

AIREDALE

STANDARD REPORTING METHOD
FOR PROBLEM SOLVING

6-PANEL



ENERGY SAVINGS - ELECTRICITY

Project Leader: Kevin Makin
Project Champion: Tony Cole
Process Owner: Arif Shahab
Organization: Airedale
Project Location: Leeds

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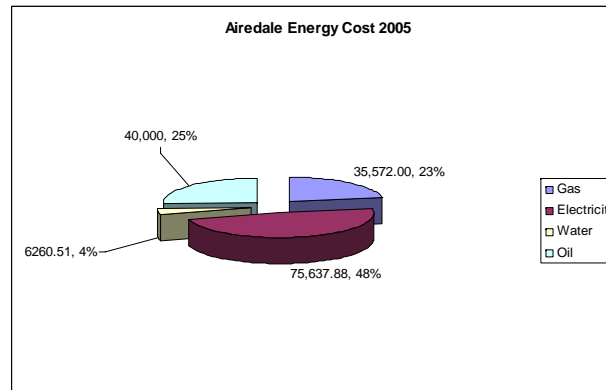
	Plant Energy Use	Leeds Operations
Cost Objective/Environmental Impact		BB – K.Makin

PROJECT CLASSIFICATION:

Cost : Linked to Presidents Initiative, plant tasked to reduce energy cost by 12% in 2006.

Environment : Aligned to local objectives - 1kWh consumption produces .43kg Co2.

TREND CHARTS and BREAKDOWN OF ISSUE: 2005 Data



Utility	Cost £
Gas	33,572
Electricity	75,637
Water	6260
Oil	40,000
Total	115,469

VOICE OF THE CUSTOMER: In 2005 at the Leeds facility the cost of electricity was £75637 – Due to a rise in the cost of the utility our YTD spend is up to £128444(31st August).

CTQ STATEMENT (Customer Requirement): Reduce energy consumption in line with Presidents Initiative.

DEFECT DEFINITION for Y (Engineering Metric): Electricity use not to exceed 57.33 kWh/1000€ sales.

PROBLEM STATEMENT, SCOPE, AND GOAL:

A 12% reduction in energy consumption is required at Airedale Leeds, in line with the Presidents initiative. This project has been scoped to investigate electricity use.

$Y=f(x)$

Policy Deployment = (Safety, Quality, Volume, Cost, Environment)

Big Y

Environmental/ Cost Objectives =(Production waste ,Scrap, Utility usage)

Small Y

Utility usage = **Gas, Water, Electricity**

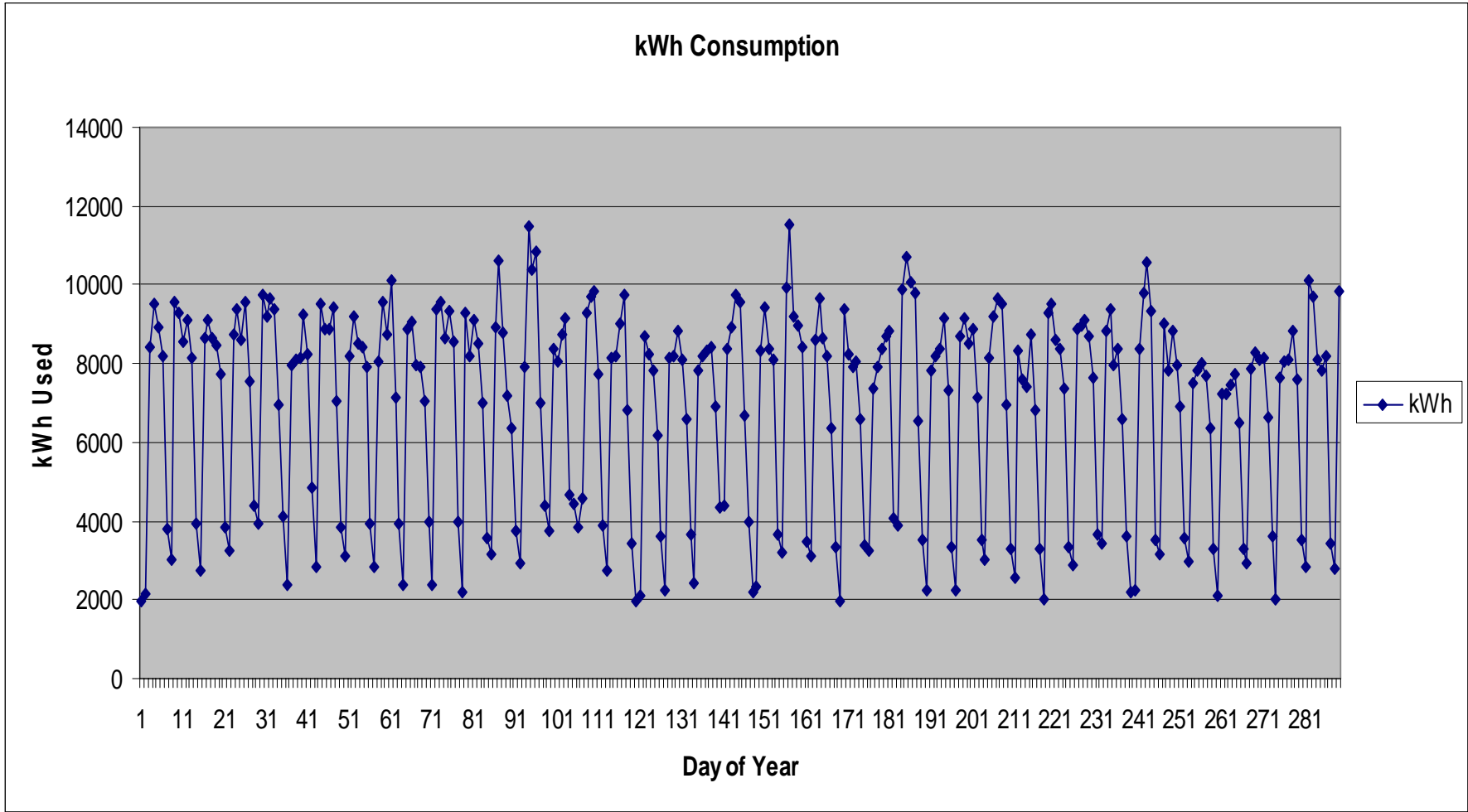
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kWh CONSUMPTION 2006



