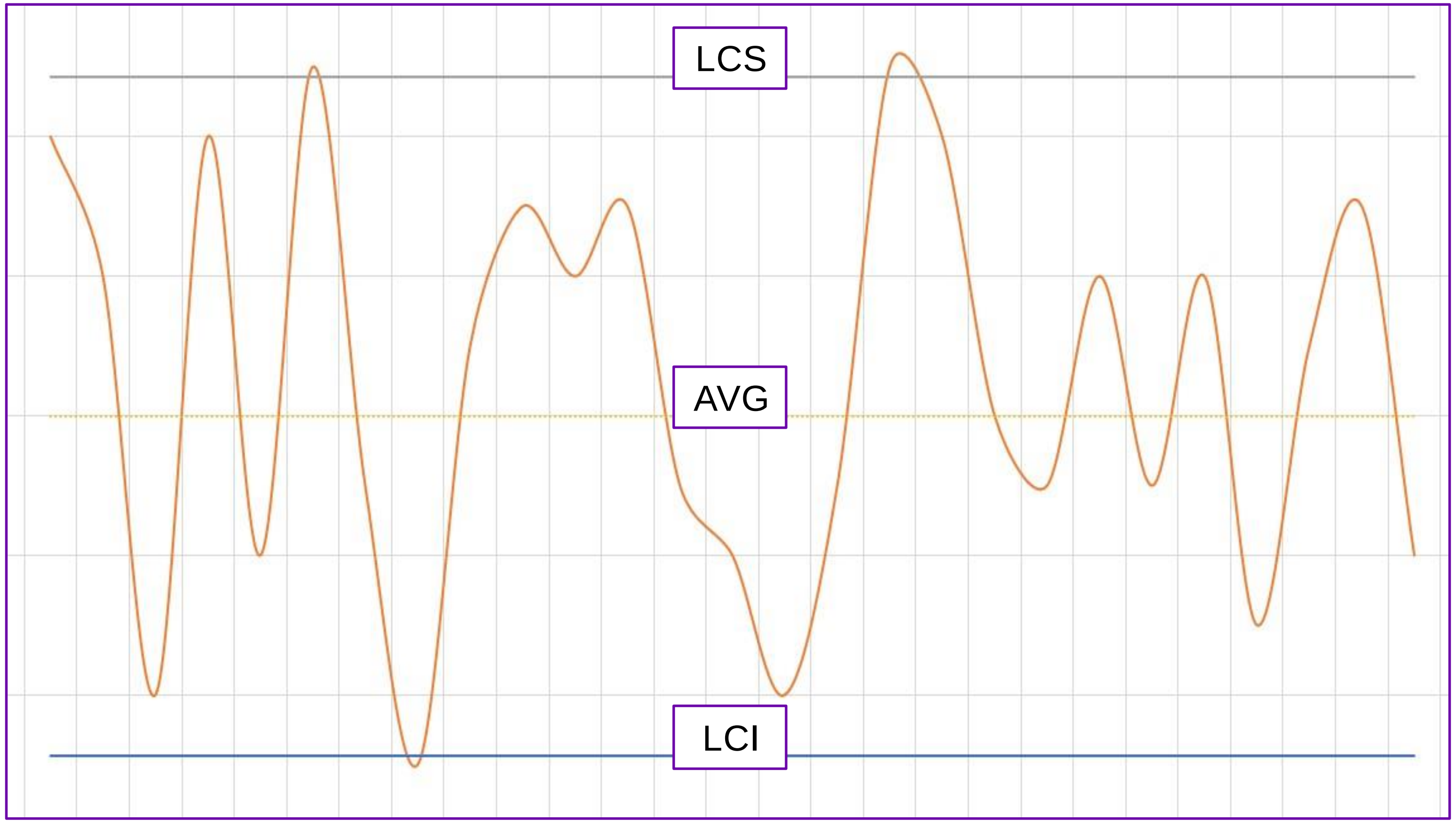


Solution

2. Defining Variable Limits for Quality Control

Establish variable limits using a Statistical Quality Control (SQC) model, enabling the clear demarcation of acceptable and unacceptable levels.

