WeldComputer
The Technology Leader in Resistance Welding

Manufacturer Study

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CLIFFORD
MACHINES & TECHNOLOGY

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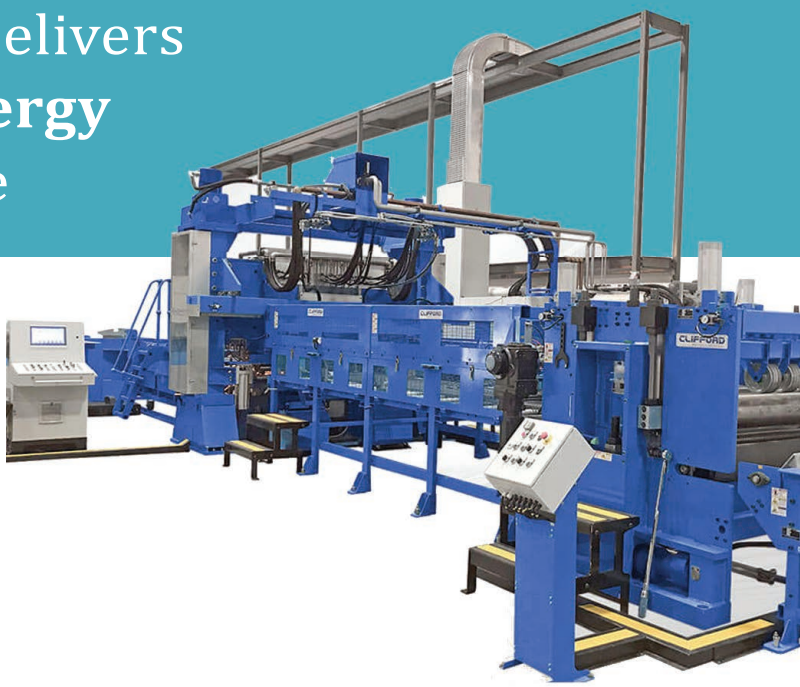

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CLIFFORD
MACHINES & TECHNOLOGY
BUILDING RELATIONSHIPS THROUGH TECHNOLOGY

OVERVIEW

South African equipment manufacturer **Clifford Machines & Technology** conducted an independent study that uncovered 45% energy savings after utilizing the advanced WeldComputer Adaptive Control as a replacement for their standard SCR control. By making the switch to WeldComputer, Clifford was able to drive their existing AC transformers, provide a balanced load across a Three Phase power line, achieve high energy efficiency, and take advantage of inverter technology to get better current regulation - all from simply changing their resistance welding control. All data in this report was provided by Clifford Machines & Technology. This report showcases the findings and results in detail.

BACKGROUND

For over 50 years, South African company Clifford Machines & Technology (Clifford) has specialized in industrial welding, grating, and wire working equipment. Throughout the company's long tenure in the manufacturing industry, Clifford has used a Single Phase SCR technology control driving 2, 3, or 4 big AC transformers.

As a company interested in always providing exceptional welding equipment, Clifford realized that modern resistance welding advances have moved the industry beyond the traditional SCR control. Due to their inefficient and poor performance—especially when it comes to handling power line fluctuations—Single Phase SCR controls have been replaced by new technology.

In an effort to modernize their equipment and solutions for their customer, Clifford evaluated multiple solutions to upgrade their technology. Their search was motivated by four factors:

- drive the AC transformers in their equipment,
- provide a balanced load across a Three Phase power line,
- find a solution for better energy efficiency, and
- achieve better current regulation that ensures welding is immune from power line fluctuations.

A potential solution could be to use an MFDC transformer; however, their team found that there were additional challenges related to the MFDC transformer's structural integrity. Most MFDC transformers Clifford tested failed to survive in the industrial environment due to their delicate design.

The second solution was to evaluate the WeldComputer AC Inverter wave synthesis technology. To conduct this analysis, Clifford's team compared the WeldComputer Adaptive Control against their existing PWC2 SCR control using the weld size as a benchmark. In doing so, the benefits of using the WeldComputer Adaptive Control were clear.

Using a WeldComputer Adaptive Control to drive their resistance welding equipment, Clifford machines are able to achieve superior weld consistency, significant energy efficiency benefits, and balancing of the power across three power line phases - something commonly associated with MFDC.

METHOD

Clifford tested the WeldComputer Adaptive Control against their existing SCR control. This test was conducted using WeldComputer's 250,000-watt power assembly (WC-400) by the Clifford team in the Clifford facility. The purpose of this test was to focus on measuring and comparing energy efficiency of the two systems when making the same size weld.

