American Superconductor®

REVOLUTIONIZING THE WAY THE WORLD USES ELECTRICITY®

Case Study

# PQ-SVC System Solves Voltage Sag Problems for Manufacturer and Other Users of Utility Substation

## The Problem

The utility customer serves a 200-employee manufacturing plant near a small town — a manufacturer of muffler hangers for the domestic, foreign and after-sales markets. To maintain productivity, the manufacturer added large automated welders.

This produced a 12-cycle 4% voltage sag at 30-second intervals whenever the plant was operating. The utility had customer complaints from all circuits fed from the same substation. The manufacturer indicated that it would need to add another welding line to maintain competitiveness or it would have to shut down.

The area is served by a single substation, and near-term load growth did not justify construction of additional substations. The radial distribution feeders made anything other than a dedicated substation very expensive, and revenue from this customer could not justify a dedicated substation.

## The Impact of Voltage Disturbances

To quantify the negative effects of the voltage sags, the utility collected data that confirmed the frequency and duration of voltage sags. Voltage sags varied by phase for each weld, and frequently did not correlate with same-phase current. This combination of high speed, phase-independent impact and non-predictable sags required high-speed phase-independent control.

In-plant sags of 7-8% were observed affecting lighting and motor controls. However, this particular manufacturing customer was not the primary motivation for the installation of a static VAR compensator SVC system. Other utility customers served by the same substation were continually complaining.

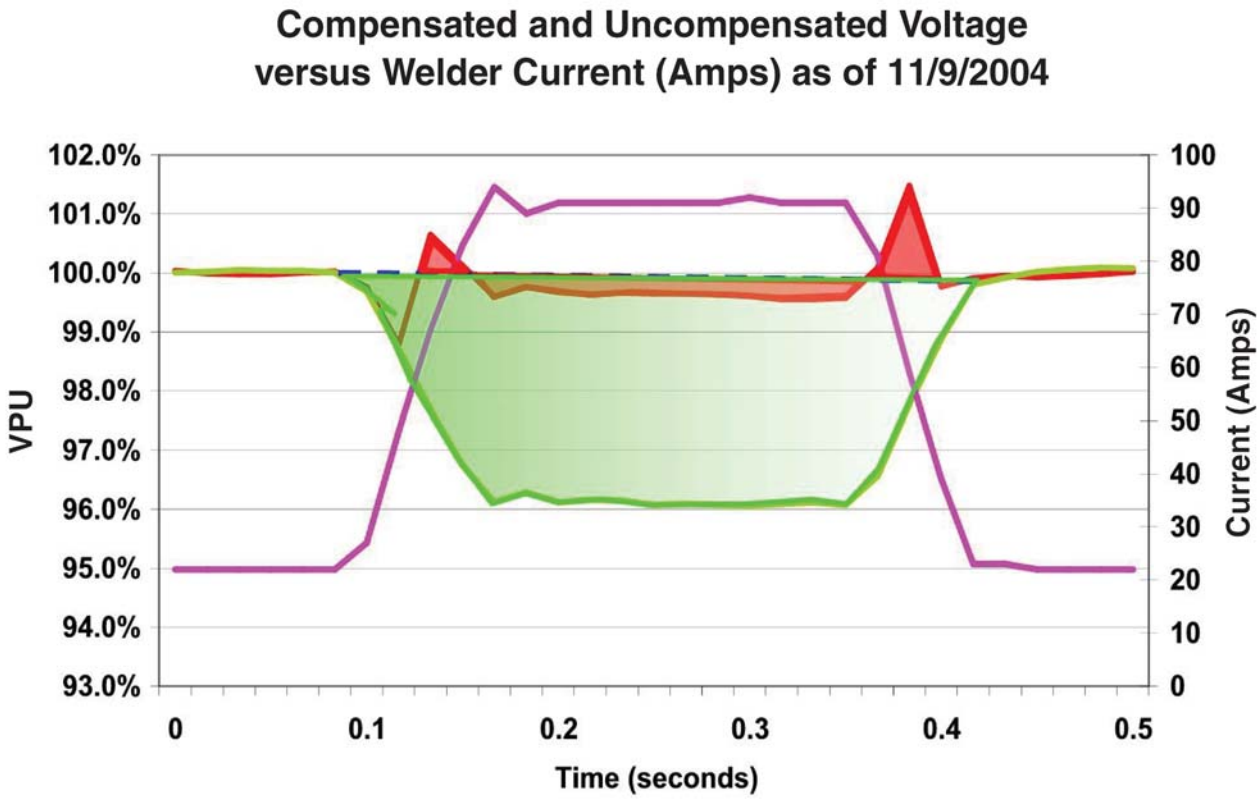
The analysis of the sag data warranted the installation of a robust power solution to keep critical equipment online.

## The PQ-SVC Solution

The PQ-SVC system proposed was a 2.2 MVAR, phase-independent, 7-step PQ-SVC for direct connection at 13200V. The PQ-SVC is optimized for phase-independent VAR support and does not require the use of harmonic filters.

- PQ-SVC cost about 1/6th of the lowest cost T&D alternative.
- An expandable PQ-SVC system will allow the end-customer to easily double operations.
- The PQ-SVC can be relocated on the utility system if end-customer ceases operation.
- AMSC modified software to meet customer requirements for custom reporting.
- Time required for set-up: ~ 1.5 days

Connection Details: The PQ-SVC system highlighted above was connected to the 13.2 KV distribution primary circuits immediately outside customer's service entrance, using a standard voltage regulator platform. The utility installed one current sensor on each phase pointing at the load (circled in red). Utility disconnect and line to ground fault protection was provided by 3 cutouts using 100A "T-type" fuses (circled in yellow).




## The Results

Since the system operates in each phase independently, the easiest way to show the effect is a single phase "compensated and uncompensated" for a single weld. Note that about 1,500 welds occur per day at the manufacturer's site.

The area shown above in red is the PQ-SVC-corrected voltage. Note that as the weld begins there is 1.1% sag for one cycle, followed by correction to within 0.5% of nominal. As the weld ends there is a one cycle "overshoot" of about 1%. On an area basis, over 92% of the sag has been eliminated.

## Empirical Observations:

| Factor | Pre-installation | Post-installation |
|---|---|---|
| Utility-side sag | 4% | < 0.65% |
| In-plant sag | 8% | < 3% |
| Customer complaints | Numerous | None |

## Conclusion

VAR support is sometimes addressed with traditional capacitor banks. These can correct power factor during steady-state operations, but can't eliminate sags or flicker or address transient operating conditions. Moreover, they increase the chances of harmonic resonance and switching transients problems. The solution is to provide the required VAR support each moment of operation — and to eliminate shortcomings of traditional VAR support.

The AMSC PQ-SVC systems provide instant support and eliminate traditional VAR shortcomings. They automatically adjust to provide the correct amount of VAR support required each cycle, thereby eliminating the reactive power component, steady voltage and near-unity power factor.

Used where electric use and plant operating characteristics change often, such as at this example at the muffler hanger plant, the PQ-SVC's transient-free, cycle-by-cycle operation eliminates voltage fluctuations, provides savings and improves plant performance and control.

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