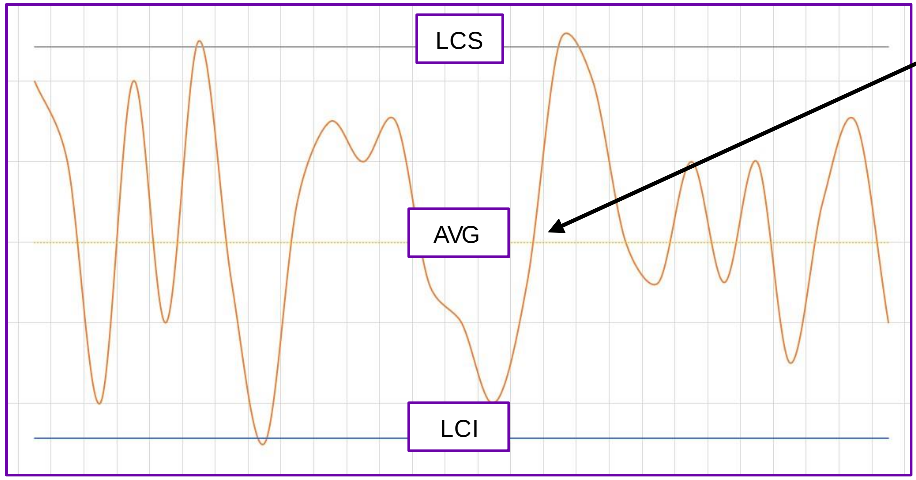
Trigger alerts when a variable's value deviates from the established limits for a specified duration.