Clifford used the following parameters for both tests to evaluate the difference in each control's power consumption and energy efficiency:

- Both tests were conducted using the same machine with control settings made to achieve comparable welding results between the PWC2 SCR control and the WeldComputer Adaptive Control.
- The Squeeze, Weld and Hold timing of each stage were set as closely as possible to match on the two controls.
- Each system was tested with 7 samples. These sample welds were done by welding together two intersections of 6mm galvanized wire, with 2 joints each.
- The cylinder pressure to clamp the parts to be welded was set to 6.4bar for the tests performed. The high clamping pressure was used to reduce surface resistance variability in the test samples.
- All tests were captured on an Elspec Power Quality Meter (BlackBox), which took 512 samples per cycle on all line voltages and currents. The results from the meter were used to make the comparison.

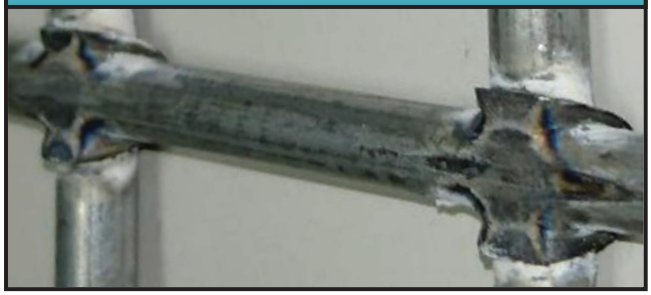
THE DATA

Below are results of tests that the Clifford team performed with comparisons of the SCR control with the WeldComputer Adaptive Control.

SCR Control

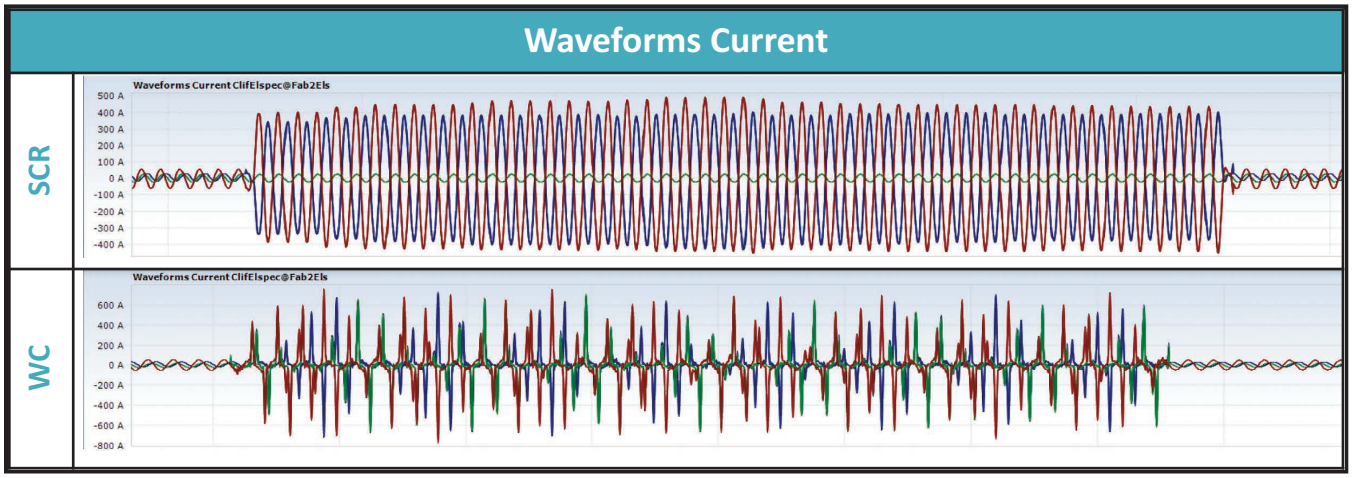
The Clifford PWC2 is a standard SCR-based Single Phase AC control.