Facility daily electricity consumption - 2006

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BASELINE YEAR 2005/2006



David B. Rayburn
President and
Chief Executive Officer

Modine Manufacturing Company
1500 DuSoyan Avenue
Racine, Wisconsin 53403-2552

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Fax 262.636.8472
d.b.rayburn@na.modine.com

October 27, 2004



Energy Conservation
Presidential Initiative

Energy Conservation Initiative

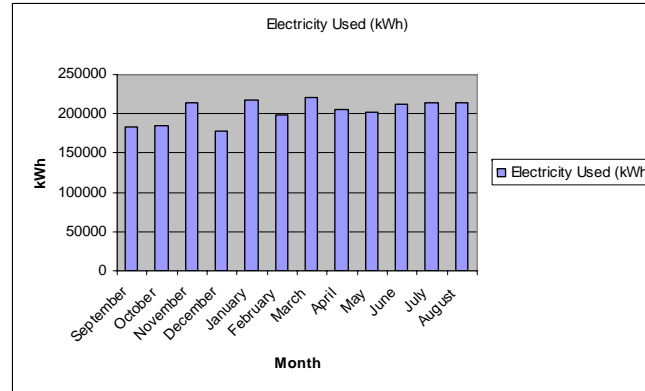
Modine's Environmental Policy states our commitment to minimize the impact of our manufacturing operations on human health and the environment and to implement economical improvements for environmental protection. This commitment includes our pursuit of opportunities to conserve resources, prevent pollution and eliminate waste.

The burning of fossil fuels for generating heat and electricity has a significant impact on the earth's environment. The consumption of these fuels and the resulting impact on global warming is the subject of considerable study and concern throughout the world. Modine's world-wide locations emit greenhouse gases with an associated annual energy cost approaching \$19 million.

In keeping with our Company's commitment to reducing our impact on the environment, I am introducing the President's Initiative for Energy Conservation. This initiative joins the First Pass Yield and Scrap Reduction Initiatives that are currently in place. I am challenging each of you to reduce energy use by 12% over the 2003-04 baseline year. If all facilities successfully meet this challenge, the environment would benefit from a reduction in greenhouse gas emissions, and Modine would benefit from a \$2.3 million annual cost savings.

You will be receiving more details of this initiative from the corporate Environmental Engineering and Facilities Engineering Departments. I encourage all locations world-wide to place a high level of emphasis on this initiative and am confident that we can concurrently benefit the environment and become a more efficient organization.

David B. Rayburn



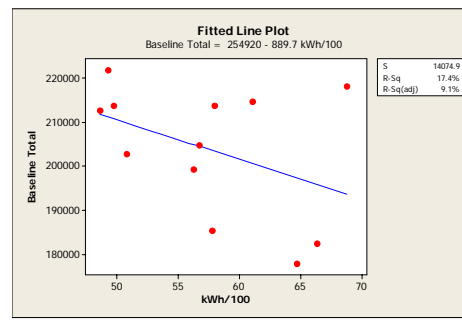
← Electricity used
2005-2006

Month	Electricity Used (kWh)	Electricity Used (kWh/1000€)
September	182407	66.37
October	185385	57.81
November	214688	61.07
December	177965	64.73
January	218017	68.81
February	199255	56.29
March	221674	49.23
April	204826	56.73
May	202749	50.75
June	212666	48.62
July	213623	57.96
August	213618	49.69

← kWh/1000€
sales

Baseline for 2005-2006
57.33 kWh/1000€ sales

The President's initiative tasks each plant with reducing energy consumption by 12%. The baseline year for Leeds is September 2005-August 2006. The electricity and gas figures are combined to give an overall figure based on kWh/1000€ sales. For the purpose of this project only electricity figures are shown.



