Case Study

Solving Flicker & Voltage Fluctuation in Electrical Systems - Case study from the Welding Industry

This case study focuses on the benefits of Elspec's real-time reactive power compensation technology and continuous waveform recording technique in addressing the challenges of Flicker & Voltage Fluctuation in Electrical Systems within the Welding Industry in Europe.

Flicker occurs when voltage fluctuations affect lighting systems, typically caused by rapid-changing loads in the electrical network. Flicker is characterized by voltage variations typically within the range of ±10%. The ΔUmax (maximum voltage variation) is constrained to be smaller than or equal to 5% of Un in situations without production stops, big loads, or connections. These limitations ensure stable voltage levels and minimize disruptions, providing a reliable electrical environment for operations.

Voltage variations are influenced by the current sequence, active power (real power) and reactive power within an electrical system.

Customer Situation

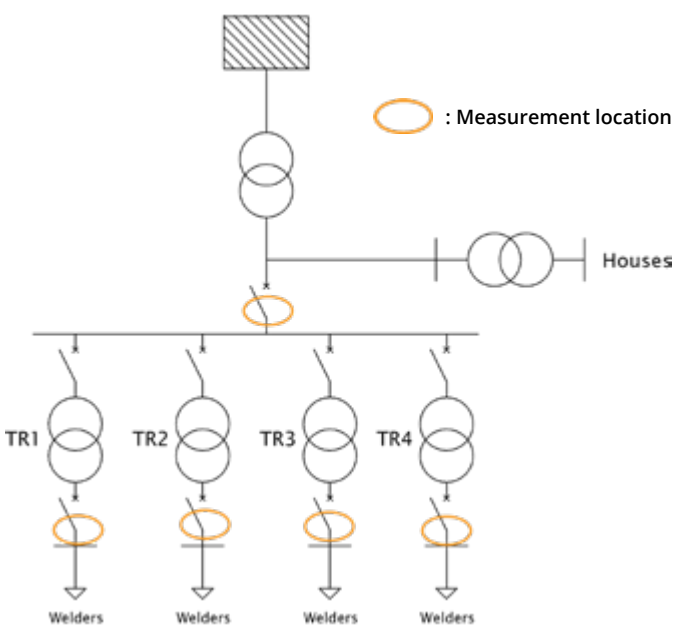
A brazing and welding supplier in Europe faced recurring high flicker values, reaching up to 3.5 on a 10kV scale. These fluctuations not only impacted the supplier's operations but also caused electrical disturbances and flickering issues for the neighboring town. Consequently, the Grid operator requested the customer to adhere to the grid code requirements and resolve these flicker problems; otherwise, the plant would face disconnection.

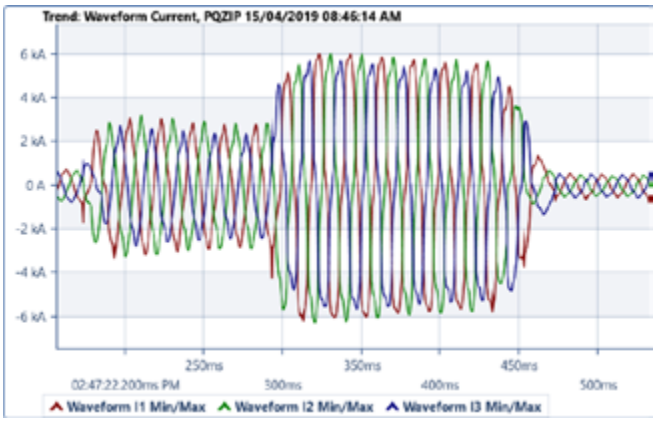
To tackle this challenge, the customer reached out to HyTEPS, Elspec's agent in the Netherlands, for assistance.

The Investigation Process

To identify the source of these flickering issues, Elspec's agent conducted in-depth investigation using the G4500 continuous waveform recording power quality analyzer.

