WILSON POWER SOLUTIONS
Responsible Power Engineering

Smurfit Kappa


SUPER LOW LOSS AMORPHOUS

# TRANSFORMER REPLACEMENT PROJECT

## PROJECT SUMMARY

Smurfit Kappa are a global leading paper based packaging manufacturer with a strong sustainability agenda. Following an energy efficiency review, their Stalybridge production site was identified as being able to benefit from voltage management. With the supply transformer owned by the company, the decision was made to replace the existing transformer with a modern super low loss amorphous unit that would provide savings through reduced transformer losses as well as reduced supply voltage to site.

The installation of the Wilson e2 Super Low loss Amorphous Transformer, combined with a 5.9% voltage reduction, has significantly reduced the kWh used at the Stalybridge site. The projected annual savings (based on £0.09/kWh) are in excess of £10,500 per annum. The payback on the total investment including transformer purchase and installation will be achieved in under three years.

**99176**
**ANNUAL KWH SAVINGS**

**PAYBACK**
**£10,500**
**ANNUALLY**

Based on electricity costs of £0.09 /kWh

# INSTALLATION BENEFITS AT A GLANCE

1. ELECTRICITY USAGE REDUCED BY 3.5%
2. ANNUAL SAVINGS OF 99,176 KWH (~£10,500)*
3. SITE VOLTAGE REDUCED FROM 244V TO 230V
4. IMPROVED POWER FACTOR

## OUR FINDINGS

The measurements show that the installation of the Super Low loss Amorphous Transformer, combined with a 5.9% voltage reduction, has reduced the kWh used.

- The measurements taken before installation and those with the super low loss transformer on tap 3 show a 3.5% reduction in kWh. On a projected usage of 2,861,652kWh prior to installation, the savings are estimated to be 99,176kWh p.a.
- The kWh reduction can be trended long term using the electricity supplier's half hourly averaged value data.
- The reduction in voltage has also improved the site power factor.

## THE SCOPE

Following the installation of a Super Low Loss Transformer at site, an energy efficiency and power quality survey was conducted to quantify the energy savings. This report presents the recorded Power before and after the new transformer was installed.

Many aspects of power quality and energy efficiency are interrelated so due diligence requires a comprehensive assessment to represent the best interests of the end customer.

Power analysing monitoring equipment was connected at the main incoming LV supply and left in situ for 7 days. The data shows the before and after installation readings.

*Based on electricity costs of £0.09 /kWh

# GENERAL INFORMATION

## VOLTAGE

The voltage supplied to many sites is higher than it needs to be. The network operator often keeps the Primary Voltage high to reduce transmission losses while keeping the voltage within statutory limits for all customers on the network.. In 2008 the final stage of the European Voltage Harmonisation came into place setting the voltage levels to 230V ± 10% (see Appendix A); the statutory limits for voltage are now from 207 to 253V phase-neutral.

Most sites have a L-N voltage of 240V or higher giving rise to equipment running at inappropriate levels resulting in additional costs. Reducing and maintaining the voltage at the most favourable level is an established way to significantly reduce energy consumption and costs whilst having the additional benefits of reduced maintenance and increased equipment life.

## POWER EFFICIENCY

The efficiency of a supply is expressed as a 'power factor' (pf) where 1.0 (unity) is ideal and anything below 0.95 is highly likely to attract significant penalty charges. Power Factor Correction (PFC) equipment is installed to ensure that the pf is automatically maintained above the charging threshold of 0.95. The correct type and rating of this equipment is based upon the total power, the uncorrected pf, and levels of harmonic currents.

# LOAD SUMMARY

## PRE WORKS SURVEY WITH PREVIOUS STANDARD TRANSFORMER

| | Amps | | | | kVA | kW | kvar | PF |
|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | N | | | | |
| Max | 876.8 | | | | 644.7 | 640.8 | 70.5 | 0.99 |
| Min | 107.8 | | | | 78.8 | 75.1 | 23.9 | 0.95 |
| Average | 448.2 | | | | 327.3 | 326.7 | 20.7 | 1.00 |

* Power Factor given at stated kVA value
** It was only possible to measure L1, however the loads were well balanced

| | Volts | | |
|---|---|---|---|
| | L1-N | L2-N | L3-N |
| Max | 248.8 | 249.5 | 249.8 |
| Min | 238.4 | 238.7 | 239.3 |
| Average | 244.0 | 244.6 | 245.0 |

| Recorded Energy | 7 Day | Year |
|---|---|---|
| kWh | 54,881 | 2,861,652 |
| kvarh | 3,476 | 181,249 |

## AFTER NEW TRANSFORMER INSTALLATION

| | Amps | | | | kVA | kW | kvar | PF |
|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | N | | | | |
| Max | 882.3 | | | | 618.4 | 614.7 | 67.6 | 0.99 |
| Min | 68.8 | | | | 47.7 | 47.2 | 6.7 | 0.99 |
| Average | 457.1 | | | | 316.0 | 315.4 | 20.0 | 1.00 |