Regression analysis shows that there is a weak negative relationship between electricity consumption and sales

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BMP Project Status

Priority	1	2	3	4	5	6	7	8	9	10	11	12	13	
BMP Name <small>(Click on each of the BMP names for additional information)</small>	Conduct Compressed Air System Leak Survey & Correct ID'd Leaks	Institute Energy Standby / Shut-Down Procedure (for non-operating periods)	Institute Weekend Equipment Standby/Shutdown Procedures	Conduct Employee Energy Training and Communicate Energy Goals	Install Programmable HVAC Thermostats or Controls (Offices, Lunchrooms)	Conduct Plant-Wide Energy Survey	Conduct Lighting Survey (incl. bulbs & ballasts). Install Motion Sensor Office Lighting (automated on/off)	Install Automated Process Equipment Shutoff	Conduct Compressed Air Survey, supply & demand assess. plant-wide operating pressure	Retrofit Make-up Air Units with Modulating Gas Valves* (*may not be applicable at all facilities)	Institute Make-up Air Unit Shutdown (dependent on plant-wide air balance)* (*may not be applicable at all facilities)	Conduct Unit Heater Rationalization Survey* (may not be applicable at all facilities)	Tune Up Combustion Units in boilers, evaporators, AC Units* (*may not be applicable at all facilities)	Other Plant Projects and Comments
Typical Investment	Low	Low	Low	Low	Moderate	Moderate	Low-Moderate	Low-Moderate	Moderate	Moderate	High	Low	Low	Low-Moderate
Potential Return	High	High	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	High	Moderate	Low-Moderate	Low-Moderate	Moderate
Capital Expense	Expense	Expense	Expense	Expense	Capital	Expense	Capital	Capital	Expense	Capital	Expense	Expense	Expense	
Americas	Buena Vista	Complete	Complete	Complete	Complete	12/15/06	Complete	Complete	12/15/06	Complete	Complete	Complete	Complete	Click Here
Americas	Camdenton	Complete	November 15, 06	December 15, 06	October 31, 06	Complete	Complete	January 31, 07	Complete	NA	NA	December 31, 06	January 31, 07	Click Here
Americas	Clinton	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	Harrodsburg P	9/30/2006	Complete	Complete	Complete	Complete	09-Jun	Complete	Complete	Complete	Complete	11/01/2006	Complete	Click Here
Americas	Jackson	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	Jefferson City	9/29/06	12/29/06	Complete	Complete	Complete	Complete	Complete	Complete	Complete	10/31/06	Complete	Complete	Click Here
Americas	Joplin	Complete	Complete	Complete	09/01/2006	Complete	12/01/2006	Complete	01/01/2007	Complete	Complete	Complete	Complete	
Americas	Lancaster	Complete	Complete	Complete	Complete	9/29/06	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Click Here
Americas	Lawrenceburg	Complete	9/30/06	9/30/06	8/31/06	9/30/06	Complete	9/30/06	Complete	10/31/06	Complete	10/31/06	Complete	Click Here
Americas	Logansport	Complete	Complete	Complete	Complete	10/31/06	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	McHenry P.I.	Complete	Complete	Complete	Complete	Complete	8/31/06	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	Nuevo Laredo	02/06/2007	Complete	Complete	11/27/06	Complete	12/01/2006	10/31/06	02/06/2007	10/06/2006	N/A	11/15/06	N/A	1/13/07
Americas	Pemberville P	Complete	Complete	Complete	Complete	Complete	Complete	Complete	6/15/2007	Complete	Complete	Complete	Complete	4/15/2007
Americas	Racine	12/07/2006	01/01/2007	Complete	11/01/2006	Complete	Complete	Complete	Complete	Complete	n/a	Complete	01/01/2007	01/01/2007
Americas	Radiadores Vi	week 42/2006	Complete	Complete	week 42/2006	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	Richland	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Americas	Toledo	Complete	Complete	Complete	Complete	Complete	10/30/06	Complete	Complete	Complete	N/A	N/A	N/A	Click Here
Americas	Trenton P.I.	Complete	Complete	Complete	10-Jun	Complete	Complete	Complete	10-Jun	Reeval 10/06	Complete	Eval 11/06	Eval 1/07	Complete
Americas	Washington	Complete	Complete	Complete	10/15/06	Complete	Complete	Complete	11/01/2006	Complete	Complete	11/01/2006	Complete	Click Here
Americas	West Kingstor	Complete	Complete	Complete	10/30/06	Complete	10/30/06	2007	2007	10/30/06	Complete	Complete	2007	
Asia	Asan City	Complete	Complete	Complete	Complete	Complete	31/05/2007	Complete	Complete	30/11/2006	Complete	NA	Complete	Click Here
Asia	Shanghai	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Europe	Ashington	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Europe	Berndorf	Complete	Complete	Complete	Complete	Complete	week 47/06	week 50/06	week 08/07	Complete	n.a.	Complete	n.a.	n.a.
Europe	Bontanden	Complete	Complete	Complete	Week 44	Complete	Complete	Complete	Complete	Complete	not applicable to check kW 35	Complete	not applicable to check kW 35	Complete
Europe	Kirchentellinsf	Complete	Complete	Complete	Complete	not applicable	Complete	Complete	Complete	Complete	Complete	Complete	Complete	
Europe	Leeds	Complete	Complete	Complete	31/10/2006	31/10/2006	Complete	30/11/2006	31/12/2006	Complete	Complete	Complete	31/12/2006	Click Here
Europe	Mezokovesd	Complete	not applicable	not applicable	Complete	Complete	Complete	Complete	Complete	Complete	N/A	not applicable	12/31/06	not applicable
Europe	Neuenkirchen	Complete	n/a	n/a	31.11.06	31.10.06	31.12.06	31.11.06	n/a	Complete	Complete	31.12.06	31.12.06	31.12.06
Europe	Pleizhausen	Complete	Complete	Complete	Complete	Complete	week 43/06	week 43/06	week 43/06	Complete	Complete	Complete	Complete	Click Here
Europe	Ponteviso	Complete	Complete	Complete	W39/06	Complete	W44/06	Complete	Complete	Complete	Complete	Complete	Complete	
Europe	Tubingen	Complete	Complete	Complete	Complete	Complete	Complete	Complete	N/A	Complete	Complete	Complete	Complete	Click Here
Europe	Uden P.I.	week 38/2006	Complete	Complete	Complete	Complete	week 39/2006	not applicable	week 46/2006	week 46/2006	not applicable	not applicable	week 46/2006	week 46/2006
Europe	Wackersdorf	Complete	not applicable	not applicable	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete	