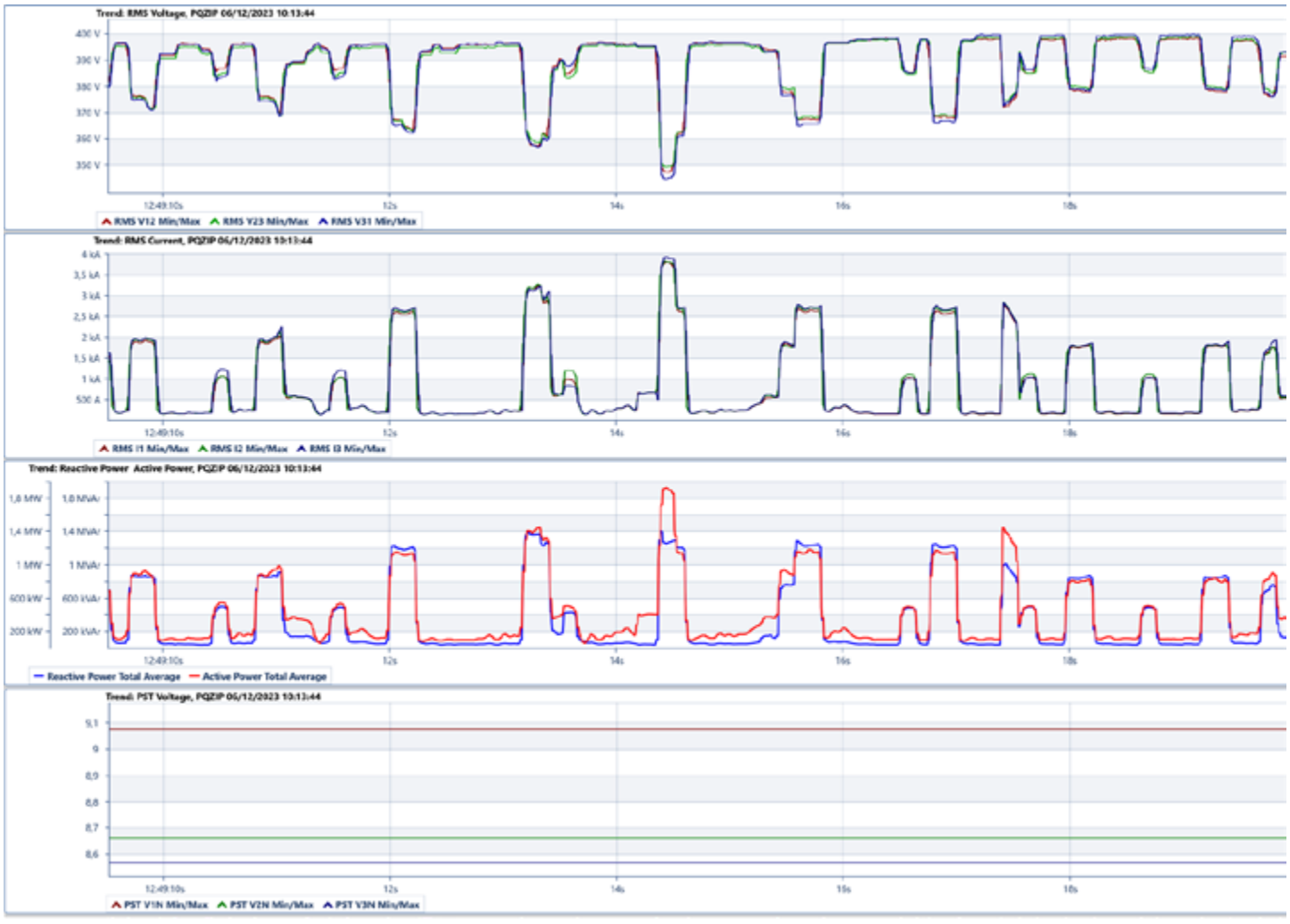
In cases like this, continuous waveform recording plays a pivotal role as it allows for the evaluation of intensity changes and the rate of voltage changes per minute, directly influencing the perception of flicker. The G4500 Analyzers were strategically installed at key points within the electrical system of the plant. With access to extensive waveform recording data, we were able to analyze the electrical system thoroughly and gather crucial insights into the flickering issues.