WeldComputer Adaptive Control



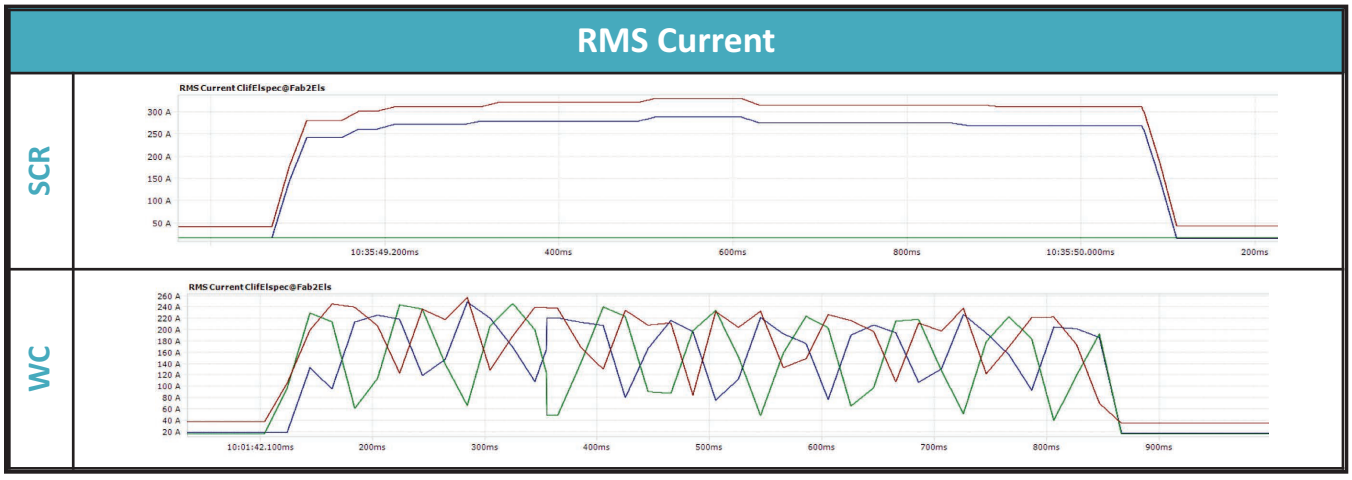
The WeldComputer Adaptive Control is a current adaptive IGBT control, utilizing all 3 phases.

ELECTRIC ANALYSIS DATA



SCR results: *Only 2 phases are used. No abnormal distortion is visible during the weld.*

WeldComputer results: *All phases are used. No abnormal distortion is visible during the weld.*

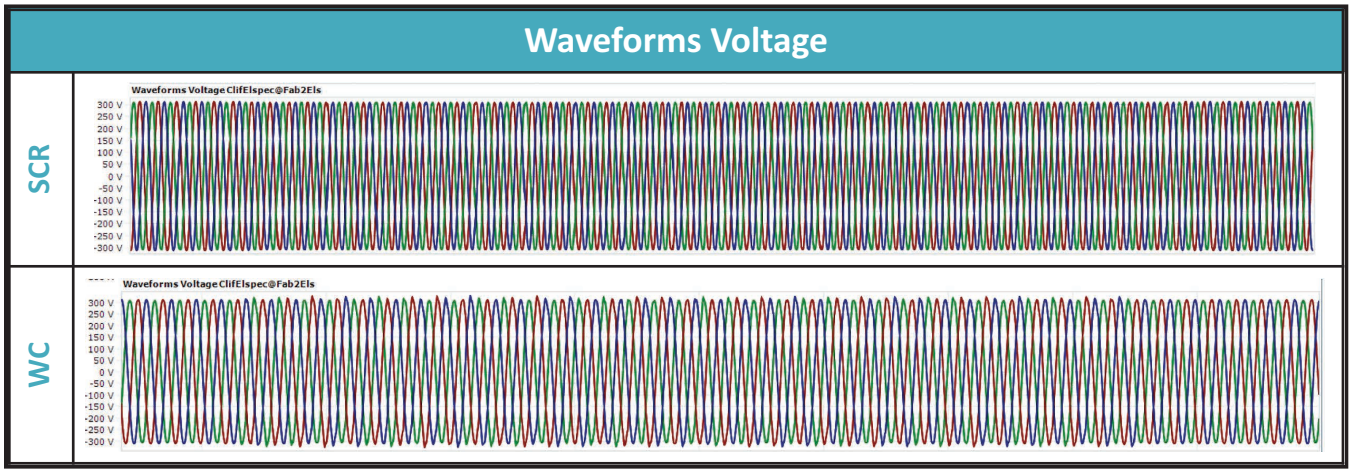


SCR results: *The RMS current on average was 315A.*

WeldComputer results: *The RMS current on average was 180A.*

Take Away: *WeldComputer uses 42.8% less amps for the same weld.*

Waveforms Voltage

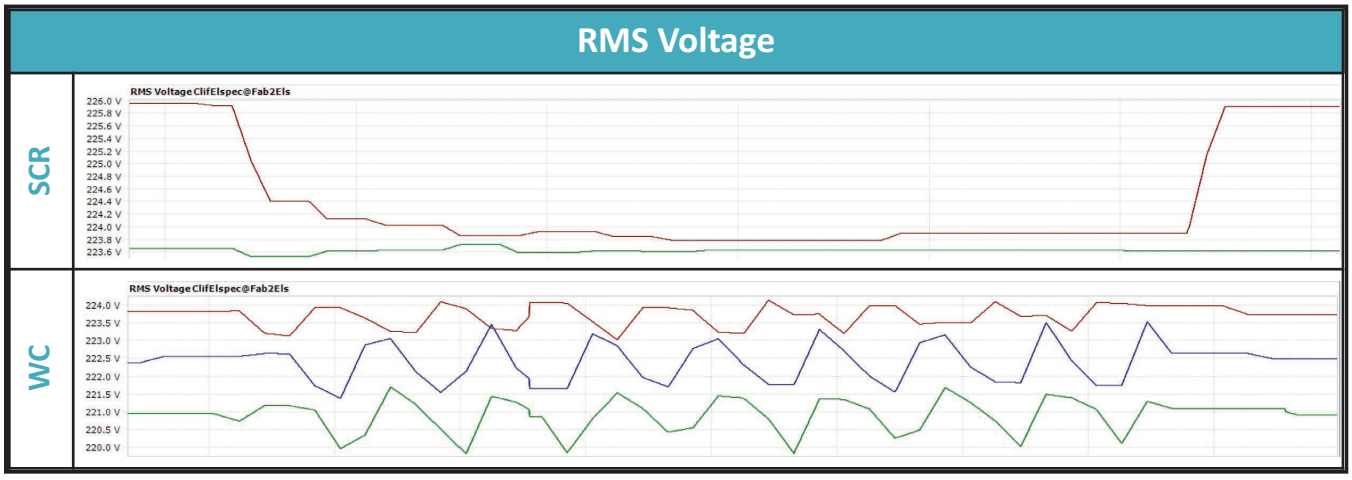


SCR results: *There were no significant voltage fluctuations and the waveform is not showing abnormal sinus distortion.*

WeldComputer results: *There were no significant voltage fluctuations and the waveform is not showing abnormal sinus distortion.*