Leeds is on target to have all actions completed by end of year

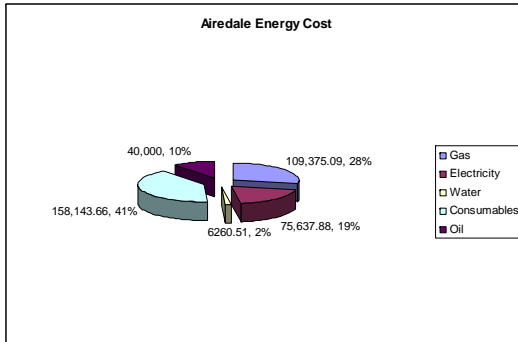
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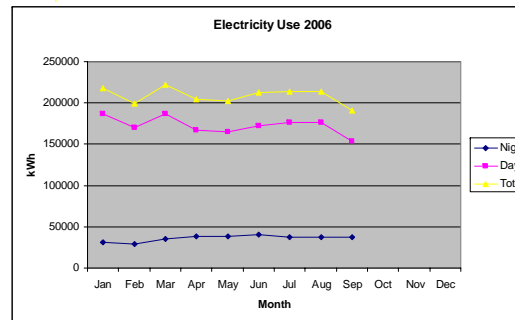
D[✓] M A I C R

DEFINE VOICE OF THE CUSTOMER

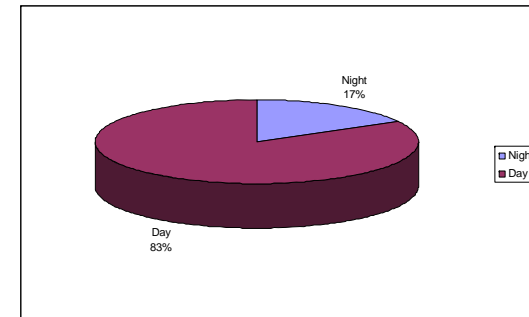


The data from the billing information is broken down to highlight the areas for investigation – for the purpose of this project – Electricity.

Electricity is charged at three rates : Summer/Winter days, Evenings and weekends



Year to Date we Airedale has consumed **1986096 kWh** which equates to a cost of **£128444**. The breakdown is £106609 for 0700 - Midnight and **£21835** for Midnight - 0700 The next step in the project is to map the process. We also need more resolution in the billing information to quantify any savings due to the implementation of improvements. This is done using information available on the E-on website.



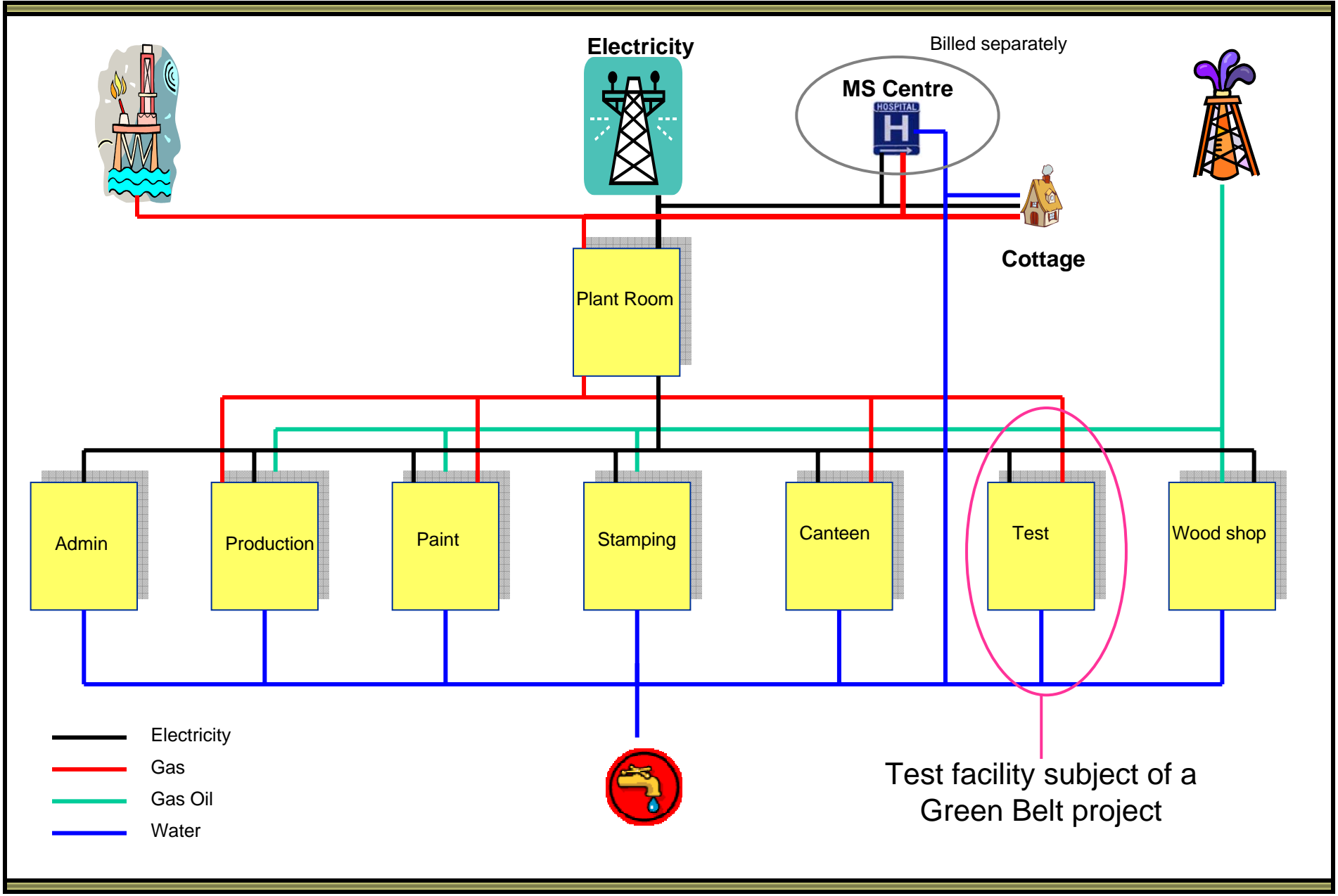
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HIGH LEVEL PROCESS MAP