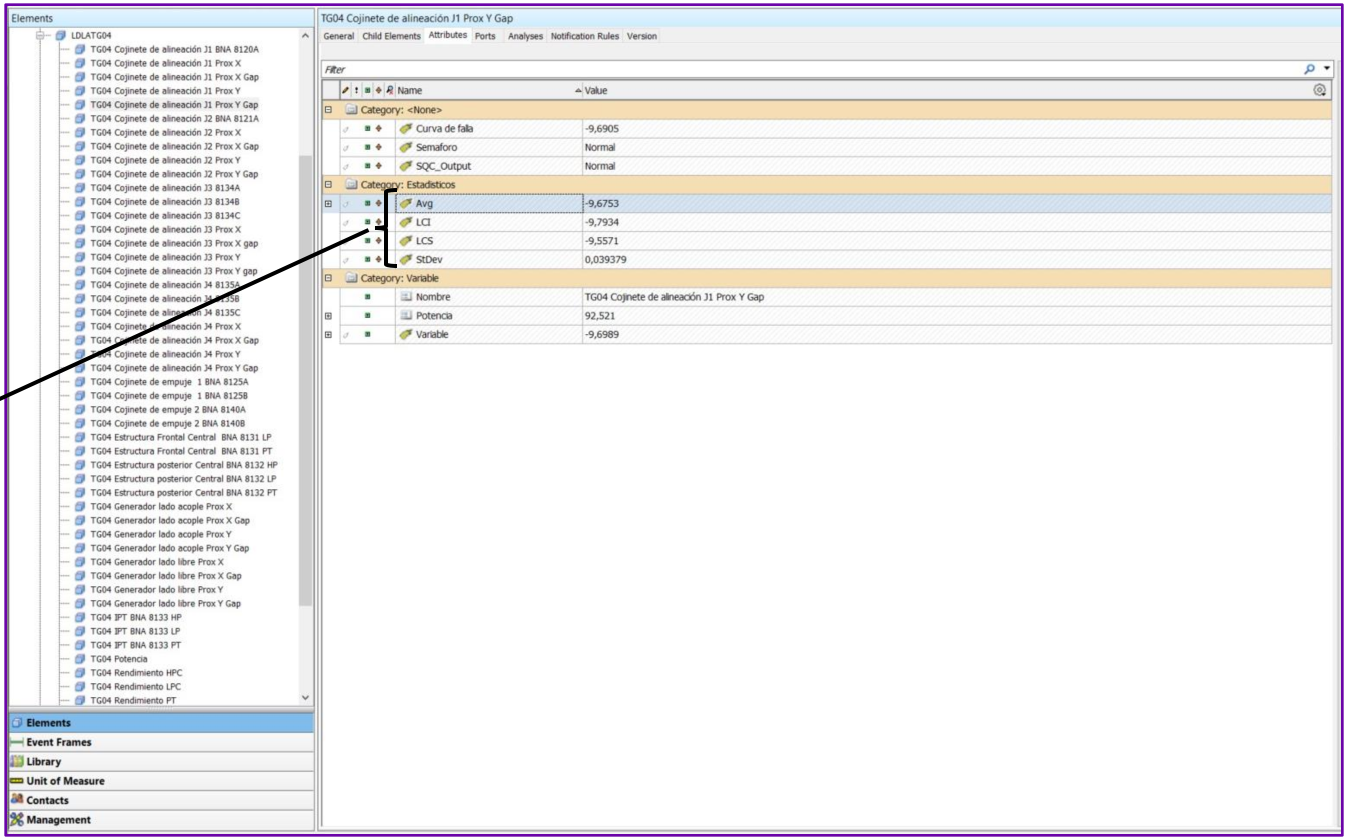


Solution

3. SQC Model Implementation in AF

Incorporated the SQC model into the PI Asset Framework, enabling automated and efficient monitoring and analysis of vibration data.



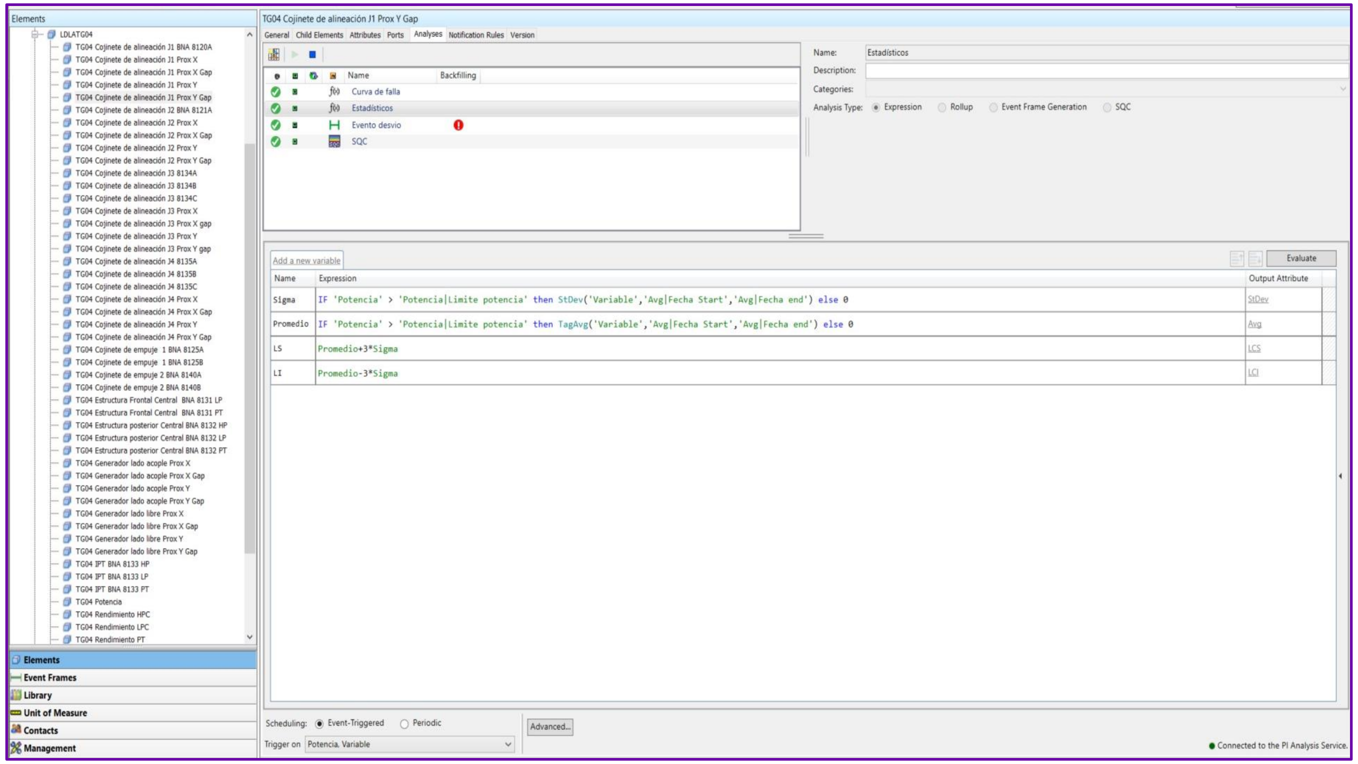


Solution

3. SQC Model Implementation in AF

Integration of the SQC model into PI Asset Framework allowing for automated monitoring and analysis of vibration data. Implemented the following analytics:

- Failure Curve
- Power Statistics
- Deviation Event



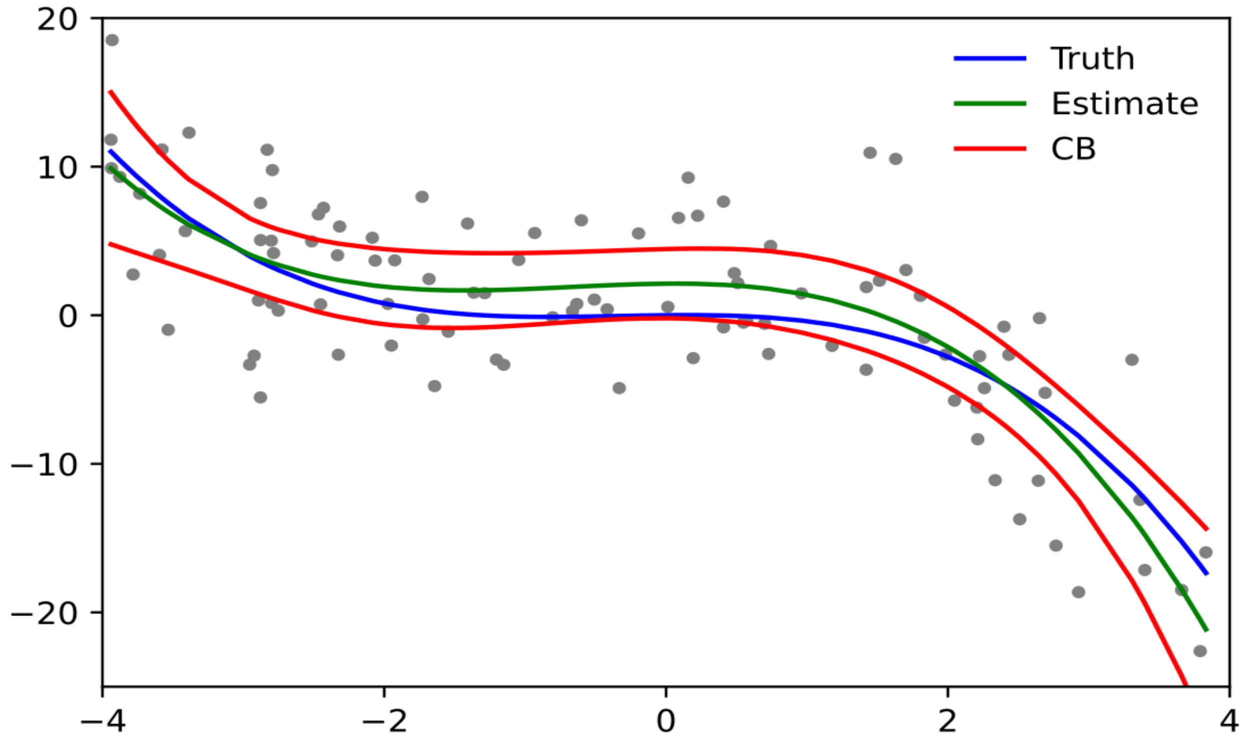
Solution

$$Y=C_1+ C_2X_1 + C_3X_2 + C_4X_3 + C_5X_1^2+ + C_6X_2^2 + C_7X_3^2 + C_8X_1 X_2 + C_9X_1 X_3 + C_{10}X_2 X_3 + + C_{11}X_1^3+ + C_{12}X_2^3 + C_{13}X_3^3$$

4. Defining Polynomial Regression for Statistical Analysis

Incorporated polynomial regression, a powerful statistical method in data analysis and statistics, to model the intricate relationship between an independent variable (predictor) and a dependent variable (response).

PI WEB API was leveraged to seamlessly transmit historical data to Python for in-depth analysis and modeling.



Solution

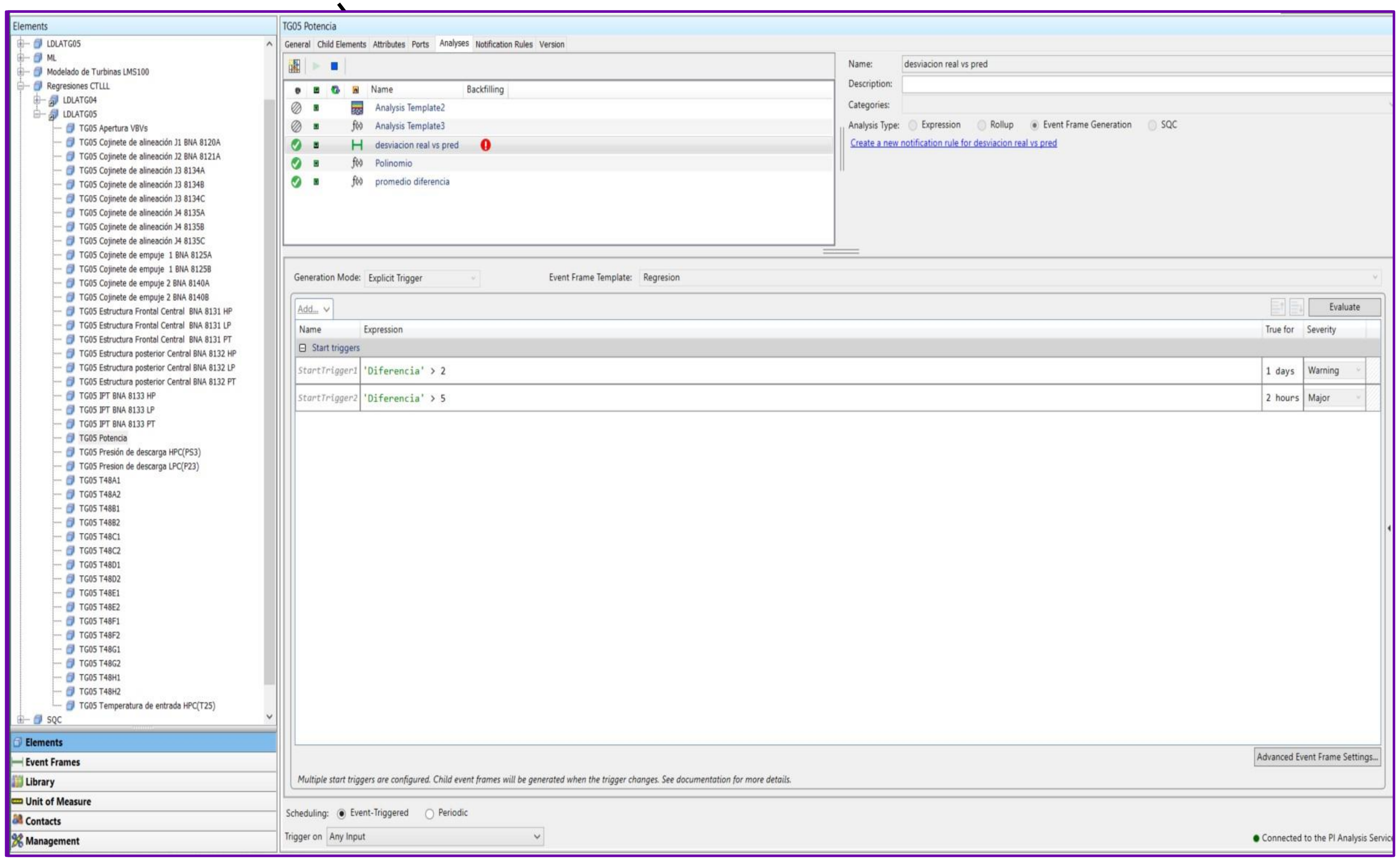
$$Y=C_1+ C_2X_1 + C_3X_2 + C_4X_3 + C_5X_1^2+ + C_6X_2^2 + C_7X_3^2 + C_8X_1 X_2 + C_9X_1 X_3 + C_{10}X_2 X_3 + + C_{11}X_1^3+ + C_{12}X_2^3 + C_{13}X_3^3$$

5. Implemented polynomial regressions in AF

Define third-degree polynomial regressions, a mathematical model, to further.

This was done in Python, using data form PI System.

Implementing the model in PI AF.