Take Away: *No significant differences in voltages.*

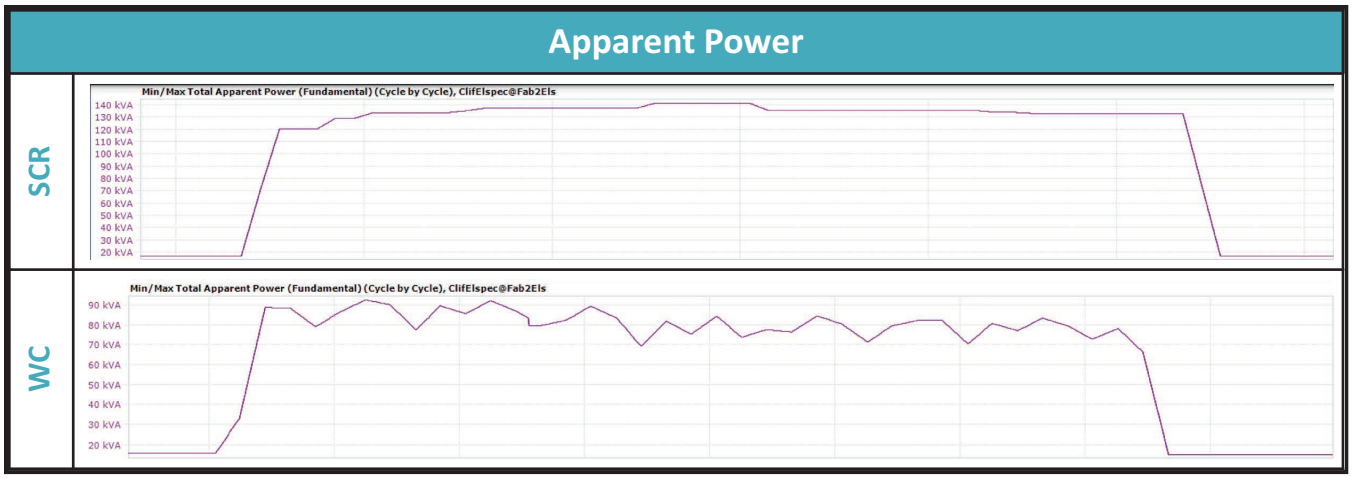
RMS Voltage



SCR results: *2 VRMS fluctuation measured.*

WeldComputer results: *1.5 VRMS fluctuation measured.*

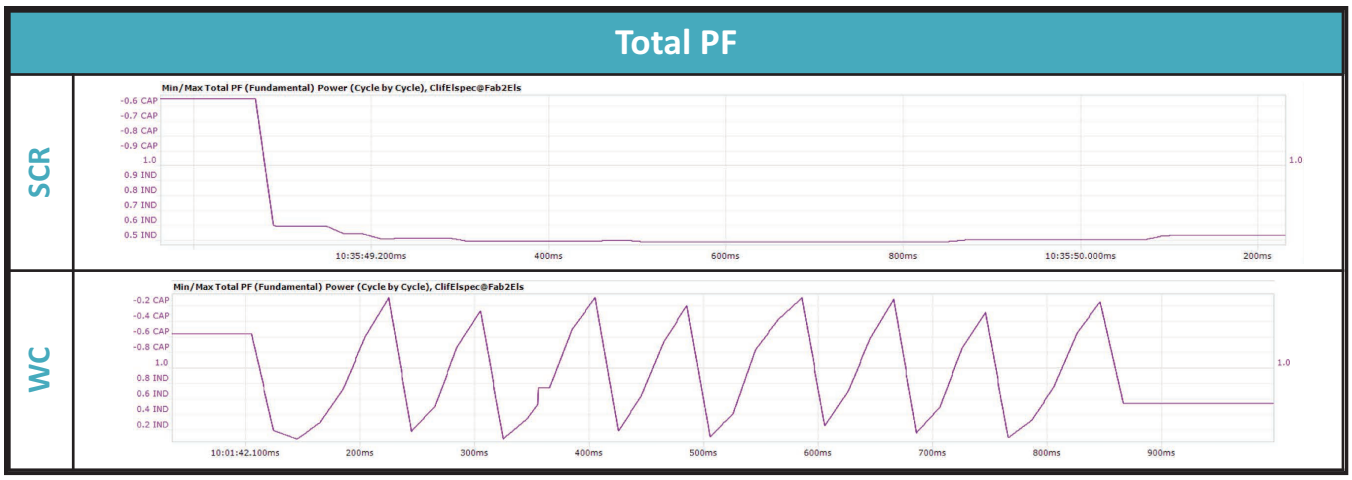
Take Away: *Voltage fluctuation on the power line was lower for the WeldComputer Adaptive Control.*



SCR results: *The average apparent power was 142kVA.*

WeldComputer results: *The average apparent power was 81kVA.*

Take Away: *WeldComputer uses 43% less energy for the same weld.*



SCR results: *The Power Factor (PF) dropped to 0.42 for a sustained period of time during the weld, and remained below 0.6 throughout the entire weld. A value much less than 1 indicates low energy efficiency.*

WeldComputer results: *The PF remained at an average of ~1 throughout the weld, indicating high energy efficiency.*

Take Away: *The SCR control has a relatively low PF, and therefore there is a high amount of energy/power wasted. Some of this energy loss can be seen as heat generation in the stack and the temperature rise on the transformer. The WeldComputer control is operating at almost 100% efficiency.*

ELECTRICAL COMPARISON RESULTS

To interpret these results we need to first clarify some basic units of electrical measurement:

- **Amps (A)** is a measure of how much electric current is flowing to the machine.
- **Kilovolt-ampere (kVA)** is a measure of "apparent" power. This tells us how much power is being consumed by the machine. A lower reading means the machine draws less power overall.
- **Kilowatt (kW)** is often called real power or working power. In other words, this is the amount of power that is converted into useful output to do work.

- **Power Factor (PF)** is a measure of electrical system energy conversion efficiency. A Power Factor of 1 means the system is working at 100% efficiency. All of the energy received from the power company is being converted into useful work and none of the power is being wasted. A Power Factor of 0 means the system is working at 0% efficiency. All of the energy received from the power company is being thrown away and none of it is being used by the machine to perform useful work.

Clifford's test comparison yielded the following results:

Parameter	Description	Current Control (Clifford PWC2)	WeldComputer
A	Measure of current flow	315	180
kVA	Measure of "apparent" power (amount a machine will draw/consume)	142	81
PF	Measure of real power utilization (how efficiently is power used)	0.42	~1.00

CONCLUSION 1

WELDCOMPUTER ADAPTIVE CONTROL DRAWS 42.9% LESS CURRENT TO ACHIEVE THE SAME WELD.

The WeldComputer Adaptive Control significantly reduces the current draw on the factory power lines. It draws only 180 amps on the power lines to make the same size weld that takes 315 amps with the PWC2 control. This allows factories to reduce flicker on the power lines and use less costly lower amperage service supplying power to the machine.

CONCLUSION 2

WELDCOMPUTER ADAPTIVE CONTROL DRAWS 43% LESS KVA FROM THE POWER COMPANY TO ACHIEVE THE SAME WELD.

The WeldComputer Adaptive Control significantly reduces the amount of energy that is needed to make each weld. It requires only 81kVA from the power company to make the same weld that consumes 142kVA with the PWC2 control. This equates to a corresponding reduction in the monthly power bill to operate the machine.

CONCLUSION 3

WELDCOMPUTER ADAPTIVE CONTROL HAS NEARLY 100% ENERGY CONVERSION EFFICIENCY.

The most important measure here is the Power Factor (PF) which indicates the percentage of power drawn from the power company that's actually transferred to the machine. The results show that the WeldComputer Adaptive Control optimized the real power utilization and provided almost perfect power conversion efficiency to the weld machine. Combined with using fewer amps and drawing less power, the WeldComputer Adaptive Control offered Clifford a valuable solution to reduce the power consumption on their resistance welding equipment, lowering the cost to run the machine, while improving the performance and quality of the welds produced.

CLIFFORD'S CONCLUSION

The results from Clifford's testing show that "WeldComputer is roughly 45% more efficient to obtain the same [welding] results. If energy consumption/efficiency and overall reticulation balance are driving factors in a design, the WeldComputer [Control] is really the controller to use."

TAKE-AWAYS

The report can be summarized by three findings:

WELDCOMPUTER'S INVERTER TECHNOLOGY IS A ROBUST AND RELIABLE SOLUTION TO HANDLE THE CONSIDERABLE POWER AND WORKLOAD DEMANDED BY THE CLIFFORD GRATING WELDERS.

The report demonstrated that the WC-400 inverter maintained energy efficiency, balanced across three power line phases, and proved the viability to reliably deliver highly efficient and consistent performance to their heavy-duty welders.

When applied to the full scale and power of a typical Clifford grading welder, the WeldComputer power supply would meet and exceed the performance criteria required by Clifford. To put in perspective the power of a single Clifford welder, consider there are 6,500 windows in the Empire State Building. If you put fifteen 30 watt lightbulbs in every window (97,500 total bulbs), the power level delivered by the WeldComputer power supply to the Clifford grating welder is the equivalent of what would be needed to light up the Empire State Building like a Christmas tree, and have the capability of adjusting the brightness 8,000 times per second! So when dealing with high power levels like this it's easy to see how improving the energy efficiency by 45% translates into substantial savings.

WELDCOMPUTER IS ABLE TO DELIVER HIGHER-QUALITY WELDS THAN A SCR CONTROL.

The control makes dozens of adjustments every cycle to deliver consistent current to every weld that is invariant of power line fluctuations. The more consistent current makes more consistent welds. The Clifford report cited that, not only does the WeldComputer Adaptive Control operate with three phases, compared to the existing control that welds with two phases, using the WeldComputer Adaptive Control, the "weld strength and quality improves greatly."

WELDCOMPUTER PROVIDED EXCEPTIONAL ENERGY SAVINGS AND ROI IMPACT.

Clifford proved there were incredible cost savings in energy efficiency by using the control provided by the WC-400. The report determined that "current consumption was almost halved when weld tests were done using the PWC2 (existing SCR control) and WeldComputer [Control]," further quantifying that the "WeldComputer [Control] is roughly 45% more efficient to obtain the same results."

The report continued, "If energy consumption/ efficiency and overall reticulation balance are driving factors in a design [for a resistance welding solution], the WeldComputer [Control] is really the controller to use."

So how else does this system translate into actual bottom-line impact? One Clifford customer shared that their power company had previously required them to purchase a capacitor bank, at a cost of $250,000, to perform the power factor correction needed to allow them to operate the traditional inefficient SCR control on two phases. With the WeldComputer Adaptive Control, expenditure on power factor correction equipment is no longer necessary. This savings alone pays for the WeldComputer Adaptive Control instantly. When considering the benefits of more consistently higher quality welds at a fraction of the monthly power bill, the ROI impact makes this the clear control choice for the grating welders.

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