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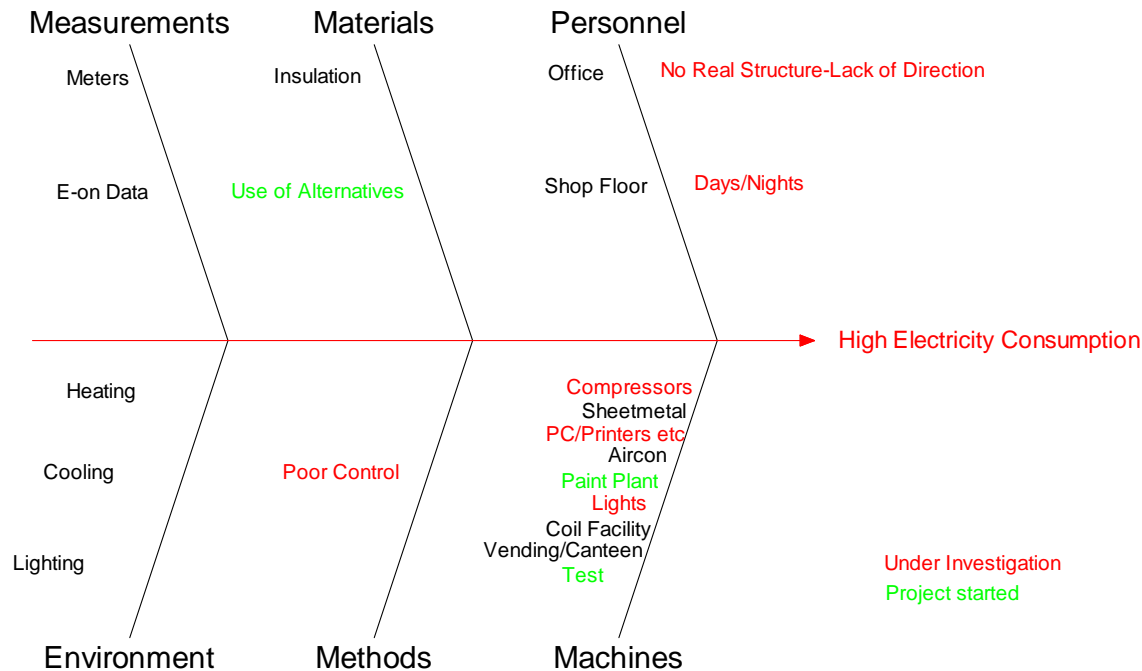


D - **M** - **A** - **I** - **C** - **R**
ELECTRICITY USE - CAUSE AND EFFECT

The team were then asked to complete a cause and effect diagram where the output was – High Electricity Consumption.

Airedale Electricity Use C&E

Days-Evenings-Weekends



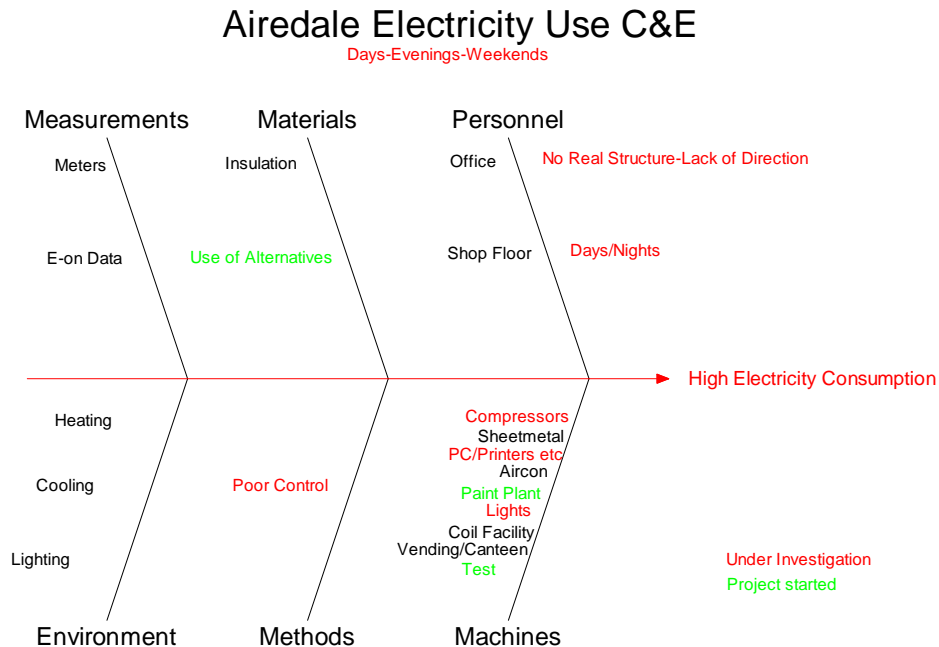
Using cause and effect tools a number of key areas were identified and further investigations begun. These include : Night time Consumption, Facility Lighting, Compressed Air generation, The use of P.C's, Printers, Copiers etc and the Test Facility.