The analysis showed a very short current sequence and current peaks reaching from 0.35kA to 6kA.

Voltage variations (Δ) reached up to 6% and the Short-term flicker "perceptibility" value (Pst) reached a maximum of 6.87.

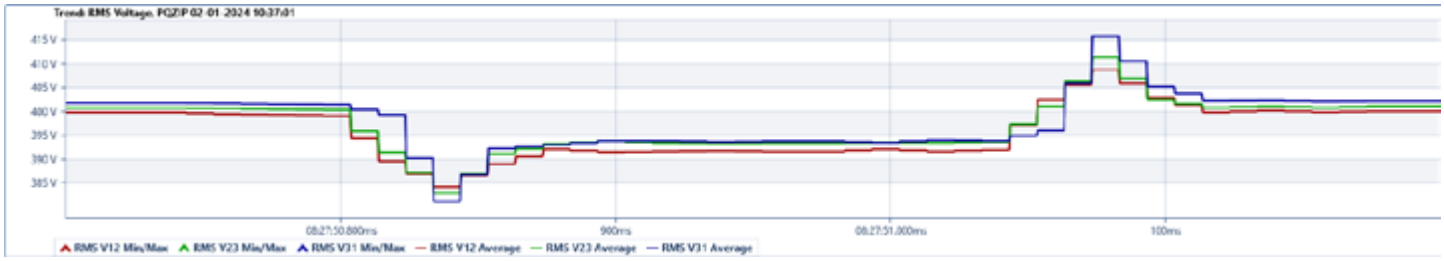


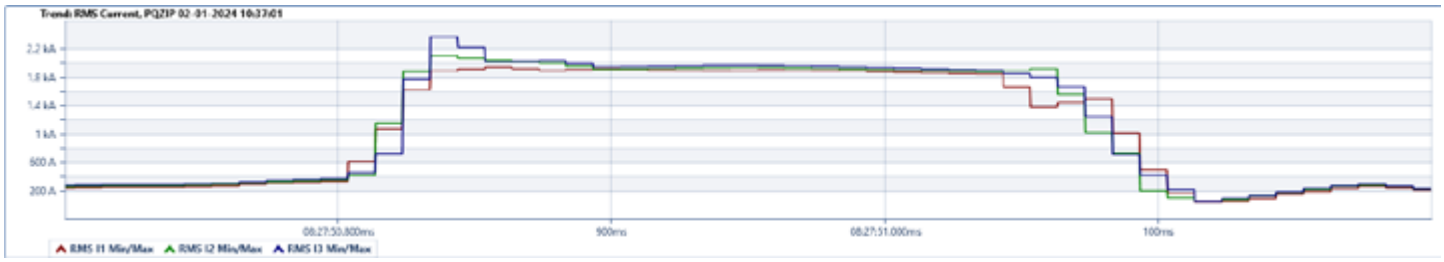
The Solution: Elspec's Dynamic Reactive Power Compensation System

After making a simulation, our agent HyTEPS recommended the installation of Elspec's 1500kVAr Equalizer unbalanced systems in several places at the plant.

The Equalizer real-time reactive power compensation system, designed for dynamic loads, with the ability to compensate each phase independently. It utilizes ultra-high power thyristor switching technology, ensuring smooth and transient-free switching by connecting capacitors at zero-crossing. With a rapid full acquisition time of less than one cycle, the system reacts within just 20ms.