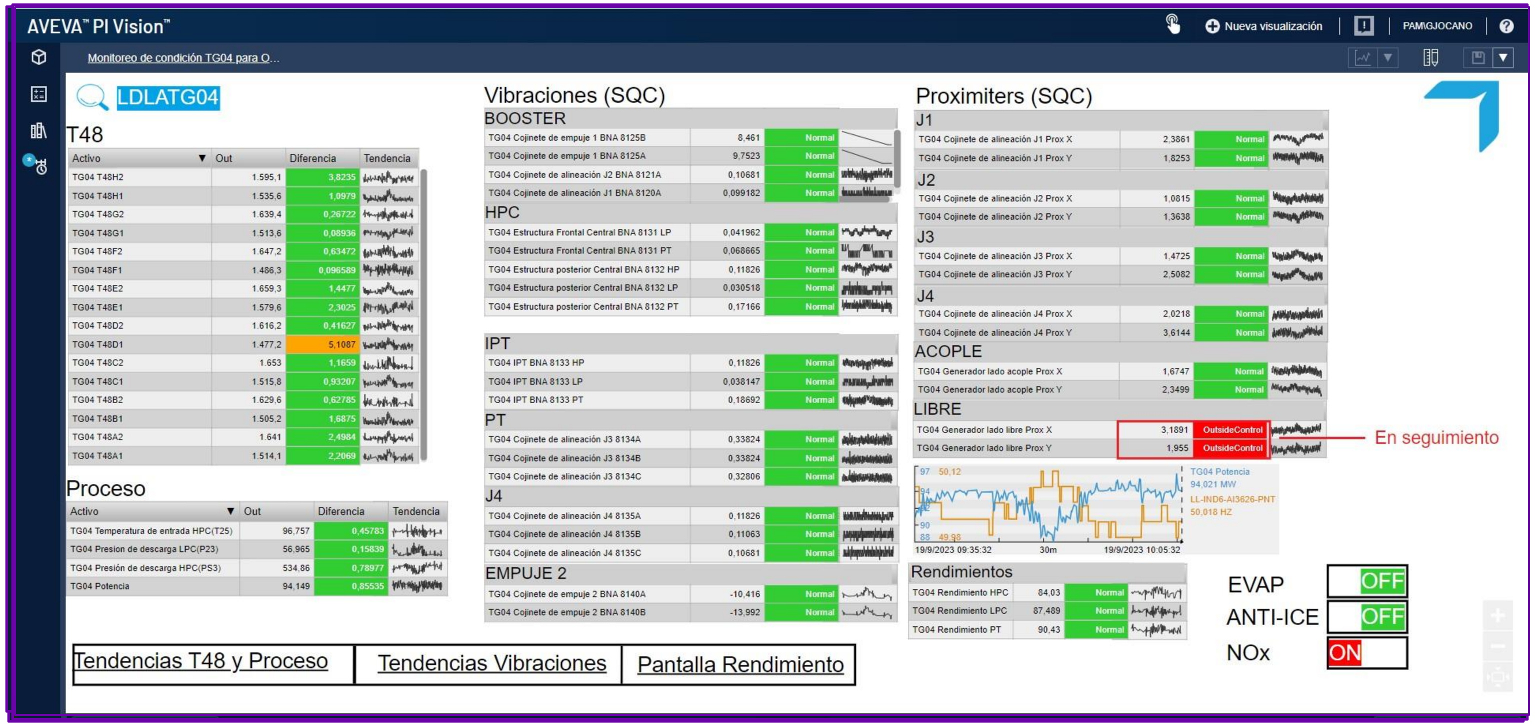
Solution

6. **Dashboard Development**

Dashboards are developed displays in PI Vision with the information related to vibrations and power data in a user-friendly and easily accessible format.

Alert System Implementation:

An alert system is integrated into the displays to notify operators in real time when variables perform outside of the established limits. These alerts serve as early warning signs of potential equipment failures.



Summary

Challenges

- Our current gas turbine control systems at CTLL lack advanced analytics.
- Operators rely on basic alarms, which offer limited lead time for proactive interventions.
- Seeking alternatives to enable early failure detection in aeroderivative turbines.

Solution

- Leverage historical LMS100 turbine data combined with real-time information (PI Web API)
- Build PI AF model with predictive analytics (SQC / Python) to monitor performance, pressure, and vibrations of LMS100 turbine.
- Create alerts when LMS100 behavior deviates from the expected.
- Build displays for the operators to take preventive actions.

Results or Impact

- With just **three months** of operation, the **models detected a deviation** in the turbine's behavior.
- The following preventive actions were taken:
  - Properly stopped the LMS100 turbine.
  - Conduct an inspection
- A **small crack in a blade was detected**, preventing a catastrophic failure and extended downtime.

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

Thank you!

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