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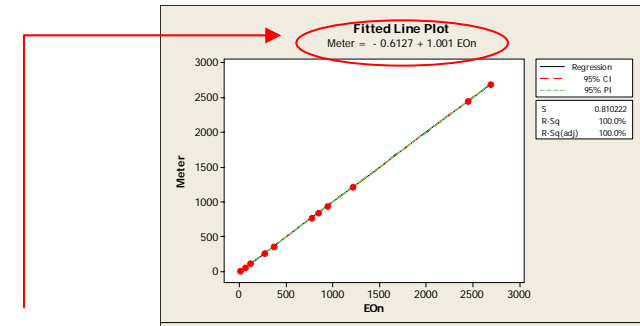


D M A I C R MEASURE CTQ (y) CAPABILITY

Cause & Effect Diagram w/ Ranking:

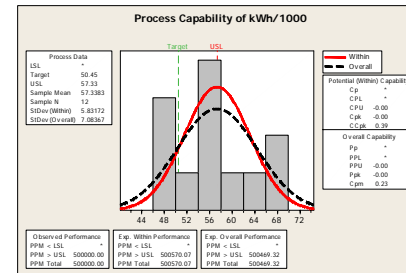


MSA & Process Capability:



Equation shows almost perfect correlation

with the different sets of meter readings.



Process capability calculated using baseline year of 2005-2006. Target for P.I. year is not to exceed **50.46 kWh/1000€ sales.**

CONTAINMENT (state reasoning if not required):

State action

- Compressed air and lighting survey conducted
- Trial evening shutdown all non essential consumers

Process Owner

Date

Before Data

After Data

A. Cole
A. Cole

August 2006
October 2006

Not calculated
Not calculated

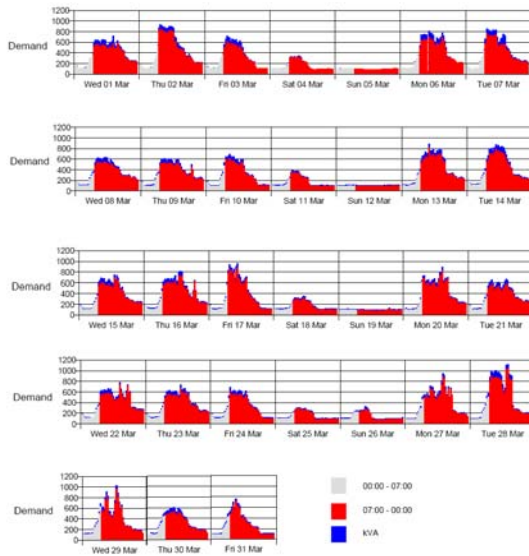
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E-On DATA BREAKDOWN

March 2006 Daily Data



Data generated by E-on can be looked at every 30 minutes. In order to complete a gauge R and R, the study would require the observation of the meters by two operators over a period of time. The data is however generated automatically through the computer system and an operator confirms the readings. A more meaningful measurement system therefore would be to ensure the meters we record from are telling us the same as the meters that we get billed from. Hence a correlation exercise is completed to compare internal meter readings with the E-on meter readings in the bills.

This graph shows amount of electricity used every 30 minutes for a 24 hour period. This is the resolution we require to conduct the gage study.

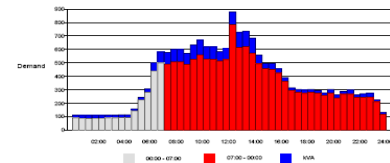
e-on Energy

Airedale International Air Conditio - Rawdon Leeds - Site Level

5.1c Daily Electricity Analysis

Total Night Consumption	Total Day Consumption	Total Consumption	CO2 emissions (kg)	Power Factor	Capacity Factor	ABC (kVA)
1,159	6,875	8,034	3,472	0.83	25.49 %	1500