Results

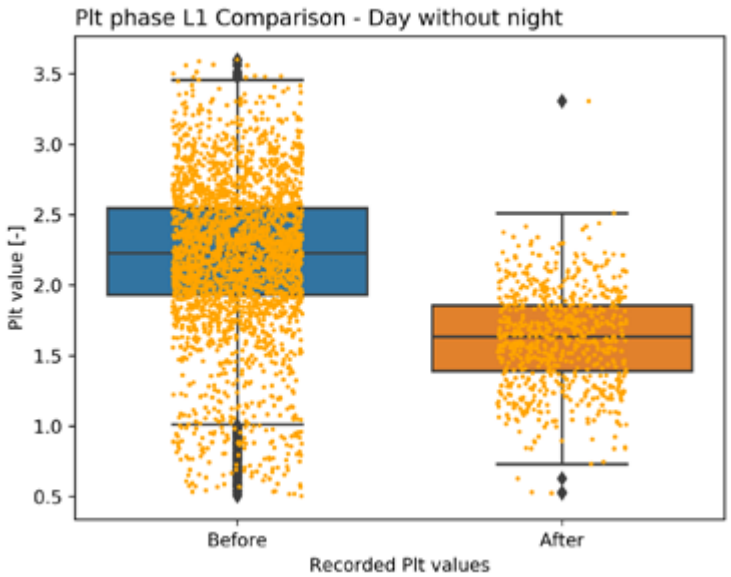




Voltage variations are influenced by the current sequence, active power (real power) and reactive power within an electrical system. Comparing these factors before and after installing the Equalizer, we see that voltage stability has greatly improved, hovering around 400V. Current has dropped by 32%, and there's been a substantial 90% reduction in kVAr from 1285kVAr to 135kVAr. As the production process at the plant completely changed in the period after the installation, it was necessary to assess the long-term flicker (Plt) by considering a full-year range. The assessment of flicker involves deriving momentary values, from which the short-term flicker "perceptibility" value (Pst) is calculated using a statistical process over a standardized 10-minute observation interval. Plt is calculated as the cubic mean of multiple Pst values over this period. A comparison between the Plt value from the year before the installation of the Equalizer and the Plt value from the year after revealed a reduction in the Short-term flicker "perceptibility" value (Pst).

Before:
Pst Q1 = 1.9
Pst Med = 2.2
Pst Q3 = 2.5

After:
Pst Q1 = 1.4
Pst Med = 1.6
Pst Q3 = 1.8



Simulation

Level	Load On	Real Values			Simulated Results	
		Voltage Welder Off	Voltage Welder On	Delta V.	Voltage Welder On	Delta V.
LV	1 Transformer	400V	374V	-6.5%	392V	-2%
	2 Transformers	400V	353V	-11.7%	380V	-5%
MV	3 Transformers	10kV	9.8kV	-2%	9.9kV	-1%
	4 Transformers	10kV	9.25kV	-7.5%	9.6kV	-3.9%

Results

EQ	KW	Current	Voltage	V. Drop	kVAr	Pst
Without	1322KW	2842A	374V	6%	1285kVAr	6.87
With	1322KW	1925A	392V	2%	135kVAr	5.2
Delta		**-32%**	**+4.8%**	**-66%**	**-90%**	**-25%**

The comparison between the results and the simulation indicates a close correspondence between the two. The successful implementation of Elspec's Equalizer system resulted in a significant reduction in voltage variation and current sequence, leading to improvements in both the Short-term flicker "perceptibility" value (Pst) and the Long-term flicker value (Plt).Voltage became stable and the ΔUmax (maximum voltage variation) was reduced to 5.2%. As a result, the flickering phenomenon was effectively mitigated, minimizing disruptions, providing a reliable electrical environment for operations and eliminating the risk of grid disconnection.

Conclusions

This case study demonstrates the positive outcomes achieved through the deployment of Elspec's Equalizer system with transient free switching technology in mitigating flickering phenomenon and underscores the advantages of utilizing continuous waveform recording for comprehensive analysis.