* Power Factor given at stated kVA value
** It was only possible to measure L1, however the loads were well balanced

| | Volts | | |
|---|---|---|---|
| | L1-N | L2-N | L3-N |
| Max | 233.7 | 234.5 | 235.9 |
| Min | 224.9 | 225.4 | 226.4 |
| Average | 229.5 | 230.2 | 231.3 |

| Recorded Energy | 7 Day | Year |
|---|---|---|
| kWh | 72,063 | 3,757,571 |
| kvarh | 21,296 | 1,110,434 |

## LOAD SURVEY CONTINUED...

### VOLTAGE OPTIMISATION SAVINGS

The reduction to Tap 3 (11000/417V Transformer) shows a saving of 3.5% which equates to 99,176kWh (£10,500 gross), based on the yearly kWh estimated in 2.1 above.

### VOLTAGE OPTIMISATION

- Minimum Voltage Recorded (Substation) – 224.9V

- Minimum Voltage Recorded (Furthest Electrical Point) - 221.9V

Super low loss amorphous transformer tap setting options
Currently set to Tap 3.

| Tap | Lowest Voltage* | Saving | |
|---|---|---|---|
| 6 | 236.9 | - | - |
| 5 | 231.3 | - | - |
| 4 | 225.6 | - | - |
| 3 | 221.9 | 3.5% | Measured |
| 2 | 214.3 | - | - |
| 1 | 208.7 | - | - |

*Minimum recommended for loads is 220V

### FINANCIAL SAVINGS

| Substation Details | Tap Settings | Transformer Size | Transformer Load Factor |
|---|---|---|---|
| TX1 | 3 | 1000kVA | 32.7% |

| No Load Loss Annual Saving (per annum)* | Load Loss Annual Saving (per annum)# | Voltage optimisation Annual Saving | CRC Saving | Total Annual Saving |
|---|---|---|---|---|
| £670 | £413 | £8,926 | £507 | £10,516 |

* Using a super low loss transformer
#All monetary values are based on 9p/kWh

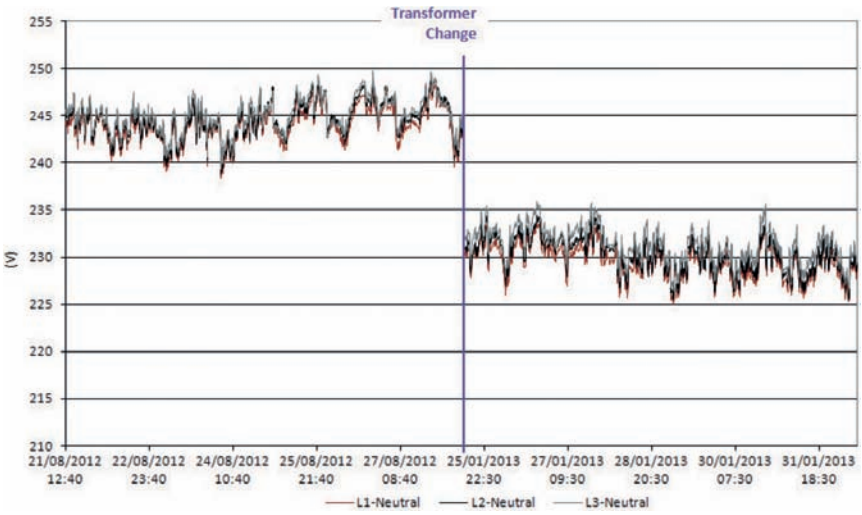
# RECORDED POWER DATA

The following results show the electrical characteristics present for the before/ after period.

V

### VOLTAGE DATA

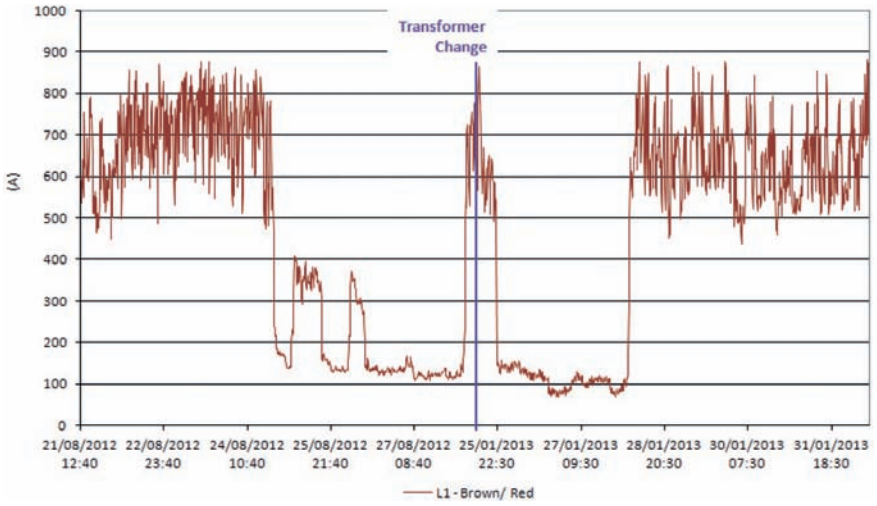
The following graph details the recorded RMS voltage for the supply.



V

## CURRENT DATA

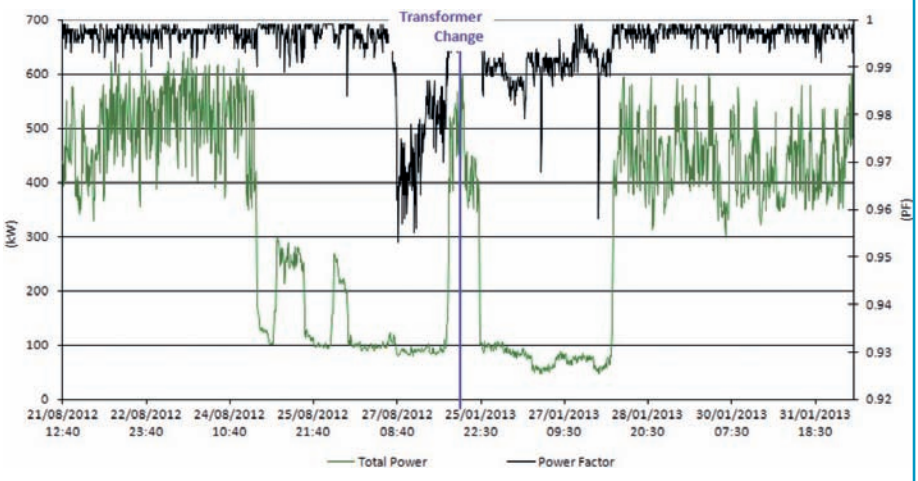
The following graph details the recorded RMS voltage for the supply.




kW

## POWER DATA

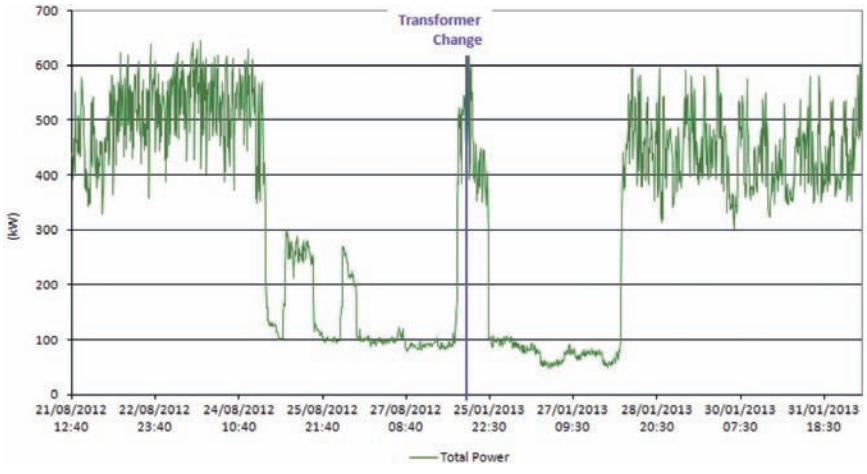
The following graph details the recorded total power during the period of the survey.




kW

## AVERAGE POWER DATA

The following graph details the recorded total half hour average power during the period of the survey.



# APPENDIX A

Up until January 1995 the nominal supply voltage in the UK was 240/415V +/- 6%. In Europe the nominal standard was 220/380V +/- 6%.

Following European harmonisation standards coordinated by The European Committee for Electro-technical Standardisation (CENELEC) , all electricity supplies within the EU are now nominally 230V +/-10% . The statutory band that electricity network operators have to supply within is therefore between 216.2 and 253V for single phase and 380V to 440V for three phase. Customers can expect to remain within these limits except in abnormal circumstances, which are described in the Grid Code.

These limits enable countries such as the UK who previously supplied at 240V nominal to continue, thus reducing the need for considerable investment in distribution infrastructure to accommodate the new nominal voltage. The continued deviation in the UK from harmonised European voltage has been criticised in particular by light bulb manufacturers. The higher voltage reduces significantly the lifetime of their product.

The next stage in the European harmonisation process took place in 2008, when the voltage supply range in the UK broadened to 207 and 253V (+/-10%) . Most equipment manufactured for use in Europe is typically rated at 230V (or even 220V) meaning that it could be running as much as 33V above the supplied voltage.

WILSON POWER SOLUTIONS
Responsible Power Engineering