Meter Point Number: 231564042115



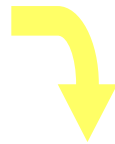
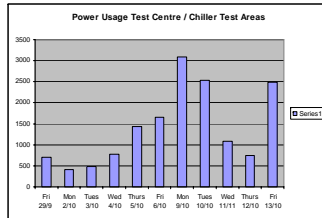
Time	Read Type	kW	kVA	Time	Read Type	kW	kVA	Time	Read Type	kW	kVA
00:30	A	90	111	03:30	A	508	600	16:30	A	304	361
01:00	A	86	106	04:00	A	508	600	17:00	A	298	355
01:30	A	86	106	04:30	A	508	600	17:30	A	298	355
02:00	A	86	106	05:00	A	501	600	18:00	A	279	338
02:30	A	86	106	05:30	A	508	616	18:30	A	281	339
03:00	A	80	111	06:00	A	508	616	19:00	A	275	333
03:30	A	80	111	06:30	A	514	585	19:30	A	286	339
04:00	A	80	114	07:00	A	505	600	20:00	A	274	330
04:30	A	80	114	07:30	A	508	616	20:30	A	281	339
05:00	A	142	169	08:00	A	618	726	21:00	A	287	348
05:30	A	224	249	08:30	A	621	736	21:30	A	287	348
06:00	A	283	307	09:00	A	618	684	22:00	A	248	293
06:30	A	442	500	09:30	A	498	589	22:30	A	245	272
07:00	A	492	491	10:00	A	498	497	23:00	A	241	274
07:30	A	490	478	10:30	A	492	486	23:30	A	270	257
08:00	A	510	493	11:00	A	493	490	24:00	A	116	132

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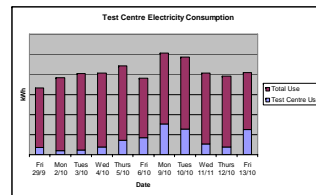
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D M A I C R TEST CENTRE BREAKDOWN

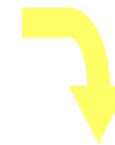
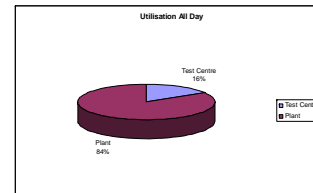


Test centre data recorded at local level

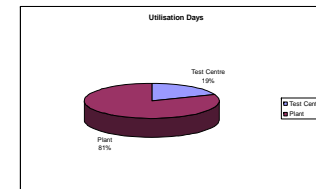


Compared against plant daily consumption

Gives an average of 16% use on full days consumption



Up to an average of 19% test centre consumption based on Day Rate charge for electricity



Test centre use of electricity is the subject of a Green Belt project

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- ❑ Compressed air generation investigation
- ❑ Lighting survey
- ❑ Evening shutdown
- ❑ Test centre usage Green Belt project
- ❑ Weekend/evening usage investigation

COMPRESSED AIR GENERATION

The objectives of this project were to identify and prioritise actions that can save energy by making improvements to the site's compressed air system. This was achieved by compiling detailed information on the site's air compressor utilisation efficiency; measuring and quantifying the associated costs of productive and non-productive compressed air energy usage, the compressed air treatment levels, the system demand profile and any potential misuse and wastage. This information is then to be used as a basis for energy saving recommendations, which are quantified and rationalised to provide reason and justification for action. Emphasis is always given to maximising financial savings with minimal capital expenditure.

Compressor Type

- ❑ **Compressor No.1)** Kaeser HPC CS76 fixed speed oil lubricated rotary screw compressor with a nominal motor rating of 48 kW, capable of delivering 7.25 m³/min (256 cfm) at an operating pressure of 7.5 barg.
- ❑ **Compressor No.2)** Kaeser HPC AS47 fixed speed oil lubricated rotary screw compressor with a nominal motor rating of 31 kW, capable of delivering 4.4 m³/min (155 cfm) at an operating pressure of 7.5 barg.
- ❑ Both compressors feed into a 1,100 litre vertical air receiver; there is a second 445 litre receiver but this was isolated at the time of the audit. The air then flows from the vessel into a Kaeser TD76 refrigerant type compressed air dryer unit capable of providing air to a +3°C pressure dew point. There are HPC line filters connected to either side of the dryer unit. There is an additional Tempair 250 dryer unit which is also isolated.

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COMPRESSED AIR- Key Performance Indicators

Key Performance Indicator			
Company	Airedale	Audit Start	23/08/2006 05:42
Site	Leeds	Audit Finish	23/08/2006 23:42
Compressor Station	Main	Audit Hours	19.0

Site Data			
Working Hours/Year	4,750	Electrical Cost/kWh	£ 0.062
Total Compressed Air Capacity Available (m³)	11.65	Maximum Power Requirement of Air Compressors (kW)	79.00

Recorded Input / Output	Average	Minimum	Maximum
Power (kW)	35.08	22.05	42.51
Pressure (barg)	6.67	6.41	6.76
Flow (m³/min)	3.70	1.45	5.99
System Utilisation (%)	31.90%	12.71%	50.57%

Audit Totals	
Power (kWh)	896.12
Flow (m³)	4,222.70
Cost/m³	£ 0.0082
Average Efficiency (kW/m³/min)	9.49
Productive Input	66.79%
Non-Productive Input	33.21%
Total Cost of Productive Input	£ 23.13
Total Cost of Non-Productive Input	£ 11.51
Total Cost During Audit	£ 34.64

Calculated Annual Totals	
Annual Power (kWh)	168,530.48
Total Cost of Productive Periods	£ 5,783.31
Total Cost of Non-Productive Periods	£ 2,876.28
Total Annual Cost	£ 8,659.59

Carbon Usage	
Carbon Used During Audit (Tonnes)	0.29
Calculated Annual Carbon Usage (Tonnes)	71.61

Notes: Data is sampled at the following intervals: 1 hour
 Pressure is filtered between: No Filter
 Date is filtered between: 23/08/2006 05:22 24/08/2006 00:22

A compressed air audit was carried out at the facility and highlighted four major areas for improvement:

1. Compressor timing
2. Air leaks
3. Compressor switchover
4. Reduction of plant working pressure

The cost to produced compressed air at Airedale is £8659 p.a.

All recommendations from audit completed 30th September 2006.

We can now use hypothesis testing to validate the changes made to the compressed air generation system.

- Practical Problem - After the changes to optimise the system is the electricity consumption the same as pre optimisation.
- Statistical Problem –
 - Ho - Pre 30th Consumption is equal to Post 30th Consumption
 - Ha - Pre 30th Consumption is less than Post 30th Consumption

- Statistical Solution -

2-Sample t-test

- | | N | Mean | StDev | SE Mean |
|----------|----|------|-------|---------|
| □ After | 10 | 7228 | 426 | 135 |
| □ Before | 34 | 7610 | 561 | 96 |
- **P value 0.015**

- Practical Solution

The mean difference in kWh is 235 which would equate to a saving of **£4288 p.a.** - a saving of over **45%** in compressed air generation costs and a reduction of over **3%** in total electricity cost for the plant

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Light Burning Hours for the plant

□ Upper Level

Manufacturing area	12 hrs x 5 days x 50 weeks 8 hrs x 1 day x 50 weeks
Offices	12 hrs x 5 days x 50 weeks

□ Lower Level

Machine Shop/Welding Area	19 hrs x 4 days x 50 weeks 13 hrs x 1 day x 50 weeks
Other Areas	12 hrs x 5 days x 50 weeks

Energy Costs

Nights	Midnight – 0700	0.043p per kWh
Weekend		0.055p per kWh
Summer Day	01/04-31/10	0.055p per kWh
Winter Day	01/11-31/03	0.071p per kWh

In order to calculate potential savings, we have used the following site operating hours

31 Weeks @ 0.055p per kWh

19 weeks @ 0.071p per kWh

Nights and Weekends have been omitted from the calculations.

Potential Savings

Total cost for Lighting 2005 = £ 21,363.00

All Areas

All areas energy consumption existing = £16,416.07

After refit with triphosphor reflex lamp = £ 9,401.65

Savings = **£ 7,014.42**

Machine Shop

Energy consumption = £ 4,974.95

After refit = £ 4,344.46

Savings = **£ 603.39**

All Other Areas

Savings = **£ 1,969.00**

Total Potential Savings = £9,581.81 a 7% saving on electricity cost.

Associated costs for upgrade available.

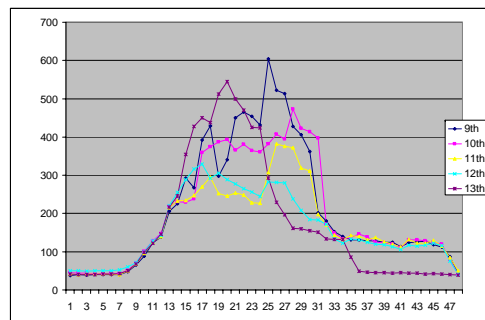
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AIREDALE

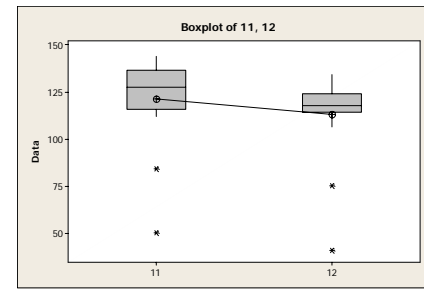


EVENING SHUTDOWN

In an attempt to quantify potential savings a trial was conducted on Thursday 12th October 2006 during which all air con, computers, printers, photocopiers, vending machines and all non-essential electrical equipment was shutdown. The shutdown started at 1700 in production areas, 1730 hours in the offices. The Twilight shift worked until Midnight. Data was analysed using 2 sample t-test and savings calculated.



kWh data for week 41



Boxplot comparing 11th Oct with 12th Oct

Potential Savings

Savings were calculated using e-on data which gives a reading for consumption and demand every 30 minutes. The cost of electricity is 0.043 p per kWh nights for and 0.055 p per kWh for days.

Total Difference Day i.e. 1730 – Midnight = 150kWh @ 0.055 = £7.50

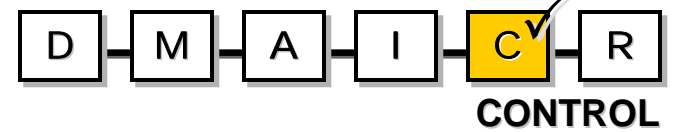
Midnight - 0700 = 93kWh @0.043 = £4.00

If site maintained usage savings for year = £4000 p.a. a 3 % saving in electricity costs.

- If we realise a 13% saving on electricity consumption September 2006 – August 2007 we will reduce Co2 emissions by 130000 kg p.a.

6-PANEL

AIREDALE



1. Set target consumptions based on P.I requirement.
2. Report on daily/weekly basis on usage to senior management. Display information on plant notice boards and cascade to workgroups.
3. As per BMP - inform and educate workforce of best practices to reduce energy consumption. (Utilise security – discuss)
4. Reaction plan to be formulated – Energy focus group to be formed.
5. Liaise with U.S to release further AFE funding.
6. Strict controls of air-con/plant heating- upgrade Building Management System.

6-PANEL



REPLICATE

REPLICATION (who else across Modine could benefit?):

Key Actions

Is this Replicable?

If Yes, Where?

Responsibility

UPDATES TO CORPORATE KNOWLEDGE BASE (who else across Modine Corporation could benefit?):

Core Book

Change Made

Owner

Document #

Completed

PROJECT END – PROOF OF SUSTAINMENT: