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Attachment N^o B.1
Emissions to Surface Waters

Attachment N^o B.1

Emissions to Surface Waters

INTRODUCTION

Waste water arising from processing activities at the Meadow Meats Ltd. facility discharges to the Erkina River at emission point ref. EW2 , following treatment at the on-site waste water treatment plant.

SOURCES OF EFFLUENT

Process Waste Water

Waste water on site is primarily generated through washdown activities in the various process and handling areas throughout the plant.

Washdown activities at the animal intake, lairage and slaughtering hall generate the largest quantities of effluent. In addition, large volumes of wash water are generated during truck cleaning operations.

Wash water generated on site can be characterised as having a high organic loading. Arising from the nature of activities on site, the presence of List I or List II substances is not anticipated.

Process waste water is treated at the on-site biological wastewater treatment plant prior to discharge via pipeline approximately 280m long to the Erkina.

Surface Water

Surface (storm) water run-off from roof and clean yard areas is diverted to storm water drains and discharges during periods of rainfall to a stream which runs from the Mill Pond in front of the site, to the Erkina. These discharges are numbered EW3, EW4, EW5, EW6, EW7, and EW8

Locations of discharge points is Tabulated on Table B.2.

B.2 Tabular Data on Emission Points to surface water

Point Code	Easting	Northing	Verified	Emission
EW2	228012	179052	No	Flow, Temperature, pH, BOD, COD, SS, Nitrates, Ammonia, Total P, Chloride, detergents, OFG, Total Nitrogen.
EW4	227940	178522	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride
EW5	227940	178535	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride
EW6	227931	178553	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride
EW7	227926	178551	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride

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Attachment N^o C.1
Treatment, Abatement and Control Systems

Attachment N^o C.1

Treatment, Abatement and Control Systems

Waste water arising from processing activities at the Meadow Meats Ltd. facility discharges by gravity to the on-site waste water treatment plant.

The treatment plant comprises the following elements:

- Lagoon sump to allow dewatering of slurry from truck wash and lairage. Liquor is drained to the effluent treatment plant. The solids are removed at weekly intervals.
- Coarse screen and effluent sump
- Transfer pumps.
- Fine brush screen - solids removed by chute to skip.
- DAF unit - solids are removed to skip for spreading on land.
- Balance Tank
Capacity 1257m³, with 20kw floating aerator. Covered with odour control.
- Aeration Tanks:
 - No. 1 *Circular Steel Tank - 900m³ capacity - 20kw aerator.*
 - No. 2 *Reinforced Concrete Rectangular Tank 690m³ - 2 x 10 aerators*
 - No. 3 *Reinforced Concrete Rectangular Tank 650m³ - 2 x 7 aerators*
- Clarifiers:
Reinforced Concrete Rectangular Tank, in three chambers, total capacity 115m³
- Sludge Return Pumps.
- Sludge Holding Tank.
- Belt Press
- Pump Sump for final pumping to Erkina

The treatment plant has the following design capacity

Weekly load	hydraulic	-	4250m ³
	BOD	-	5600kgs

The processing plant operates over 5 days per week, but the effluent treatment plant operates continuously for design purposes, it is assumed that the effluent is treated over 6 days i.e. balance tank empty Monday a.m., and full Friday p.m.

Thus the daily load in the plant is	708m ³
	933kgs BOD

Balance tank capacity	-	1257m ³
Daily flow	-	850m ³
Aeration requirement	-	15kw
Aerator provided	-	20kw

DAF capacity	-	40m ³ /hr
Daily average flow	-	35m ³ /hr
Allow 20% of BOD	-	187kgs
BOD transferred to Aeration Tank	-	746kgs

Aeration Tanks

Volumetric capacity	900 + 690 + 650	2240m ³
BOD removal required	933 - 17	916kgs
Efficiency required		98.1%

Recommended F/M Rates 0.1

Actual F/M = 933×1000 0.099
 2240×4200

Loading Rate = $\frac{933}{2240}$ 0.416kgs/m³ BOD

Allow 1.7kgs O₂ /kg BOD = kgs O₂ required 1586 kg O₂/day
 66kg O₂/hr

Aerators provided 54kw

Oxygen transfer capacity 108kg O₂/hr

Clarifier

Upward flow velocity 0.65m/hr

Recommended 0.6m/hr

Excess Sludge Production

Excess BOD/week = 729×6 4374kgs

Excess solid production = 0.75kgs D.S./kg BOD 3280kgs/week

Removal of sludge from clarifiers at 0.5% D.S. content 656m³/week

Sludge thickened to 12% i.e. 27m³/week

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The treatment plant operates to meet the following Emission Limit Values as specified in Schedule 1 (i) of the site IPPC Licence.

Volume to be Emitted: Maximum in any one day: 700 m³
Maximum Rate per hour: 30 m³

Parameter	Emission Limit Value
Temperature	25°C (max)
pH	6-9
	mg/l
BOD	20
COD	80
Suspended Solids	30
Detergents	10
Nitrates (as N)	25
Total Ammonia (as N)	2
Total Phosphorous (as P)	2
Oils, Fats and Grease	15
Chloride	1000

BAT Evaluation

Concentrations of the relevant parameters in emissions of treated process waste water to surface water from Meadow Meats meet and exceed BAT, as specified in the Guidance Note for the Slaughtering Sector (EPA, 2008).

Table C.1 Comparison of emissions against BAT

Parameter	BAT ELV (mg/l)	Meadow Meats ELV (mg/l)	BAT Compliant
pH	6-9	6-9	Yes
BOD	20-40 (> 90% removal)	20 (99% removal)	Yes
COD	125-250 (>75% removal)	80 (96% removal)	Yes
Suspended Solids	60	30	Yes
Detergents	-	10	N/A
Nitrates (as N)	-	25	N/A
Total Ammonia (as N)	10	2	Yes
Total Phosphorous (as P)	2-5 (>80% removal)	2 (93% removal)	Yes
Oils, Fats and Grease	10-15	15	Yes
Chloride	-	1000	N/A

Over the past years, significant investment has been made at the site to reduce the volume of process waste water and to ensure that discharges are below emission limit values.

Discharges of treated wastewater from the site, and accordingly assessment of impact on surface waters is based on emissions which are at maximum flow and at ELV throughout the year (i.e maximum mass emissions over 24/7/365).

A review of the site AER for 2010 shows that actual emissions are significantly lower as shown below.

Table C.2 Comparison of annual emissions against Licence

Parameter	Mass Emission (2009)(kgs)	Mass Emission (2010)(kgs)	Permitted Mass Emission (kgs)
Flow (m ³)	152778	150520	255500
BOD	1635	1021	5110
COD	6276	8052	20440
Suspended Solids	4563	2486	7665
Detergents	15	10	2555
Nitrates (as N)	1504	846	6388
Total Ammonia (as N)	111	165	511
Total Phosphorous (as P)	261	90	511
Oils, Fats and Grease	504	152	3833
Chloride	1119130	92500	255550

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Attachment N^o C.2
Monitoring and Sampling Points

Attachment N^o C.2

Monitoring and Sampling Points

Information on Monitoring and Sampling Points is tabulated below for the monitoring locations specified in Schedule 1 and 3 of the site IPPC Licence.

Point Code	Easting	Northing	Verified	Emission
EW2	228012	179052	No	Flow, Temperature, pH, BOD, COD, SS, Nitrates, Ammonia, Total P, Chloride, detergents, OFG, Total Nitrogen.
EW4	227940	178522	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride
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EW7	227926	178551	No	Visual Inspection, pH, Conductivity, COD, Total Ammonia, Chloride

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Attachment N^o D.1.1
Assessment of Impact on Receiving Surface Water

Attachment N^o D.1.1

Assessment of Impact on Receiving Surface Water

The receiving waters for the purposes of the assessment are the Erkina River, which is a tributary of the River Nore. The discharge at Rathdowney is situated approximately 7km upstream of the River Barrow and River Nore SAC (Site Code 002162).

RECEIVING WATERS - FLOW DATA

Discharges of treated process wastewater are made to the Erkina River at a point approximately 280m north of the site.

The River Erkina has a catchment area of 387 km² and has had hydrological data collected at Durrow since 1978. Durrow is immediately downstream of the Meadow Meats discharge.

Hydrological data for the river shows the following volumetric flow information:

Dry Weather Flow (DWF)(est)	0.400 m ³ /s
95 %ile Flow (est)	0.750 m ³ /s

RECEIVING WATERS – WATER QUALITY

Physico-chemical data collected by the EPA has been used to determine the mean upstream water quality values for the SI 272 parameters as follows:

Parameter	Long Term Upstream Value (Mean)(mg/l)
BOD	1.20
Total Ammonia (as N)	0.029
Ortho P (est)	0.033

(EPA River Chemistry: Erkina RS15E010100, Clarneyball Br 226656, 178749)

ASSIMILATIVE CAPACITY

The assimilative capacity of the Erkina River to accept discharges of treated waste water from the plant has been calculated based on the following input parameters, which taking account of SI 272 of 2009, are based on *Good Status* values (The Erkina Water Management Unit Action Plan required the section of Erkina to reach *Good Status* by 2021)

The formula used to determine the assimilative capacity is as follows:

Assimilative Capacity =	River Flow (m3/sec)	x	Limit or MAC Conc (mg/l)	-	River Flow (m3/sec)	x	Actual or Average Conc (mg/l)	x	$\frac{60 \times 60 \times 24}{1000}$
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The model used the following input parameters.

Input Parameter	Descriptor	Limit Value
In stream Flow	95%-ile	0.750 m ³ /sec
BOD	95%-ile	2.60 mg/l
Ammonia (as N)	95%-ile	0.140 mg/l
Ortho P	95%-ile	0.075 mg/l

The assimilative capacity of the River therefore, for the key parameters specified under SI 272 of 2009 are tabulated below:

Parameter	Flow (percentile)	Assimilative Capacity (kg/d)
BOD	0.750m ³ /s (95%ile)	91.720
Ammonia (as N)	0.750m ³ /s (95%ile)	7.193
Ortho P	0.750m ³ /s (95%ile)	2.722

Based on the above, there is significant capacity within the Erkina to absorb discharges from the Meadow Meats facility.

ASSESSMENT OF IMPACT

The assessment of impact (and compliance with SI 272 of 2009) is based on the load to the stream. This is calculated, based on a limited maximum flow of 700m³ per day and licensed ELV's for each parameter as:

Parameter	ELV (mg/l)	Mass Emission (kg/d)	As %-age of AC
BOD	20	14.000	16%
Ammonia (as N)	2	1.400	20%
Ortho P	1.2	0.840	31%

The levels of emissions, expressed as kgs per day, are significantly below the available assimilative capacity of each of the relevant parameters and reflect the capacity within the system to accommodate discharges from the site while maintaining water quality objectives. Based on the calculations, there is a remaining headspace for BOD of 84% of the available assimilative capacity, 80% in the case of ammonia and 69% for ortho P.

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Attachment N^o D.1.2
Proposals to Comply with the requirements of SI 272

Attachment N^o D.1.2

Proposals to comply with the requirements of SI 272

Discharges from the site currently comply with the requirements of SI 272.

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Attachment N° D2
Environmental Considerations and Best Available Techniques (BAT)

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Attachment N^o D2

Environmental Considerations and Best Available Techniques (BAT)

Describe, in outline, the main alternatives, if any, to the proposals contained in the Review Form.

Not Applicable

Describe any environmental considerations which were made with respect to the use of cleaner technologies, waste minimisation and raw material substitution.

The Meadow Meats plant is located on a site of approximately 18 acres close to the centre of the town in Rathdowney, Co. Laois. There is considerable residential and commercial development along the southern boundary of the site.

The plant has a capacity to slaughter 70 animals per hour together with associated cutting, chilling and freezing of beef and beef products. The nature of the beef industry in Ireland (gives preferentiality towards a seasonal wash), with the peak time normally being in the autumn and early winter months.

Meadow Meats directly employs approximately 90 staff. . A copy of the management structure for the facility can be seen in Figure 1. Normal hours of production at the plant are Monday to Friday 7.00 a.m. to 4.00 p.m., with cleaning operations continuing until 11.00 p.m. The refrigeration plant, which controls the temperature of the Chill Rooms and the Cold Store, operates continuously.

Hygiene at the plant is a major consideration and is inspected by the Department of Agriculture Food and Forestry who has one Veterinary Inspector based full-time at the plant. In the past the FMD and BSE crises have focused additional emphasis on hygiene with consequent environmental implications, particularly in the areas of wastes management and water consumption.

Products produced at the plant are sold both in fresh and in frozen form. Fresh form products are sold in Ireland, UK and other EU countries, and products in frozen form are exported to several countries throughout the World.

The primary environmental emissions at the plant relate to the discharge of treated wastewater and the generation of organic waste as sludge, which is land spread.

The environmental performance of the facility is regulated under an IPPC licence (Reg. No. 183-01). Environmental management at the site, including compliance with the IPPC licence, is achieved through a structured Environmental Management System (EMS).

Describe the measures proposed or in place to ensure that:

- (a) the best available techniques are or will be used to prevent or eliminate or, where that is not practicable, generally reduce an emission from the activity;

Best Available Techniques (BAT) are adopted throughout the processing plant and at the WWTP.

The treatment plant has a high compliance rate and overall emissions are well within the Emission Limit Values (ELV's) specified in the IPPC Licence.

All discharges are below the relevant BAT ELV as specified in the Guidance Note for the Slaughtering Sector, both as actual values and in terms of treatment plant performance (as % removal efficiency).

(b) no significant pollution is caused;

All wastewater treatment plant emissions are below the emission limit values set out in IPPC Licence Reg. No. P0183-01.

(c) waste production is avoided in accordance with *Council Directive 75/442/EEC of 15 July 1975 on waste*; where waste is produced, it is recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;

The principles of Prevention are applied to all resource use at the site in order to improve efficiency and reduce wastes at sources where practicable. Where waste generation is unavoidable, the site environmental management system sets out registers, procedures and recording systems to ensure that wastes are collected, transported and recycled or disposed of in accordance with waste legislation and the site IPPC Licence.

(d) energy and other resources are used efficiently;

The facility has undertaken an energy audit for the facility and has put in place a programme for actioning the recommendations made in the study.

(e) the necessary measures are taken to prevent accidents and limit their consequences; and,

There is a documented Accident Prevention and Emergency Response Plan in place at the site which addresses risk reduction at the facility and describes the measures which will be taken to reduce the consequences of a loss of control incident at the site.

(f) the necessary measures are taken upon definitive cessation of activities to avoid any pollution risk and return the site of operation to a satisfactory state.

Meadow Meats has prepared a Decommissioning and Closure Plan for the site which describes the measures which will be taken in the event of closure of part or all of the facility.

This section should present a statement on energy efficiency at the site to include, where appropriate, an energy audit with reference to the *EPA Guidance document on Energy Audits*. Licensees should have regard to Section 5 of the *EPA Acts 1992 and 2003* in selecting BAT and in particular the following:

- The use of low-waste technology;
- The use of less hazardous substances;
- The furthering of recovery and recycling of substances generated and used in the process and of waste where appropriate;
- Comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale;
- Technological advances and changes in scientific knowledge and understanding;
- The nature, effects and volume of the emissions concerned;
- The commissioning dates for new or existing facilities;
- The length of time needed to introduce the BAT;
- The consumption and nature of raw materials, including water, used in the process and their energy efficiency;
- The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- The need to prevent accidents and to minimize the consequences for the Environment; and,
- The information published by the Agency in the form of sectoral BAT Guidance documents and the relevant BREF documents published by the EC (available for download at <http://eippcb.jrc.es> and at www.epa.ie).

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Environmental Efficiency
Consulting Engineers

Parnell House,
19 Quinsboro Road,
Bray Co. Wicklow,
Ireland.

ENERGY AUDIT REPORT

FOR

Meadow Meats

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Tel: 353 1 276 1428 Fax: 353 1 276 1561 Email: energy@iol.ie

www.enviro-consult.com

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Where it is a requirement that this report be issued to a regulatory or other authority, then the client should sign the appropriate place in the above table and, unless specifically agreed in writing to the contrary, forward copies to the appropriate authority (e.g. EPA).

EEC Project Manager:

Bob Sutcliffe, CEng, MIMechE

EEC Document Author:

Agnes Ricoux, Diplôme d'Ingénieur Industrial Processes

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1 Introduction

Environmental Efficiency Consultants have been commissioned by Meadow Meats Ltd. to conduct a full energy audit at their site in Rathdowney, County Laois. This audit was carried out on 28th September 2006, which was a day of normal production.

This assessment is concerned with identifying practical, proven energy saving measures within specified payback periods in order to make the company more energy efficient and hence reduce their energy usage and costs as well as their CO₂ emissions. By energy efficiency we mean using the energy needed more effectively so that less energy can be used to produce the same result.

2 Scope of the audit

During this audit, the different sources of energy used on the site and their consumptions were assessed and normalised against an appropriate parameter, such as the production levels, whenever possible. The main energy consuming areas or systems seen during the survey were then reviewed and their energy performance estimated using a scoring system. In terms of Meadow Meats Ltd., the sub-systems assessed include:

- The refrigeration system (cold stores, freezers, chillers)
- The lighting
- The steam boiler
- The air compressors
- The wastewater treatment plant

The audit shall also involve further analysis of the information available and comparison of current practices with best recommended practices.

This report details the analysis of the energy consumption and billing for the client and recommends a series of suitable energy saving measures. These measures are described in sufficient detail in terms of savings (in money, energy and CO₂ emissions), implementation cost and payback period such that a project design phase, leading to the eventual implementation of these measures, is the realistic next step.

3 Overview of site activities

Meadow Meats Ltd. is a meat processing plant located in Rathdowney, Co. Laois. Activities at the plant include the slaughter and processing of cattle and the boning of beef to primal stages. During the period September 2005 – August 2006, the company produced 15,308 tonnes of beef. The company currently employs 120 people.

Hours of operation vary by department. Approximate operating times for each department are, as follows:

- Slaughter Line: 7.30am – 4.30pm
- Boning Hall: 8.00am – 5.00pm
- Wash down: 4.30am – 12.00 ~ 1.00am

The frequency of the killing varies throughout the year:

- January – March: 3-4 days per week
- April – July: 3 days per week
- August – December: 4-5 days per week

3.1 Production Process

Once received at the site, the cattle are held until a suitable time for slaughter.

The cattle are stunned by means of a hammer gun prior to slaughter. Following slaughter, the carcasses are bled and initially processed to remove the heads, feet and major organs. The remaining carcasses are then cut in half and progressively chilled in the carcass chills.

After cooling the main proportion of the carcasses are deboned and cut. The meat is then vacuum packed and stored in holding chills until distribution.

The site also comprises a tallow plant producing edible tallow and a wastewater treatment plant.

4 Current energy management system

An energy management system can best be described as a system put in place to track the energy usage of various energy consuming equipment at a site in order to highlight any areas in need of improved energy efficiency.

The company keeps records of energy consumption in terms of units of electricity, oil and gas used and their associated costs based on invoice data. No analysis of these figures takes place such as standardising against production level. Therefore the efficiency of the company in terms of energy usage has not been assessed to date.

Table 4-1 below shows an energy management matrix. This matrix can be used to illustrate the maturity of the company in terms of energy policy and management. Following the energy survey, levels for the various aspects were chosen which it was felt best illustrated the company's position in terms of energy policy and management. These levels are highlighted in the matrix.

The matrix shows that Meadow Meats lacks a formal structured approach to energy management and that there is room for significant improvement for the company in terms of energy efficiency. Relevant personnel do, however, have a good awareness of energy issues and are knowledgeable of energy saving and energy cost saving techniques.

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Table 4-1 Energy Management Matrix

Level	Energy Policy	Organising	Motivation	Information systems	Marketing	Investment
4	Energy policy, action plan and regular review have commitment of top management as part of an environmental strategy	Energy management fully integrated into management structure. Clear delegation of responsibility for energy consumption.	Formal and informal channels of communication regularly exploited by energy manager and energy staff at all levels.	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking.	Marketing the value of energy efficiency and the performance of energy management both within the organisation and outside it.	Positive discrimination in favour of 'green' schemes with detailed investment appraisal of all new-build and refurbishment opportunities.
3	Formal energy policy, but no active commitment from top management.	Energy manager accountable to energy committee representing all users chaired by a member of the managing board.		M&T reports for individual premises based on sub-metering, but savings not reported effectively to users.	Programme of staff awareness and regular publicity campaigns.	
2	Un-adopted energy policy set by energy manager or senior departmental manager.	Energy manager in post, reporting to ad-hoc committee, but line management and authority are unclear.	Contact with major users through ad-hoc committee chaired by senior departmental manager.			Investment using short-term payback criteria only.
1			Informal contacts between engineer and a few users.	Cost reporting based on invoice data. Engineer compiles reports for internal use within technical department.	Informal contacts used to promote energy efficiency.	Only low cost measures taken.
0	No explicit policy	No energy management or any formal delegation of responsibility for energy consumption	No contact with users.	No information system. No accounting for energy consumption.	No promotion of energy efficiency.	No investment in increasing energy efficiency in premises.

5 Energy Billing Audit

A number of energy sources are used at the Meadow Meats site. These include electricity and fuel oil. The consumption figures shall be standardised against an appropriate variable for the particular energy source. This analysis should help to identify trends in energy usage and highlight any peaks that have occurred in energy usage. Questions can then be asked as to the reasons for these peaks and allow us to determine whether they were unnecessary and due to energy inefficiency.

5.1 Electricity

5.1.1 Electricity Usage

Electricity is one of the major forms of energy used at the meat processing facility and it is supplied to the plant by Energia and a generator. This generator is used to meet the peak demands of the site.

Owing to the nature of the company's business, the refrigeration system, the generation of compressed air, the lighting, electrical motors and the heating elements for the knife sterilizers are believed to be the main electricity consumers. A fuller investigation into the main areas of electricity consumption is detailed later in this report.

Table 5-1 below details the annual electricity consumption (combined consumption from the grid and from the generator) and associated costs for September 2005 to August 2006. Electricity as a percentage of the total energy consumption for the year is also detailed.

A more detailed account of the electricity billing is given in Appendix 1 at the back of this report.

Table 5-1 Summary Electricity Usage

	2005-2006
Consumption, kWh	4,812,010
Consumption, GJ	17,323
Annual Cost €	446,559
% Annual Energy	38.7
% Energy Cost	68.7
Cost c/kWh	9.28
Cost €/GJ	25.78

Figure 5-1 Monthly electricity trend from January 2004 to August 2006

Electricity consumption trend from January 2004 to October 2006

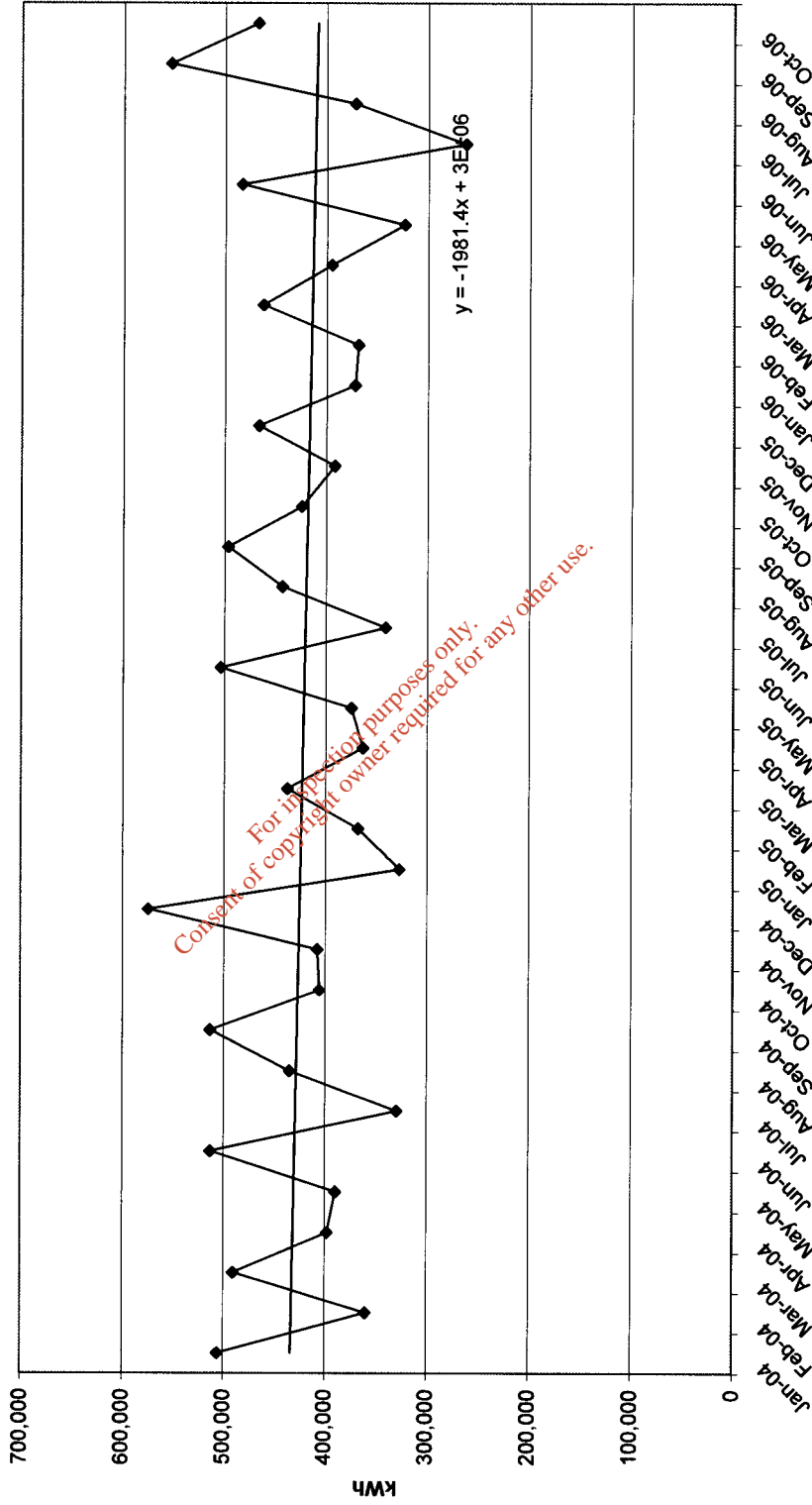
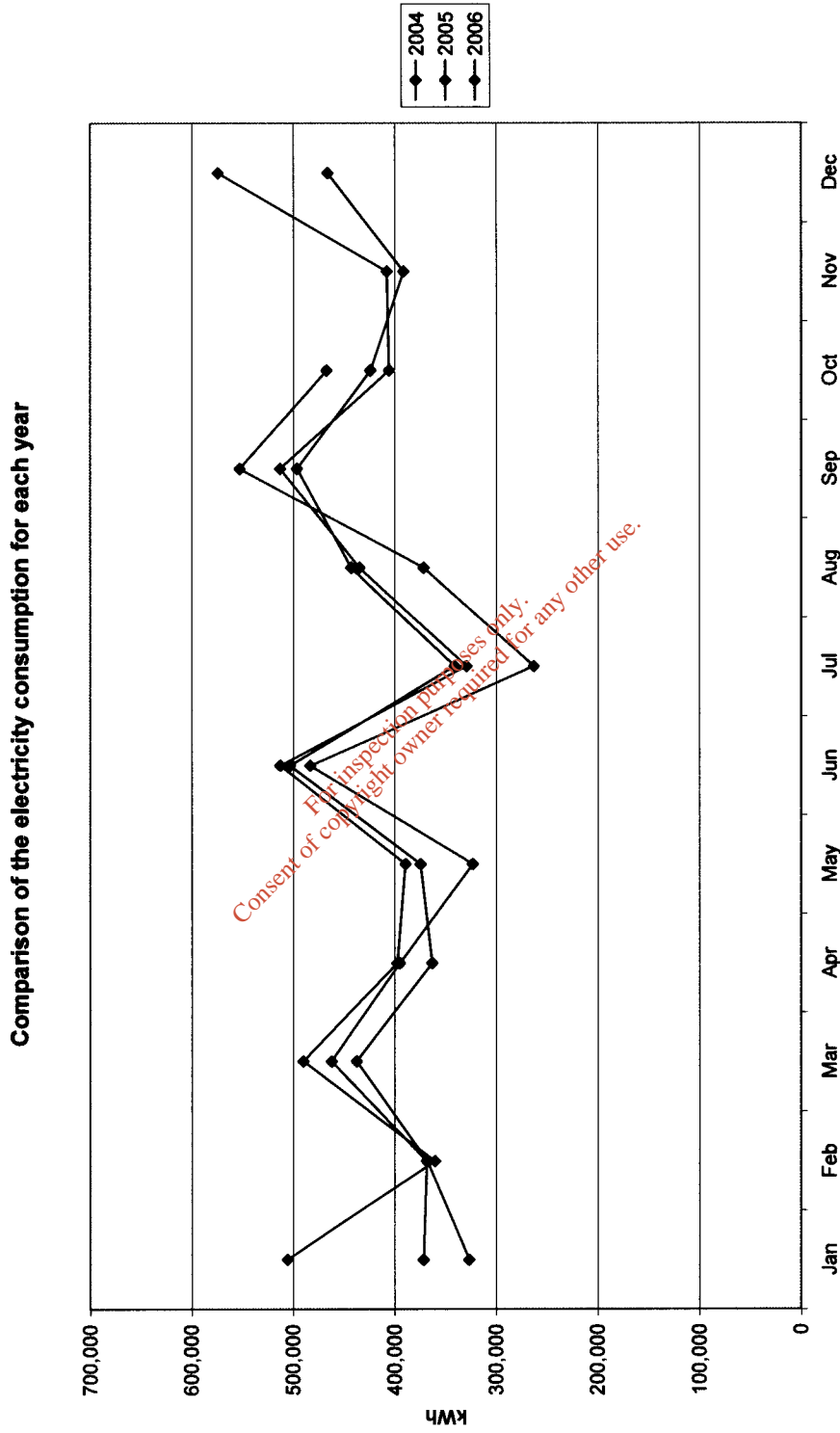


Figure 5-2 Comparison of the monthly electricity consumption for the past three years



In this figure, we can notice that the total electricity consumption trend has been repeating over the years. The lowest consumption appears to be in August, which is most likely due to the annual holiday closure.

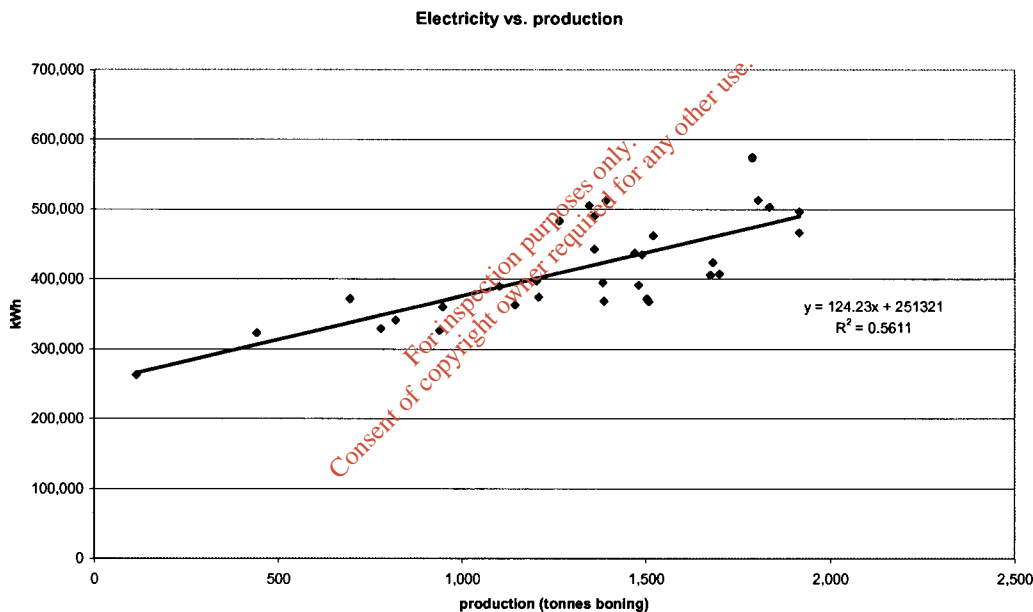
5.1.2 Standardisation of the electricity consumption

Electricity consumption vs. production:

As for the other group sites, the main consumer of electricity on the site is the refrigeration system. Although the refrigeration runs even during non-productive periods (i.e. night-time), it is believed that the load on this system is largely dependent on the production level (and therefore the amount of meat to cool). Also, a very large number of electrical equipment is used during the process (e.g. compressed air, electrical saws, knife sterilizers and lighting).

The following graph compares the electricity usage to the production level.

Figure 5-3 Total electricity consumption vs. production level

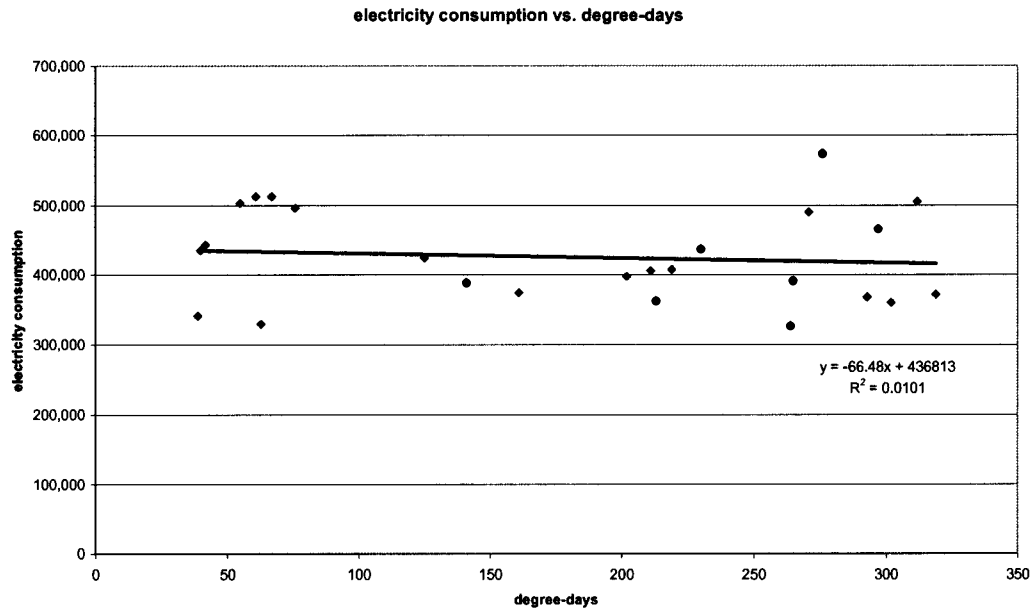


The R-squared value of 0.5611 suggests that there is a correlation between electricity consumption and production.

Electricity consumption vs. degree-days:

The temperature in most of the production areas is controlled by the refrigeration system and is thus constant throughout the year. Parts of the system such as the condensers are exposed to the outside environment and their efficiency is greatly dependant on the weather conditions. The effort that the refrigeration system has to provide is thus partly dependant on the outside temperature.

The electricity consumption and the outside temperature (as degree-days) are compared in the flowing graph:

Figure 5-4 Total electricity consumption vs. degree-days

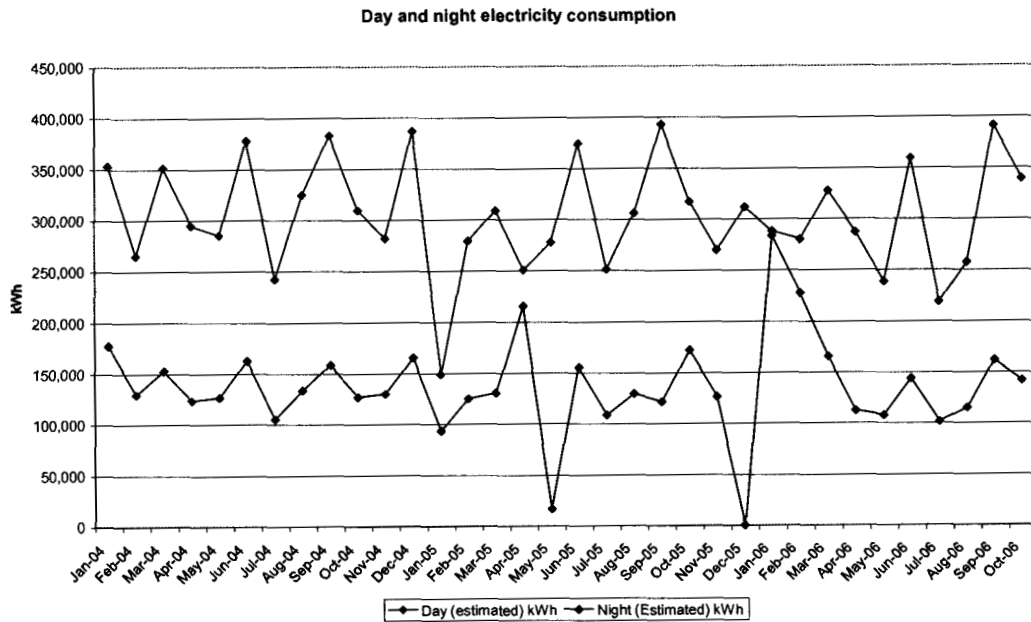
The R-squared value on this graph is 0.0101 and thus shows that there is no correlation between outside temperature and electricity usage.

Day-time and night-time electricity consumption:

Day-time and night-time electricity consumption was not available from the bills. However, meter readings are manually taken by the company staff. Although these readings may not be as accurate as in the bills, they can be used for the comparison of night and day electricity usage at the site.

The following graph presents the trends in day and night electricity consumption readings from January 2004 to October 2006 (the reading for December 2005 was changed from -121,400kWh to 0 as this reading must have resulted from a human error).

Figure 5-5 Day and night electricity consumption



These readings show that the night-time electricity consumption is a significant part of the site's electricity use. On average, it represents approximately 45% of the day-time electricity usage and 30% of the total consumption.

The day-time electricity consumption and the night-time electricity consumption are also individually compared to production and degree-days as can be seen in the following figures.

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Figure 5-6 Day-time electricity consumption vs. production

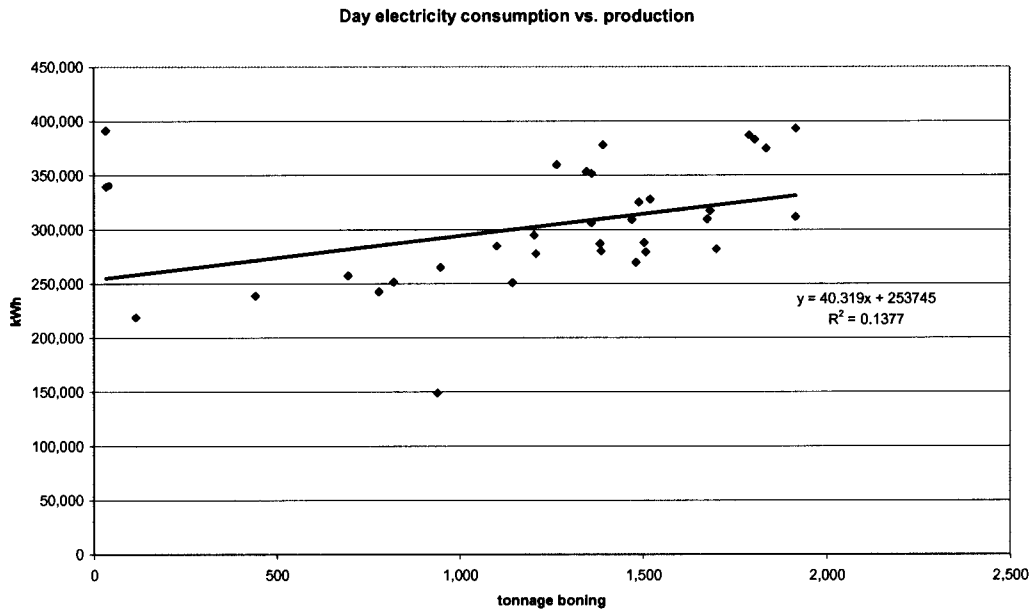
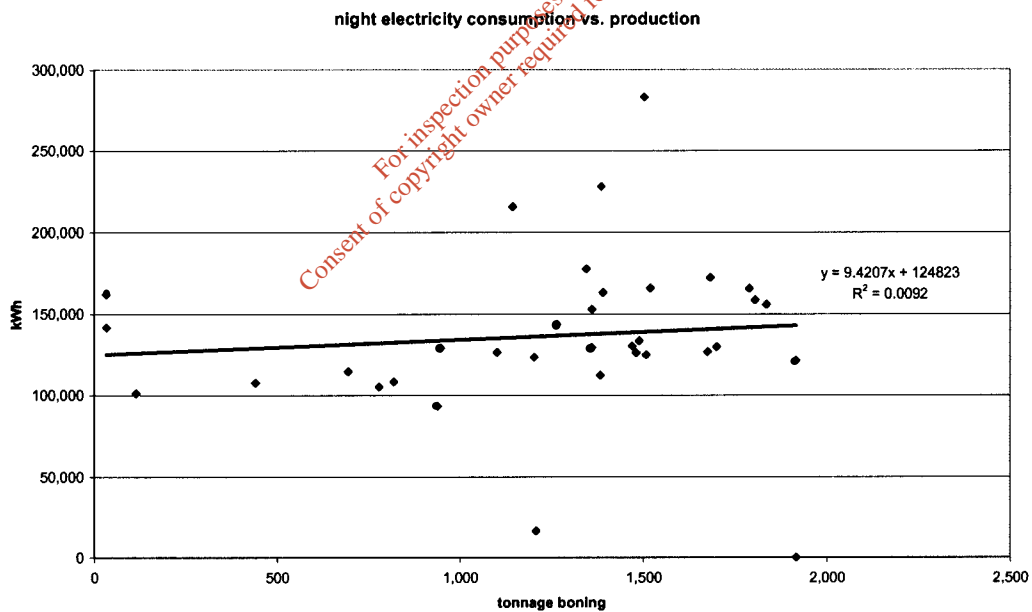


Figure 5-7 Night-time electricity consumption vs. production



It can be noticed that the R-squared values for the comparison of the electricity use against the production for the two graphs above are much lower than the R-squared value for the total electricity consumption of the site shown in Figure 5-3. This is certainly due to the fact that these electricity readings are manually taken and thus subject to human error.

Also, these graphs show that the day-time electricity is definitely related to the production levels whereas the night-time consumption is not.

Figure 5-8 Day-time electricity consumption vs. degree-days

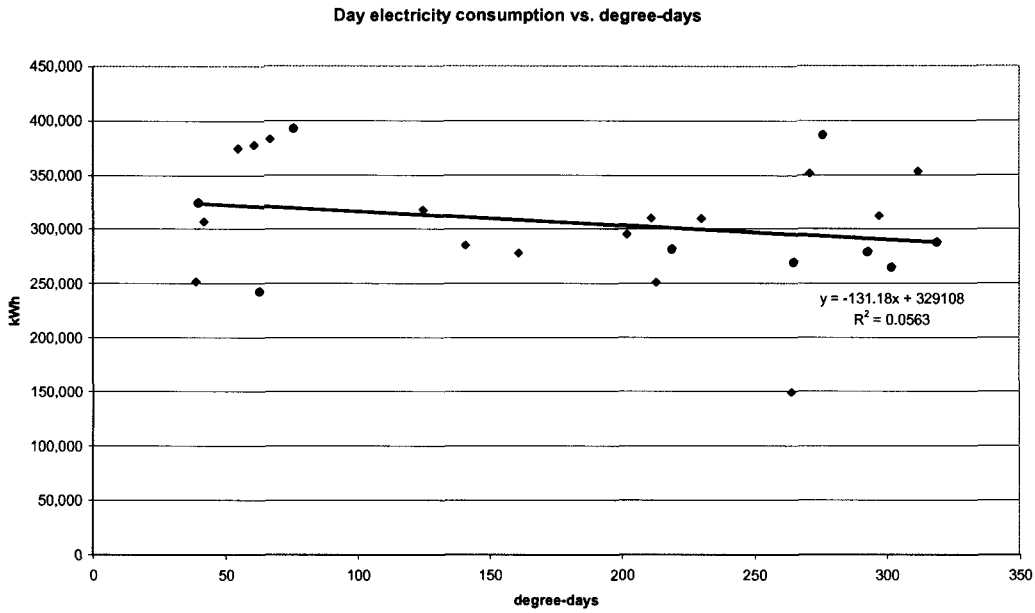
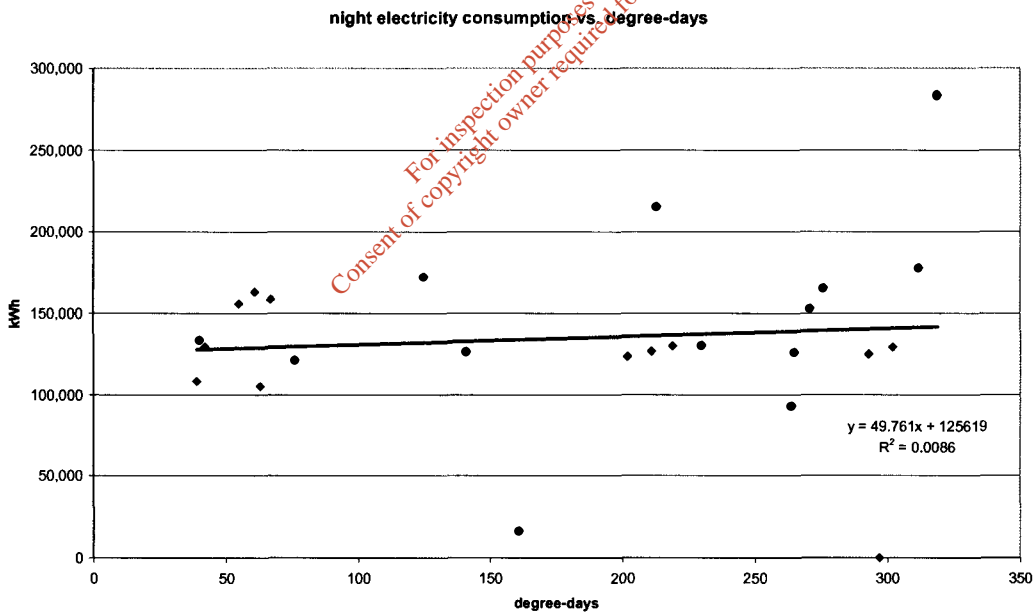


Figure 5-9 Night-time electricity consumption vs. degree-days



As for Figure 5-4, which compared the total electricity consumption to degree-days, the two graphs above show no correlation between the power usage and the outside temperature.

5.2 Fuel oil

5.2.1 Fuel oil

Fuel oil is used to operate the main steam boiler. The back up boiler is not used at present as it is out of order.

Figures for this fuel were available from the company for the period January 2006 – October 2006 and are presented in the table below.

A more detailed account of this fuel consumption is given in Appendix 1 at the back of this report.

Table 5-2 Summary Oil usage

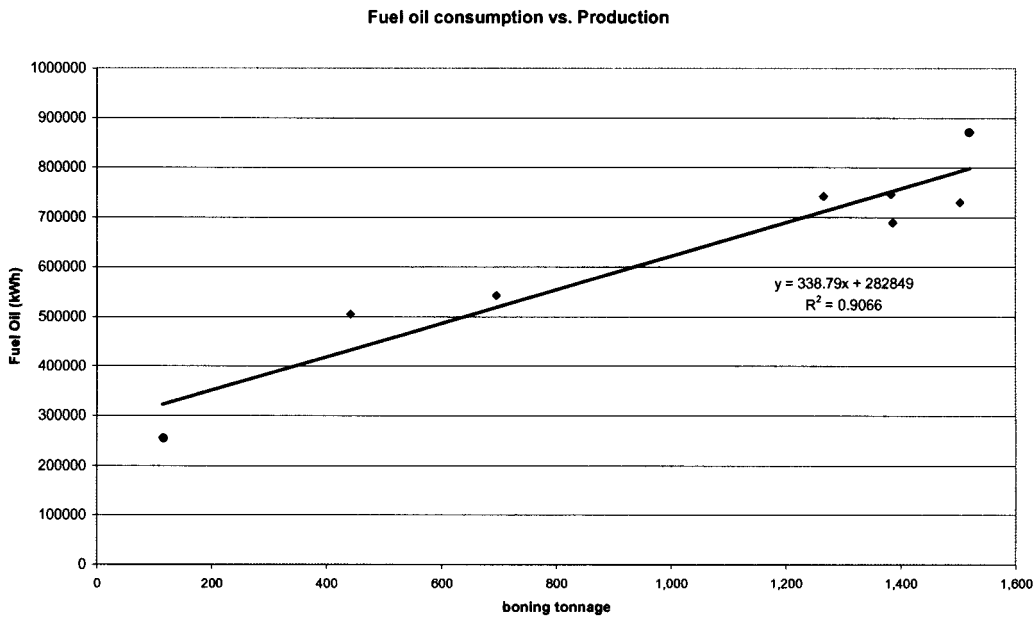
	January 2006 – October 2006	Equivalent November 2005 – October 2006
Consumption, kWh	6,353,870	7,624,644
Consumption, GJ	22,874	27,449
Annual Cost €	169,648	203,578
% Annual Energy	n/a	61.3
% Energy Cost¹	n/a	31.3
Cost c/kWh	2.67	2.67
Cost €/GJ	7.41	7.41

5.2.2 Standardisation of the oil usage

The graph below presents the comparison of the oil consumptions to the production figures. As production figures were only available until the end of August 2006, only the period January to August 2006 could be plotted here. However, the R-squared value of 0.9066 shows that there is a very good correlation between the production levels and the overall oil consumption.

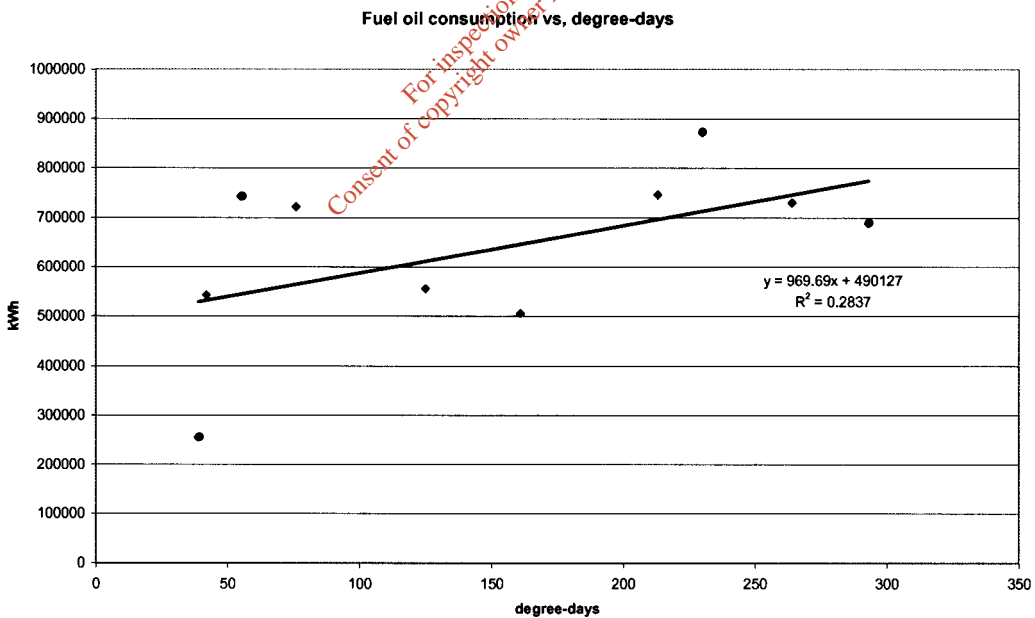
¹ The energy cost was calculated using average fuel oil costs available for January to August 2006

Figure 5-10 Fuel Oil consumption vs. Production



The same figures were compared to the degree-days as can be seen in the following graph.

Figure 5-11 Fuel oil consumption vs. degree-days



5.3 Specific Energy Consumption

The specific energy consumption is a measure of energy use per unit of output. It is used to compare the performance of one plant against another in the same sector.

The Energy Consumption Guide 32 "Red Meat Plants" defines the SEC for these industries as the electricity used to produce one tonne of meat and is expressed in kWh/tonne. Guide 32 outlines the results of an extensive survey carried out in 1992 of a number of meat plants in the UK.

The specific heating fuel consumption (SHC) is defined as energy purchased for a site in a form other than electricity. It is used for the same reason than SEC, to compare the heating fuel usage between sites. The survey averages are annual averages.

The consumption figures for the different fuels for 2005 are summarised in the table below:

Table 5-3 Consumption figures for electricity and fuel oil

	Electricity	Fuel oil	Total
Energy Consumption (kWh)	4,812,010	7,624,644	12,436,654

The quantity of meat produced (boning) for the last year (September 2005 - August 2006) was 15,308t.

The electricity consumption per tonne of meat produced (SEC) is therefore 314kWh/t and the SHC is 498kWh/t.

These figures are compared to the result of the survey done in Guide 32 for secondary production plants.

Table 5-4 SEC and SHC benchmarking

	Survey			Meadow Meats
	<i>minimum</i>	<i>maximum</i>	<i>average</i>	
SEC (kWh/t)	150	350	235	314
SHC (kWh/t)	293	660	440	498

The SEC observed at the Meadow Meat plant is was found to be above the average result for similar companies taking part in the survey and close to the maximum value. However, the SHC figure for the site was found to be close to the SHC survey mean of 440kWh/t.

5.4 Carbon Emissions

With the introduction of carbon taxing inevitable, it will become more and more critical for companies to begin examining energy efficiency from an environmental viewpoint. Companies will be obliged to quantify the carbon emissions, which are generated either directly (e.g. gas or oil usage) or indirectly (electricity usage) from their site. Targets for reductions in these carbon emissions will be set and companies will face heavy penalties if these targets are not met by certain dates. The only way to reach these targets without adversely affecting production is by improving energy efficiency.

From fuel consumption figures we can calculate the carbon emissions from the site. The different energy sources have varying carbon contents. In terms of the energy sources used at the site, the relevant emission factors are detailed in the table below.

Table 5-5 Energy source carbon emission factors

Energy Source	Emission Factor (kg CO₂/kWh)
Electricity form grid	0.776
Fuel oil	0.274

Table 5-6 Summary of annual carbon emissions from the site

	2005
Electricity	
Total Units, kWh	4,812,010
CO₂ Emissions, t	3,734
Fuel Oil	
Total Units, kWh	7,624,644
CO₂ Emissions, t	2,089
Total	
CO₂ Emissions, t	5,823

6 Energy Performance of the main sub-systems

EEC has developed a method where the energy performance of the different sub-systems within a factory can be estimated. The aim of this approach is to provide an easy to interpret overview of the energy performance of each sub-system in a tabular format.

The performance of each sub-system is rated from 1 to 3 where:

- 1 = Needs improvement
- 2 = Fair
- 3 = Good

The overall score for each sub-system corresponds to the average of the scores of all the findings.

It should be noted that these grades were assigned following a 1-day site visit and subsequent desktop review and may not be indicative of the energy performance throughout the year.

The results of this assessment are illustrated in the table below.

Table 6-1 Summary of the scores for the different systems assessed

System	Needs improvement	Fair	Good	Score
Refrigeration System		✓		2
Lighting		✓		1.6
Process and Space Heating System		✓		1.33
Compressed Air System		✓		1.8
Waste Water Treatment System			✓	3
Overall		✓		1.9

6.1 Refrigeration

The refrigeration system in Rathdowney is very old (it is believed to have been installed approximately 30 years ago) and consequently, there are no records or drawings available for this system. The refrigeration compressors constitute the main electricity consumers of the system. As there is a certain amount of freezing on the site, the refrigeration system operates with a two-stage compression.

The refrigeration system at this site is a pumped ammonia system and is mainly constituted by:

- Low stage refrigeration compressors
- High stage refrigeration compressors
- Evaporative condensers
- Solenoid expansion valves with mechanical regulation valves
- Flooded evaporators (pumped ammonia system)

Table 6-2 Main parts of the refrigeration system

Part of system	Location	Quantity	Characteristic	Control and Maintenance
Compressors	Production Building		Belt driven	Regularly inspected and maintained
Condensers	Production building roof		Evaporative	Regularly inspected and maintained
Expansion devices	Several		Solenoid valves with mechanical regulation valves	
Evaporators	Chills and freezers Boning halls Packaging rooms Dispatch areas		Flooded	Defrost controlled manually and with timers Hot gas defrosting
Refrigerant	All the refrigeration system		Ammonia (NH ₃)	No automatic air purger

6.1.1 Compressors

All the compressors in place in Rathdowney are belt driven, which was the standard type of compressors installed at the time of their installation. Although these machines are quite old, they are believed to meet their duty satisfactorily and their replacement would not generate the energy savings to justify of cost of a more recent unit. Moreover, the high stage compressors were overhauled last year by the supplier of the refrigeration system. An investigation could be carried out to determine whether the low stage compressors require overhauls.

The temperature in the room was found to be reasonable. No equipment generating heat was observed in the same room as the compressors.

6.1.2 Condensers

The condensers used at Meadow Meats are evaporative condensers. They utilise both ambient air and the evaporation of water to remove heat from the refrigerant. Good Practice Guide 280 states that *'the big advantage of evaporative condensers over shell and tube and cooling towers is that the circulating pump is much smaller. However, an evaporative condenser needs to be placed close to the compressor, to avoid long runs of refrigerant pipework'*.

A heat recovery system was installed in 1982. However, this system is not working at the moment and has not been working for several years. A more detailed investigation of this system would be necessary to determine the cause of this dysfunction and the potential for repair or replacement of the system.

6.1.3 Expansion valves

Expansion valves have 2 main purposes:

- To reduce the pressure of the liquid refrigerant from the condenser to reach the evaporating pressure;
- To regulate the flow of refrigerant into the evaporator to meet the demand and to prevent liquid refrigerant from leaving the evaporator and entering the compressor (this is done by ensuring that the temperature of the refrigerant

leaving the evaporator is approximately 5°C above the evaporating temperature).

Expansion valves in the refrigeration system are solenoid expansion valves with mechanical regulation. From our discussions with the installers of the system (Brian A. Flynn Ltd.), these valves are believed to be suitable for their duty and no replacement would be envisaged other than the replacement of the gaskets if required.

6.1.4 Evaporators

All the evaporators on site are flooded. Conversely to the direct expansion evaporators, this type of evaporators provides a fully wetted transfer surface and therefore can be considered as more efficient.

As temperatures below 0°C are reached and because the products stored in the refrigerated areas release a large amount of moisture (especially the hot carcasses), the evaporators are subject to ice build up and thus need to be defrosted regularly. At Meadow Meats, the defrosting of the freezers is controlled manually and by timers.

This type of defrosting was discussed with the installer and was thought not to be excessive as an extra defrosting is performed on some occasions. The use of defrost sensors (used to terminate the defrosting cycle automatically) was also discussed. These devices could achieve savings but they would have to be installed on each evaporator of the site, which could induce large investment cost. However, they might be worth investigating.

6.1.5 Refrigerant

Ammonia is the refrigerant used at Meadow Meats. It is a good refrigerant in term of ozone depletion potential (=0) and global warming potential (very low). However, ammonia is toxic and flammable, and reacts with copper.

An ammonia smell was noticed in the compressor room during the site visit. This suggests that there are leaks in the refrigeration system. Good Practice Guide 280 states: "The amount of refrigerant has significant effect the temperature lift – too much or too little charge of refrigerant reduces energy efficiency. Systems that leak refrigerant consume more power than necessary. On average this costs UK refrigeration plant owners an extra 11% on the running costs of their systems."

There is no automatic air purger on the refrigeration system in this plant. Automatic air purgers remove air and other non-condensable gases from an industrial or commercial refrigeration system, with minimum loss of refrigerant. Air and other non-condensable gases leak into refrigerant systems through faulty equipment, particularly seals, and during maintenance operations, especially charging of the refrigerant. In addition, slow breakdown of the refrigerant can also add to the build-up of non-condensables. The presence of air and other non-condensable gases in the condenser and receiver increases system head pressure, which results in excessive compressor power consumption and reduces system capacity. Automatic air purgers remove this air and other non-condensable gases from within the refrigeration system,

resulting in substantial energy savings. It is strongly recommended that this device be installed in the refrigeration system in operation in Meadow Meats.

6.1.6 Chill rooms

Good Practice Guide 283 indicates that the typical heat loads in chill rooms are:

- Heat gain through walls (20%)
- Air change load (30%)
- Evaporator fans (15%)
- Lighting (10%)
- Defrost (15%)

The site is not equipped with automatic doors. However, during the audit, the doors to the chill rooms and freezers were closed when not in use. This is a very good practice as the air change load is greatly reduced.

A large amount of lights are used in most of the refrigerated areas (about 250 lights) as there is no natural light in the building. During the site visit, the lights in the hot carcasses chills were found to be turned on when the rooms were unoccupied. It was also noticed that the lights in the boning hall were left on during the lunch break. This is not a good practice as it increases the cooling load on the system.

Table 6-3 Assessment of the performance of the refrigeration

Refrigeration	Needs Improvement	Fair	Good	Score
Compressors		✓		2
Condensers		✓		2
Expansion valves (thermostatic)		✓		2
Evaporators		✓		2
Refrigerant		✓		2
Chill rooms		✓		2
Overall		✓		2

6.2 Lighting

The production area being almost entirely refrigerated, there are very few openings in the building and therefore a great amount of artificial lighting is needed.

Most of the lights used at Meadow Meats are believed to be fluorescent tube lamps. Following a fire in April 2006, the boning hall was rebuilt with new materials and equipment. The lighting in all this area has refurbished with electronic ballasts. Overall, the percentage of electronic ballasts is 60%, the rest being electromagnetic ballasts.

The fluorescent tubes have a rated power consumption of 58W. There are no occupancy sensors on the site but there is a policy of turning off the lights in place. To our knowledge, this policy is well followed by the employees.

Occupancy sensors would be of interest in offices or in the offices and the different chills, but they would not be suitable in the other production areas.

Table 6-4 Assessment of the performance of the lighting

Lighting	Needs Improvement	Fair	Good	Score
Use of efficient lights (Fluorescent T8)			✓	3
60% of electronic ballasts		✓		2
Lights left on in the boning hall and killing line	✓			1
Lights left continuously on in the chillers	✓			1
Automatic lighting control (switches, timers, sensors, etc.)	✓			1
Overall				1.6

6.3 Process and Space Heating (Steam boiler(s))

There are two boilers on the site.

- The main steam boiler has a capacity of 10,000lbs of steam per hour and is fuelled by fuel oil. The boiler is generally running from 7am to 12am and was operating at a pressure of 8.5bar during the site visit.
- The back-up boiler is operated with fuel oil but is not in use anymore as it was reported to be broken. In normal conditions, the main boiler should be sufficient to meet the steam requirements for the whole plant but this boiler is necessary to meet peak demands.

The availability of only one of the two boilers is a major concern for the company as 90°C water is a fundamental requirement of the killing process for hygiene reasons. If the main boiler was to fail, the financial losses would be tremendous.

Both process water heating (at various temperatures) and space heating are supplied by the main steam boiler. The hot water is supplied at 3 different temperatures, using heat exchangers:

- 90°C Sterilizer water in the slaughtering line
- 65°C Wash down water
- 45°C Sink water

It is not considered good practice to use steam for water heating as the steam is generated at a very high temperature, requiring a large amount of energy, when it is only needed at a lower temperature. However, the use of a steam boiler cannot be totally eliminated at the facility as steam is needed for the tallow plant where it is directly injected. A few different options can be envisaged to improve the efficiency

of the boiler system. These options are described in more detail in Section 7.3.3 of the recommendations.

There is no condensate return in place at the site. Whenever possible, the opportunities for condensate recovery should be examined. Indeed, Fuel Efficiency Booklet No. 2 on "Steam" states that "*Condensate is ideal boiler feedwater due to its heat content and chemical suitability*". Moreover, there are substantial potential savings from condensate recovery; FEB2 mentions a fuel saving of 1% for every 6°C rise in the feedwater temperature. However, where the boiler is located away from the steam consumption points, the heat from the condensate might dissipate before returning to the boiler, even with good insulation. On this site, the boiler room is located away from the factory building and therefore condensate recovery might not generate any energy saving. However, the water treatment costs would be greatly reduced.

The insulation in the boiler room appeared to be relatively poor as much of the insulation was worn. Also, the fronts and backs of the boilers, the valves and flanges as well as the heat exchangers were not insulated. The temperature of the back of the main boiler was measured during the audit and was found to be of 120°C. The temperature of the plate heat exchangers and valves in the boiler room could not be measured as they could not be accessed because the metallic access ladder was too hot to be climbed. This suggests that the temperatures in this area are very high.

Both boilers are fitted with digital combustion control equipment, which is very good practice as the fuel:air ratio is an important factor for the good operation of a boiler. However, the physical control of the quantity of inlet air is done through a damper, which means that little energy is saved for the fan at part flow compared to full flow.

Table 6-5 Assessment of the performance of the process heating

Heating system	Needs Improvement	Fair	Good	Score
Configuration (Only one boiler running)	✓			1
Use of steam to heat hot water	✓			1
No condensate return	✓			1
Insulation	✓			1
Steam leaks	✓			1
Digital combustion control			✓	3
Overall		✓		1.33

6.4 Compressed air

Compressed air is especially expensive to generate and represents approximately 10% of industrial electricity usage. Typically over a ten year period the total costs involved are 75% energy, 15% capital and 10% maintenance. Therefore it is especially

important that the compressed air system has a high efficiency and that the compressed air is itself used efficiently.

There are two air compressors on the site: Cyclon 600N and Atlas Copco GA55. They are operated in a duty/stand-by configuration. One compressor is sufficient for the site.

They operate at a pressure of 8 bar which is higher than the average operating pressure of normal industrial systems (7bar). It is a good practice to operate the air compressors at the lowest possible pressure as less energy is required to generate the compressed air and as the flow of air lost in leaks decreases with the pressure. During discussions with the maintenance staff, it was reported that this pressure is necessary for the operation of the blow pots. However, it is believed that this equipment is only used during the killing days. It is unknown if this pressure is reduced when the blowing pots are not in use.

The compressors are located in a dedicated room, away from the steam boilers. However, the warm air generated by the compressors is expelled into the same room resulting in a high ambient temperature ($> 25^{\circ}\text{C}$) which reduces the compressors efficiency.

There was no leak survey carried out in the recent past. A data logger was fitted on the running compressor for a period of 24h. From the results of this survey, the percentage of leakage for the site could be estimated and was found to be of approximately 34%, which is a typical value.

Compressed air is mainly used for:

- Hand tools
- Packing
- Pneumatic stands
- Blowing the hide and paunch

Although it is understood that the use of compressed air to convey the paunch manure to its designated waste area is clean and convenient, it is also very demanding in terms of energy. The same technique was observed in other Dawn Meats sites, which suggests that this is a typical practice in meat plants. Less energy intensive alternatives should be investigated.

Table 6-6 Assessment of the performance of the compressed air system

Compressed air	Needs Improvement	Fair	Good	Score
Air pressure delivered		✓		2
Configuration			✓	3
Temperature of the intake air	✓			1
Warm air expelled in the room	✓			1
Leakage		✓		2
Overall		✓		1.8

6.5 Wastewater treatment plant

The wastewater treatment plant in Meadow Meats is one of the major energy consumers because of the high number of large motors running constantly.

The main motors in the plant are as follows:

- 5 × 11kW Aerators and 1 + 1 × 5kW Aerator
- 18.5kW Air blower for DAF Unit (30 Hz)
- Other air blower 4kW (Winter 30Hz – Summer: 30-40hz)

The aerators are controlled by the Dissolved Oxygen (DO) Concentration. This is good practice as it prevents the motors from running when not needed.

As part of the wastewater treatment process, a belt press is used for dewatering the sludge. This press is equipped with 3 × 2kW motors, running 24 hours per days, 5 days per week. There is a large amount of water used to wash the belts (25m³/h of hard water and 7-8m³/h of clean water). From discussion with the person operating the treatment plant, there is an opportunity to reuse this water to a certain degree, e.g. with a filter.

Table 6-7 Assessment of the performance of the WWTP

WWTP	Needs Improvement	Fair	Good	Score
Motors running continuously (no need for soft starters)			✓	3
Constant load (no need for VSDs)			✓	3
Maintenance			✓	3
Overall			✓	3

6.6 Other equipment

Power packs:

A number of power packs are used on-site for the operation of platforms and other hydraulic equipment. These power packs are usually left on even when the equipment that they supply is not in use. When this occurs, compressed air is still being generated by the power pack but is continuously released by a relief valve and therefore producing no work. During long breaks, such as the lunch break, this can be very wasteful of energy.

Vacuum pumps:

The vacuum pumps on the site are used to operate the two vacuum packing machines in the boning hall. There are six 15kW-vacuum pumps and one booster in total (four pumps and the booster for one machine and the other two pumps for the second vacuum packing machine). They are large users of energy and also produce a significant amount of heat. Indeed, the room where these pumps are located was warm. Although lower temperatures would be preferable for the efficiency of the motors, it is believed that it would be very difficult and costly to relocate these pumps or to provide ventilation in this area (basement).

Knife sterilizers:

Originally, all the knife sterilizers were supplied by the steam boiler. However, after the destruction of the boning hall by a fire in April 2006, the knife sterilizers in this area were replaced by electrical models (10~12 units). These units are believed to be equipped with thermostats, which is a good practice. Moreover, electrical knife sterilizers are usually considered more energy efficient than the other models as they avoid the heat losses in the steam/hot water pipes.

The sterilizers in the killing line and the chills are still heated by steam. The temperature of the water in the sterilizers is of around 80~82°C. In the killing line, most of the sterilizers are located on raise/fall platforms and are supplied by flexible hoses from the ceiling. Although the flexible hoses are not insulated as this would not be practical, the pipes are insulated until their connection to the hoses. During the staff lunch break, it was noticed that some saw sterilizers were overflowing and/or had no lid.

Typically, the presence of lids on the sterilizer boxes is found to be unpractical by the employees. However, during long breaks such as the lunch break, the heat loss from the boxes is similar to the heat losses when the sterilizers are in use. During these periods, the covering of the sterilizer boxes, at least the largest ones like the saw sterilizer boxes, should be considered to reduce the heat losses and the cooling load on the refrigeration system.

7 Recommendations

Following the site visit the information gathered was analysed and a number of energy saving opportunities have been identified and are now discussed. A distinction between energy saving and energy cost saving should be made at this juncture. An energy saving will result in an actual reduction in the total units of energy consumed by a particular piece of equipment and will signify an improvement in energy efficiency. An energy cost saving may or may not result in such a reduction but will always result in a reduction in the cost of the energy to operate a particular piece of machinery. Such a reduction will usually occur when there is change over to a cheaper source of energy. It is possible to have both an energy saving and an energy cost saving associated with the same recommendation. A number of saving measures may be made to the same system and so the exact monetary saving figures may differ depending on which recommendations are implemented. The percentage savings will however remain the same.

All of the calculations on savings and consumptions in this report are based on billing figures for the period September 2005 – August 2006. It should be noted that this report has dealt with a number of areas at the plant where it is felt energy savings are possible. However, this report cannot be exhaustive and other opportunities for further energy conservation still exist at the plant.

These recommendations are summarised in Table 7-1 and discussed in detail in this section. Other recommendations were also made in this report, for which further study would be needed, and which are therefore not included in the table:

- Investigate other means to convey the paunch manure
- Compressed air distribution measurement and control
- Install occupancy sensors in the offices
- Zoning of the lighting in some carcasses chills
- Lighting system in the carcasses chill rooms
- Use separate boiler for hot water generation / Review configuration of the boilers
- Use a separate heating system for the offices
- Further recommendations for the refrigeration system (replacement of valve gaskets, relagging of pipes, heat recovery system, overhaul of the low stage compressors)
- Implement a motor management policy

Table 7-1 Summary of energy and energy cost saving measures

Measure	Potential savings, kWh/yr	Potential emissions savings, t CO ₂	Potential cost saving, €/yr	Approx. cost of measure, €	Cost/annual CO ₂ savings, €/t	Payback period, years
Reduce compressed air leaks	18,310	14.2	1,699	0	0	0
Compressed air pressure reduction	2,482	1.9	230	0	0	0
Fix five steam leaks	117,445	32.2	3,136	0	0	0
Use cheap rate power during night-time	0	0	1,759	0	0	0
Insulate 10m of pipes, 10 valves and 10 flanges	79,688	21.8	2,126	450	20.6	0.21
Install an automatic air purger on refrigeration system	505,261	392	46,888	10,000	25.51	0.21
Monitoring and targeting	621,833	227.5	32,501	10,100	44.4	0.31
Insulate 1 plate heat exchanger	4,312	1.2	115	135	114.4	1.2
Install isolation valves on compressed air system	18,310	14.2	1,699	2,200	154.9	1.3
Insulate the front and back of the boiler	112,476	30.8	3,004	2,600	84.4	1.7
Use a separate boiler for hot water generation (Option2)	1,215,000	332.9	32,400	68,000	204.3	2.1
Reduce air inlet temperature for the air compressor	1,191	0.92	110	300	326	2.7
Totals	2,696,308	1,070	125,667	93,785	88	0.75

7.1 Air Compressors

7.1.1 Compressed air leaks

Leakage is the largest single waste of energy associated with compressed air usage with leakage rates as high as 50% common on some sites. The potential sources of leakage are numerous but the most common ones include:

- condensate drain valves left open
- shut-off valves left open
- leaking pipes and pipe joints
- leaking hoses and couplings
- leaking pressure regulators
- air cooling lines left open permanently
- air-using equipment left in operation when not needed.

It must be realised that leakage is not only a direct source of wasted energy, but is also an indirect contributor to operating costs. As leaks increase, system pressure drops, air tools function less efficiently and production is affected. Often the only solution is to increase generation pressure to compensate for the losses.

The first step in tackling leaks is to determine the level of leakage. From the data logging of the compressors carried out as part of the audit, this leakage rate was found to be approximately 34%.

However, this test can be carried out by the company using a simple and effective method called no-load testing. The method for this is as follows:

- Close down all of the air operated equipment (this may be best facilitated after production hours or during a period of shut down).
- Start the compressor and operate it to full line pressure. The compressor will off-load at this point.
- Over a period of time the system pressure will drop due to leakage and the system will on-load at the minimum running pressure set on the compressor control panel.
- Over a number of cycles make a note of average on-load time (T) and average off-load time (t).
- Total leakage can then be calculated from:

$$\text{Leakage (L / sec)} = \frac{Q \times T}{T + t} \quad (\text{where } Q = \text{air capacity of the compressor (L/sec)})$$

- No-load tests should be carried out regularly, at least every three months, to continuously monitor the leakage level on site.

Once the overall situation has been assessed then individual leaks should be identified and repaired. The best time to conduct these leak surveys is during shutdown periods as the larger leaks within the compressed air system are audible. Once the larger leaks have been identified and repaired then smaller, less audible leaks should be addressed. The minimum cost solution is to paint or spray a soap solution onto each

joint or connector and watch for bubbles or to use a suitable aerosol spray. Any leaks found should be tagged and marked on an organised repair plan. The leaks can then be repaired later. Once these leaks have been repaired the leakage rate should then be re-estimated using the method described above. If the leakage is still excessive, then it may be appropriate to purchase an ultrasonic leakage detector, these range in price from €600 to €4,500 depending on specification. Such devices will allow the operator to pin point leaks in the presence of significant background noise.

Surveys have shown that in the UK for typical industrial plant the average compressed air leakage is 39% and fell on average to 18% after the corrective action described below was carried out. The accepted leakage rate is 10%.

For the calculations, it was assumed that the site will reduce the compressed air leakage from the current 34% to 10%. It was also estimated that half of this reduction would be achieved through repairs of the leaks and the other half by the installation of isolation valves (See next recommendation).

Table 7-2 Cost & savings associated with reduction in compressed air leaks

Current electricity usage, kWh	152,580
Current electricity cost, €	14,159
% Decrease in leakage rate	12
Energy saving, kWh	18,310
Emissions savings, t CO₂	14.2
Energy cost saving, €	1,699
Cost of project, €	0
Cost per annual CO₂ savings, €/t	0
Payback, years	0

7.1.2 Isolation valves

In addition to the leakage reduction, it is also recommended that the company rationalises the compressed air system by installing solenoid isolation valves. This would prevent the supply of compressed air to broken or unused equipment or unused areas. A possible way to implement this recommendation is to divide up the compressed air system into zones and then fit isolation valves to each zone. A more detailed study should be carried out before deciding exactly where to install the isolation valves. For the purposes of this report, 4 isolation valves shall be costed (i.e. for the boning hall, the packaging areas, the killing line, paunch manure blowing pipework). The cost of a valve varies widely with its size. As an average, it was estimated that the cost including fitting per valve is of about €550.

Table 7-3 Cost & savings associated with the installation of isolation valves

Current electricity usage, kWh	152,580
Current electricity cost, €	14,159
Energy saving, kWh	18,310
Emissions savings, t CO₂	14.2
Energy cost saving, €	1,699
Cost of project, €	2,200 (4 isolation valves)
Cost per annual CO₂ savings, €/t	154.9
Payback, years	1.3

7.1.3 Air Pressure Reduction

Normal industrial systems tend to have compressed air systems operating at 7bar pressure. The air compressors operate at approximately 8 bar. This pressure is used to meet the requirement of the blow pots, which are used on killing days. However, it is believed that this setting is not reduced when the blow pots are not in use.

Moreover, a part of this pressure is used to compensate for leakage. Recommendations have been made earlier in this report with regard to leakage reduction. It is recommended that the leaks be rectified before reducing the air pressure. Once the leakage rate has been reduced sufficiently it is recommended that the cut out pressure be reduced in steps of 0.2 bar until the minimum pressure which still gives satisfactory operation is found. The Good Practice Guide 126 "Compressing Air Costs" states "it takes up to 5% more electricity to generate the air at a 10% greater pressure". In addition, if the pressure is lower, the load on the air drier will be reduced. This recommendation will give an immediate payback.

It is therefore recommended that the operating pressure be lowered as much as possible. It is not known if this reduction could be achieved on killing days as the blow pots have to be operational. However, it is believed that the pressure could be reduced during the other production days.

For the purposes of the calculation, the pressure reduction was assumed to be 1 bar which corresponds to a reduction of 12.5% in pressure and therefore 6.25% in electricity consumption.

Table 7-4 Costs & savings associated with reducing air pressure

Current electricity usage, kWh	39,714
Current electricity cost, €	3,685
Energy saving, kWh	2,482
Emissions savings, t CO₂	1.9
Energy cost saving, €	230
Total cost of project, €	0
Cost per annual CO₂ savings, €/t	0
Payback, years	0

7.1.4 Expel hot air to outside and reduce air inlet temperature

As mentioned before, the air used to cool the compressor is taken from the compressor room and expelled to inside the room. This explains why the temperature of the room is high.

Good Practice Guide 126 states that “the location of the air compressors on site can have a bearing on the amount of energy used by the compressor. Cool, clean, dry intake air will lead to more efficient compression. Where possible, air should be taken from outside the building because its temperature will be lower.” Furthermore the guide also states that “The condition of the air entering the compressor is extremely important, since fouling of inlet filters and high ambient air temperature can result in significant energy wastage”.

The air in the compressor room was greater than 25°C, which is 12.5°C higher than the average outside air temperature for September. The cooling air is drawn from inside the compressor room at 25°C. In order to reduce the air inlet temperature, the ambient air temperature in the room has to be decreased.

For every 4°C drop in intake temperature, there is a 1% increase in efficiency. For the purpose of this report, a reduction of air inlet temperature of 12°C was assumed, i.e. an energy saving of 3%.

The hot air expelled from the air compressors can be collected in ducts, then gathered in a large duct and finally rejected outside. As the hot air is expelled outside the compressor room, the ambient air temperature in the room decreases and so does the air inlet temperature. Moreover, as the distance between the compressors and the roof is reasonably short, it is not believed that fans will be needed to convey the hot air through the ducts. Further investigation should be done to design the ducts and their configuration.

Table 7-5 Costs & savings associated with reducing air inlet temperature

Current electricity usage, kWh	39,714
Current electricity cost, €	3,685
Energy saving, kWh	1,191
Emissions savings, t CO₂	0.92
Energy cost saving, €	110
Total cost of project, €	~300
Cost per annual CO₂ savings, €/t	326
Payback, years	2.7

7.1.5 Investigate other means of conveying the paunch manure

Energy surveys conducted at several of the Dawn Meat Group facilities have shown that it is common practice to use compressed air for blowing the manure paunch from the slaughtering area to a designated outside storage area at many of the sites. This system is in use at Meadow Meats. Although it provides a clean and convenient way of moving the manure, the system is believed to be very wasteful in terms of energy.

It is recommended that alternatives to the current system be considered. In particular, the Dawn Meats Group should investigate the possibility of using air blowers to move the manure instead of compressed air. As part of the energy audit, air blower suppliers were contacted. Discussions with Vacuum Spare Ireland suggest that it would be necessary for the company to change their paunch cleaning procedure if air blowers were introduced.

Currently the company use water to wash out the paunch manure from the stomachs. The stomach contents is then collected in a blow pot and blown intermittently to the collection point. This means that the contents that are blown by the compressed air are a wet mixture of grass and water which would be too heavy for the air blowers to move.

If air blowers are installed, the company will need to change to the method described by the EC's BREF document for Slaughtering houses and Animal By-Products Industries as the 'dry process'. This means that the contents are removed manually from the stomachs without water. After the dry contents are removed, the stomach is washed in running or recirculated water. It is believed that it would be possible to move this lighter mixture using air blowers. This may involve additional investment costs, such as the purchase of new workbenches or equipment.

As the implementation of this recommendation is likely to mean that procedures will need to be changed and that new equipment may need to be purchased in addition to the capital cost of installing air blowers, it was not possible to estimate the capital cost or the savings that might be achievable if this recommendation is implemented.

7.1.6 Compressed Air Distribution Measurement and Control

As part of the energy reduction programme for the whole of the Dawn Meats Group, it was suggested that compressed air flow meters should be employed to measure the compressed air usage patterns and to investigate the compressed air consumption of particular pieces of equipment. These devices may also be used to complement the annual compressed air leaks survey (e.g. to confirm the results from the repairs recommended in the survey by comparing the compressed air usage before the survey and after the repairs). Furthermore, they can be connected to any energy management system.

The cost of these flow meters is approximately €2,500 with an extra €1,000 for installation¹. Once one tapping point is installed, it is possible to insert and remove the flow meter when needed. A single flow meter can therefore be used for several measurement locations. However, an additional device will be needed (at extra cost) to adapt the parameters of the device to different pipes.

If the Dawn Meats Group decides to implement this recommendation, it is suggested that a small number of units be shared between several sites and that regular surveys be carried out.

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¹ These prices were obtained from MeasurIT. The company is also in the process of providing us with a quote for the additional device that will have to be used when moving the unit and also for a mobile unit.

7.2 Lighting

7.2.1 Install occupancy detectors

The use of occupancy detectors was discussed during the audit. As previously mentioned, these devices would not be suitable for the production areas for safety reasons. However, they could achieve savings in the offices (especially bathrooms, kitchen, meeting rooms) and in the unfrequented areas such as the compressor room.

Occupancy sensors operate by switching the lights on once somebody is detected in an area by an in-built infrared sensor. Once the person leaves the room, the light switches off automatically after a defined period of time.

It is very difficult to estimate the savings associated with such a recommendation, especially as the policy of turning off lights when a room is unoccupied appeared to be very well followed. However, these devices are relatively cheap (€80) and could therefore be worth installing where it is felt that significant saving can be achieved.

7.2.2 Lighting system in the carcasses chill rooms

For the carcass chill rooms, where there are two access doors, it is proposed to install a system to automatically switch off the lights after a predetermined period of time when both doors are closed. It is believed that this will avoid the risk of the lights turning off when the room is occupied (which could be a concern with the infra-red occupancy sensors).

Here again, it is difficult to calculate the savings from this system, especially because the policy of switching off lights is well followed in the company. However, it is believed that this recommendation can be implemented at a low cost and is therefore worth putting in place.

7.2.3 Zoning of the lighting in some of the carcasses chills:

In some of the carcasses chills, it was noticed that only one switch was controlling the lighting of the entire room. However, when the room is full of product, the back of the chill is not easily accessible and is only used for the inspection of the meat. The rest of the time, the lighting is only needed to access the next chills.

It is believed that the zoning of the lighting in these chills (e.g. in two zones) could generate energy savings with a low implementation cost.

7.3 Water heating system

7.3.1 Insulate pipes, valves, flanges, heat exchangers and tanks

During the site visit, it was noticed that valves, flanges and heat exchangers were not insulated and some pipes were poorly insulated. There was no insulation on the backs and fronts of the steam boilers.

Good Practice Guide 197 states that “*Insulating unlagged sections of pipework and fittings is one of the simplest and most cost-effective ways of increasing the energy efficiency of a heat distribution system. The payback period is typically less than a year*”.

It is now considered good practice to insulate valves and flanges. As an indication of the scale of heat loss from flanges and valves, it is generally accepted that an uninsulated valve would lose the same amount of heat as 1m of uninsulated pipe of the same bore and an uninsulated flange will lose approximately half of this amount. A common objection to the insulation of flanges and valves was the inconvenience of having to remove large boxes stuffed with insulation in order to get to the valve or flange for maintenance. New designs of valve and flange insulation typically consist of easily removable jackets constructed from 50mm foil-faced mineral fibre insulation with an outer and inner lining of fibre re-enforced fabric. The jackets can be secured either by Velcro, fasteners or tie cords. The cost of these jackets varies widely with the size and the type of valves (i.e. flanged, screwed). Potential suppliers of insulation jackets are provided in Appendix 2

The potential energy savings which could be achieved by insulating pipes, valves and flanges were calculated as shown in Table 7-6. For the purpose of the calculation, it was assumed that 10 meters of pipe, 10 valves and 10 flanges would be insulated.

Additional savings can be achieved if the front and back of the steam boiler and the heat exchangers are insulated. These savings were estimated at approximately €3,000/year for the boiler and €115/year for one plate heat exchanger.

Table 7-6 Cost & Savings associated with the insulation of 10-meter pipes, 10 valves and 10 flanges

Energy saving, kWh	79,688
Emissions savings, t CO₂	21.8
Energy cost saving, €	2,126
Total cost of project, €	450 ¹
Cost per annual CO₂ savings, €/t	20.6
Payback, year	0.21

¹ Cost estimated from Kendrick Insulation Ltd.'s price list.

Table 7-7 Cost & Savings associated with the insulation of 1 plate heat exchanger

Energy saving, kWh	4,312
Emissions savings, t CO₂	1.18
Energy cost saving, €	115
Total cost of project, €	135 ¹
Cost per annual CO₂ savings, €/t	114.4
Payback, year	1.2

Table 7-8 Cost & Savings associated with the insulation of the front and back of the boiler

Energy saving, kWh	112,476
Emissions savings, t CO₂	30.8
Energy cost saving, €	3,004
Total cost of project, €	2,600 ¹
Cost per annual CO₂ savings, €/t	84.4
Payback, year	1.7

7.3.2 Fix steam leaks

Good Practice Guide 197 states that *Preventing/curing leaks is one of the most straightforward areas for saving heat. Since steam is a vapour under pressure, leaks from flanges and valves are common.*

As some visible steam leaks were identified during the site visit, some figures are given below to evaluate the cost of repairing five steam leaks. According to Energy Consumption Guide 67, the mass of steam leaking (M_L in kg/h) can be calculated from the length of visible plume (L in m) with the following equation: $M_L = 2.8 \times 6.0^L$.

The following table shows the savings associated with the repair of five steam leaks.

¹ Cost estimated from a previous quotation from Kendrick Insulation Ltd.

Table 7-9 Cost & Savings associated in fixing five steam leaks (40cm plume)

Energy saving leaks, kWh	117,445 ¹
Emissions savings leaks, t CO₂	32.2
Energy cost saving, €	3,136
Total cost of project, €	0
Cost per annual CO₂ savings, €/t	0
Payback, months	0

7.3.3 Use a separate boiler for hot water generation / Review configuration of the boilers

As mentioned in Section 6.3, the company is mainly concerned by the fact that only one steam boiler is in operation at the site and has to meet the heating demand of the whole plant. The system therefore has to be improved to provide a back-up solution in case of failure to allow the production to continue without too much delay. The study of the different options available also focused on making the system as energy efficient as possible.

At present, the company uses this steam boiler to meet both their steam and hot water demand. Steam is used for all hot water generation by passing it through heat exchangers. This water is used in a variety of different ways including cleaning. Heating water this way is not very efficient as the generation of steam requires a large amount of energy. It is therefore recommended to use a separate hot water boiler for this purpose and to operate the steam boiler only for the parts of the process where direct injection of steam is required, i.e. for the tallow plant.

There is not enough information at present to accurately determine the different sizes that would be needed for the replacement boiler(s). It is recommended that steam meters or alternatively water meters be installed to measure the average and peak heating demand of the different parts of the process. For the purpose of this report, the hot water demand and the steam demand were roughly estimated as follows:

- Average specific heat consumption for a red meat plant: 440kWh/t
- Actual specific heat consumption for the site: 498kWh/t
- Difference between actual and average SHC: 58kWh/t

The difference between the actual and the average SHC's for the site was assumed to be the tallow plant steam demand. Indeed, it is believed that the figure given in ECG 32 does not include rendering plants as the document states that "Some UK plants still have rendering facilities on site, although this is not the norm".

The steam and hot water demands can therefore be calculated by multiply the SHC's by the tonnage of meat produced during the same period (September 2005 – August 2006), i.e. 15,308t:

¹ The boiler is running at about 7bars, 17 hours/day. The efficiency of the boiler was assumed to be of 80% and the average length of the steam plumes was estimated at 40cm.

- Steam demand = $58 \times 15,308 = 887,864 \text{ kWh/yr}$ (~12%)
- Hot Water demand = $440 \times 15,308 = 6,735,520 \text{ kWh/yr}$ (~88%)

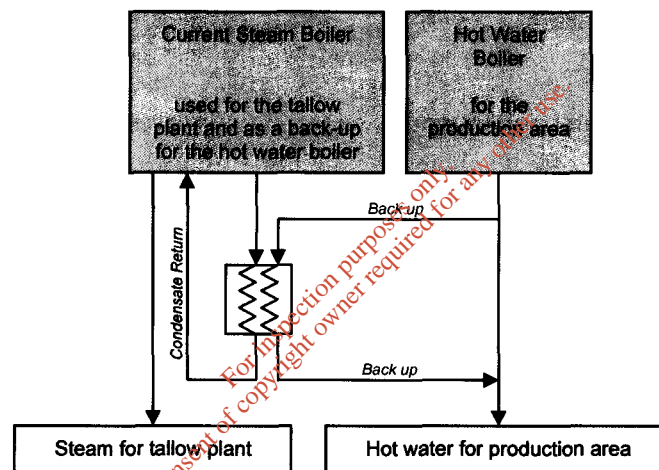
The tallow plant is operating in average 4 days per week (killing days) and it was assumed that the plant runs for 8 hours per day.

$$\rightarrow \text{Average steam demand in kW} = \frac{\text{kWh/yr}}{\text{hours/yr}} = \frac{887,864}{4 \times 8 \times 50} \approx 550 \text{ kW}$$

$$\rightarrow \text{Average hot water demand in kW} = \frac{\text{kWh/yr}}{\text{hours/yr}} = \frac{6,735,520}{5 \times 18 \times 50} \approx 1,500 \text{ kW}$$

Different options were studied to improve the current boiler system:

Option 1:



In this option, all the hot water would be generated by a medium pressure hot water boiler. The current main steam boiler would still be used for the tallow plant and would also act as a back up boiler for the hot water boiler if it was to fail. However, with this solution, it is believed that if the current steam boiler would be considerably oversized as it is used solely to supply the tallow plant. Even if the energy requirement for the steam generation will be considerably reduced, the shell losses from this boiler will remain the same (up to 10% of the kW rating on old boilers).

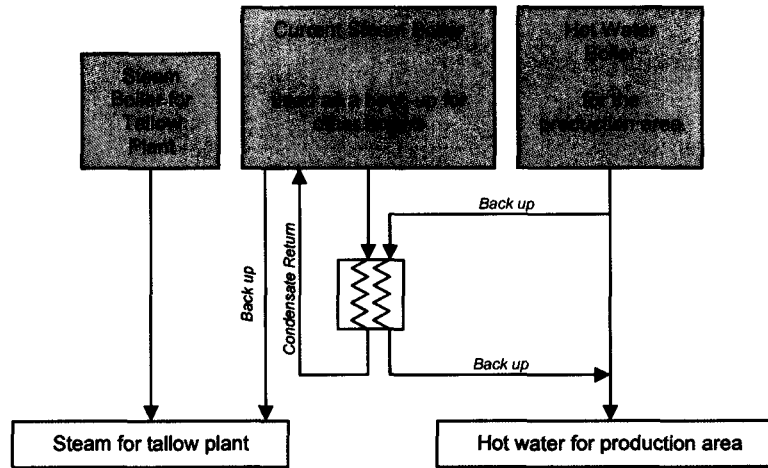
The cost of a 1.5MW boiler is of approximately €38,000¹. However, this size of boiler was calculated from the average heat demand of the site. To ensure that the hot water boiler will be able to cope with the start-up demand and other peak demands, it could be necessary to acquire a larger boiler. Another boiler with a rated power of 3MW (power rating of the current steam boiler) was also priced for this report at about €50,000.

With this option, the energy savings would mostly be generated by the reduction of the heat loss in the piping system. Indeed, the losses would decrease with the

¹ From quotation from KB Combustion, see Appendix 3

reduction of temperature of the fluid. However, it does not eliminate or reduce the shell losses from the current steam boiler.

Option2:



In this option, the main boiler would be a medium pressure hot water boiler to generate the hot water for the plant (excluding offices). A dedicated small steam boiler would supply the tallow plant. The current steam boiler would be used as a back up for the two duty boilers.

The cost of a 500kW steam boiler that would be dedicated to the tallow plant was estimated at about €18,000.

The cost of a 1.5MW boiler is of approximately €38,000¹. Here again, this size of boiler was calculated from the average heat demand of the site. To ensure that the hot water boiler will be able to cope with the start-up demand and other peak demands, it could be necessary to acquire a larger boiler. Another boiler with a rated power of 3MW was also priced for this report at about €50,000.

To reduce the required size of the hot water boiler, two options can be envisaged:

- One option would be to use the current steam boiler for the morning demand and then switch to the 1.5MW hot water boiler to cope with the average load. However, if there is no timer or tight manual control on the current steam boiler, this solution could mean that the current steam boiler would be left idling for non peak periods, thus resulting in significant shell losses.
- Alternatively, the smaller steam boiler (tallow plant) could be used to complement the 1.5MW hot water boiler during the morning peak (resulting in 2MW of available heat). This means that the production of tallow would be delayed until later in the morning but it is not believed that this would cause a problem. To achieve this, the boiler will have to be connected to the plate heat exchangers for the production of hot water (like the current steam boiler), increasing the installation costs.

In terms of savings, these would mostly arise from:

¹ From quotation from KB Combustion, see Appendix 3

- Reduction of the radiation losses from the shell of the boiler: These losses increase with the surface temperature of the boiler and therefore its operating temperature. Also, the radiation losses from the current steam boiler are believed to be high (they can be of up to 10% of the rated power in old boilers) and its replacement with a new boiler would automatically decrease the percentage of losses (usually 1% on recent boilers). This would result in an energy saving of up to 9% of the kW rating of the current steam boiler, i.e. 1,215,000kWh/year or €32,440¹.
- Reduction of the heat losses from the pipes and valves: Here again, these losses are proportional to the temperature of the fluid. There would therefore be less losses in a system using hot water than in a system using steam (when not properly insulated). It would be very difficult to estimate these savings as the level and condition of the insulation is believed to be very inconsistent throughout the site.
- Savings in the maintenance costs. It is believed that the current boiler requires a lot of maintenance. Using the new hot water boiler as the main boiler for the site will certainly reduce the maintenance costs.

For the calculation of the potential savings from option 2, only the potential reduction of the shell losses were estimated and are reported in the table below:

Table 7-10 Costs & savings associated with option 2 (reduction of shell losses only)

Current heat loss, kWh	1,350,000
Current energy cost, €	36,045
Energy saving (9%), kWh	1,215,000
Emissions savings, t CO₂	332.9
Energy cost saving, €	32,440
Total cost of project, €	68,000 (= 50,000+18,000)
Cost per annual CO₂ savings, €/t	204.3
Payback, years	2.1

For both these options, it is very difficult to accurately calculate the savings generated by upgrading the current heating system. This is due to different reasons:

- The actual hot water and steam peak and average demands are unknown and the sizing of the hot water boiler and small steam boiler cannot be accurate.
- The savings are genuinely difficult to calculate because it is not possible to precisely quantify the amount of heat that is currently lost in the radiation losses and the distribution pipes and valves (a large amount of heat is also lost in the heat exchangers). Indeed, for option 2, only a rough estimation of the reduction of the radiation losses from the boiler system could be calculated (see previous table).

It is therefore strongly recommended that water/steam readings be carried out to determine the heating load throughout relevant periods (e.g. one day, one week)

¹ Equals 3,000kW × 18hrs/day × 5 days/wk × 50 wks/ year × 9% × 2.67c/kWh = 32,440€

before a decision is made regarding the installation of a hot water boiler and potentially a small steam boiler.

7.3.4 Use a separate heating system for the offices

As mentioned earlier in this report, the main steam boiler is used for the heating demand of the entire site, including the space heating of the offices. It is recommended that the space heating for the offices be provided by a separate boiler that would be located in the office building. This will reduce the load on the current boiler and the heat losses in the distribution network (as the boiler room is located far from the offices). Moreover, the office boiler will be able to accurately match the heating demand in this area.

The heating demand for the offices is not known at the moment as there is no sub-metering carried out. Therefore, it is difficult to assess the adequate size for the boiler. For the purpose of this report, the budget cost for a 250kW oil-fired boiler was estimated and would be of approximately €4,800¹. Although it is difficult to quantify the energy savings, it is believed that a significant reduction of heat losses in the distribution network can be achieved.

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¹ This budget cost was provided by Hevac: 250kW boiler CHAPPEE NXR 38 = €3,681 + Riello RL28 Burner = €1,051. These prices are subject to trade.

7.4 Refrigeration system

7.4.1 Use cheap rate power during night-time

Fuel Efficiency Booklet No. 11 on “Economic use of Refrigeration Plant” states that ‘for system with high thermal capacity, e.g. cold stores, it may be economic to cool the product to a temperature below that required during the cheap electricity rate periods and then allow it to rise naturally during expensive periods.’

It is not known at present if this practice would be suitable for implementation at Meadow Meats as the effect on the quality of the products is unknown. However, this option should be investigated.

To estimate the savings from this recommendation, the following assumptions were made:

- A drop of 5°C in the evaporating temperature results in a 10% increase in the compressors energy consumption (most guides state that an energy saving of 2-4% can be achieved if the evaporating temperature is raised of 1°C and 2% was taken to be conservative).
- The consumption of the compressors was estimated to be of 1,172,360kWh/yr¹.
- Thus, if the evaporating temperature is decreased by 5°C during the nights, the corresponding electricity consumption is: 117,236kWh/yr. This energy will be consumed at night at the cheaper tariff and not during the day.
- The saving that can be achieved is therefore not an energy saving but financial saving as 117,936kWh /yr will be added to the night electricity consumption but deducted from the day-time electricity consumption. The day-time and night-time tariffs were not available and therefore a tariff difference of 1.5c/kWh between the day-time and night-time was taken for the calculation of the saving:

$$1.5\text{c/kWh} \times 117,936\text{kWh} = 1,759\text{€}/\text{year}$$

Table 7-11 Cost & Savings associated with using the cheaper night tariff

Current energy usage, kWh	3,368,407 ²
Current energy cost, €	312,588
Energy saving, kWh	0
Emissions savings, t CO₂	0
Energy cost saving, €	1,759
Total cost of project, €	0
Cost per annual CO₂ savings, €/t	0
Payback, months	0

¹ 70% of the estimated night-time consumption (meter readings) from Sept-05 to Aug-06 (=0.7 × 1,674,800 kWh/yr = 1,172,360kWh)

² ECG 32 Red Meat Plants: “The refrigeration plant is the greatest continuous electrical load and is typically 50-90% of the total site load.”

It should be noted that this recommendation may also result in a reduction of the electricity capacity charges as the refrigeration compressors may not be in operation until later during the day (at the moment, it is believed that the demand on these compressors is constant for most of the day). With this recommendation, the load on these compressors would be much lighter during the morning as the temperature of the system will still be let to rise until the adequate temperature is reached. However, an extensive investigation would be needed to quantify this saving.

7.4.2 Install an automatic air purger

As mentioned in Section 6.1.5, it is strongly recommended that an automatic air purger to extract non condensable gasses from the refrigeration system be installed. These devices typically cost approximately €10,000. By reducing the build-up of non-condensables in the refrigeration system, these units will decrease the systems condensing pressure and reduce the overall loading on the system. This will ultimately lead to energy savings. A case study is detailed in Appendix 4. This document states that, for the studied site, "Test work has shown that when the automatic purger is switched off, the head pressure increase during the course of one week causes an 18% increase in compressor shaft power requirement from 61kW to 70kW under test conditions". For the purpose of this calculation, a typical energy saving of 15% was assumed. It should also be noted that the maintenance costs of the refrigeration system will be greatly reduced.

Table 7-12 Cost & savings associated with automatic air-purging

Current electricity usage¹, kWh	3,368,407 ¹
Current electricity cost, €	312,588
Energy saving, kWh	505,261
Emissions savings, t CO₂	392
Energy cost saving, €	46,888
Total cost of project, €	10,000
Cost per annual CO₂ savings, €/t	25.51
Payback, years	0.21

¹ ECG 32 Red Meat Plants: "The refrigeration plant is the greatest continuous electrical load and is typically 50-90% of the total site load."

7.4.3 Further recommendations for the refrigeration system

The supplier of the refrigeration system was contacted as part of this audit and the following items will also have to be considered to improve the efficiency of the system:

- Some of the valve gaskets were found to be worn, the supplier recommends their replacement
- Any pipes that have been recently renewed should also be relagged to avoid heat losses
- The condition of the heat recovery system will have to be assessed in details to determine whether its operation is possible or if repairs will have to be carried out.
- The supplier also recommends an investigation into whether the low stage compressors require overhauls.

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7.5 Implement Motor Management Policy

According to Good Practice Guide 2 “Energy savings with electric motors and drives” motors typically account for as much as 66% of the total electricity consumed at industrial sites. This means that even small measures taken to improve motor efficiency can result in significant electricity savings. One of the most effective and low cost ways of achieving motor savings is to implement a Motor Management Policy (MMP).

A Motor Management Policy (MMP) is defined by General Information Leaflet 56 “Energy savings from motor management policies” as “*a coherent, structured approach to the purchase and repair of a company’s motors. It is designed to ensure that the best economic decision is made each time*”. It is understood that there is no MMP presently in operation for the Dawn Meats Group and it is recommended that such a policy should be put in place for the organisation as soon as possible and applied at the site.

The purpose of a MMP is to provide a written set of guidelines for all employees involved in the purchase of motors, including accounts, maintenance and operations personnel. The MMP should clearly outline the appropriate actions to take when a motor fails.

Although it may seem sensible in theory to make motor purchasing decisions based on the minimisation of life-cycle costs, this is rarely what happens in practice. Instead it is usually the equipment which offers the lowest capital costs, (and often the lowest efficiencies), which is purchased without due consideration being given to its lifelong running costs. Indeed, over an average lifespan of 10 years, the capital cost of the motor typically accounts for just 1% of the total cost of the electricity used by the motor.

Hence it is vital that the aim of MMP is clearly understood by all relevant employees so that motor purchasing decisions can be used to effectively maximise energy savings.

High Efficiency Motors vs. Standard Motors

The following figure is taken from GIL 56 and show the efficiency classification for various sizes of motors (EFF1 motors being the most efficient motors and EFF3 being the least efficient).

Figure 7-1 Efficiency classification for induction motors

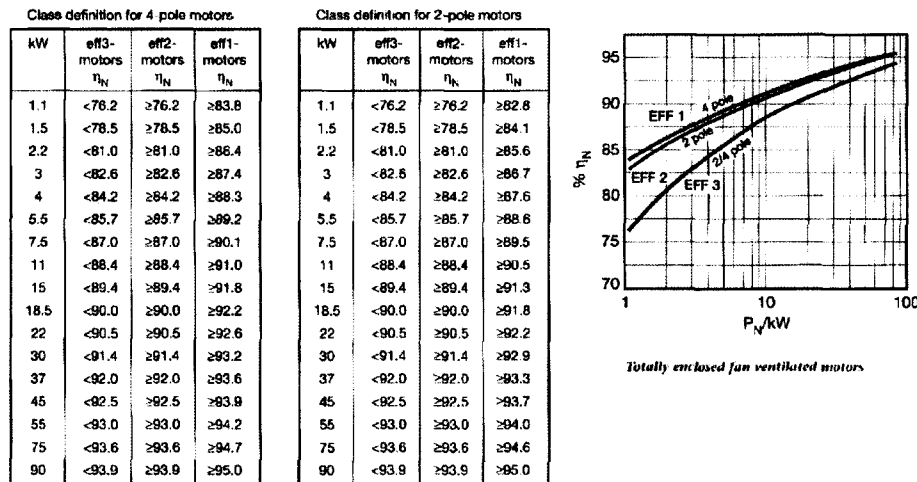


Fig 6 EU-CEMEP AC Induction motor efficiency classification scheme for 400V, 50Hz, 3-phase (full load efficiency measured in accordance with IEC 34-2)

As can be seen in the two tables and in the graph, the difference in efficiency between EFF1 and EFF3 motors ranges from 1.1% for the large motors to 7.6% for the smaller motors. Best Practice Guides cite an average value of 3% saving from high efficiency motors.

This means that, although High Efficiency Motors (HEMs) may be slightly more expensive to purchase, the 3% reduction in energy consumption they offer over standard electric motors will provide substantial savings in the long term. It is recommended that high efficiency motors be the preferred replacement for existing motors when they fail, particularly for high usage motors.

In general, the payback (based on the cost premium over a standard electric motor) for a new high efficiency motor is less than 6 months, and on a replacement of an existing working standard electric motor is less than 3 years.

Good Practice Case Study 162 is reproduced in Appendix 5. This describes the use of high efficiency motors in pump and fan applications.

Replacement vs. Repair

It should be noted that although it may appear an attractive option to repair failed motors, GPG 2 states each time a motor is rewound its efficiency drops by approximately 1%. Over time this can considerably increase the running costs. GIL 56 therefore recommends that for small-medium sized motors, for which the price of rewinding can be almost as high as the price of a new unit, it is more economical to replace the motor than repair it. Conversely, depending on operating hours, it is usually more economical to repair larger motors than replace them.

The following table provides an approximate indication of the prices for the rewinding and replacement of various motor sizes as well as their respective energy consumption.

Table 7-13 Comparison of the costs of replacement and repair of motors

Motor Size (kW)	New motor cost (€)	Rewind cost (€)	Cost differential (new-repair) (€)	Running Costs at 2500 hours/year @ 5.87c/kWh for 80% loading (€)		
				New Effl Motor	Old Rewind (5% less efficiency)	Annual running cost differential (new-old rewind)
5.5	390	600	-210	646	678	-32
11	735	900	-165	1,291.5	1,356	-64.5
22	1,275	1,200	75	2,583	2,712	-129
30	1,650	1,425	225	3,522	3,698	-176
55	3,360	3,000	360	6,457	6,780	-323
75	4,275	3,300	975	8,805	9,245	-440
110	7,650	5,250	2,400	12,914	13,560	-646
160	11,100	5,625	5,475	18,784	19,723	-939
200	13,095	6,000	7,095	23,480	24,654	-1,174

This table shows that the decision whether to replace or repair a motor should be made taking into account various parameters such as the size of the motor, its running hours and the typical load.

As the savings achievable through a MMP are largely dependent on the rate of failure of motors, it was not possible to determine the savings that might be achieved if this recommendation was implemented at the site.

7.6 Monitoring and targeting

Energy monitoring and targeting is the collection, interpretation and reporting of information on energy use. Its objectives are to measure and maintain performance, and to locate opportunities for reducing energy consumption and costs.

Good Practice Guide 316 “Undertaking an Industrial Energy Survey” explains the purpose of a monitoring and targeting system:

“An energy survey can only ever be a snapshot. It is therefore best at detecting opportunities for permanent modifications to plant, equipment, buildings and operating procedures. However, your organisation may be incurring hidden costs through avoidable waste occurring at random and remaining undetected. Examples could include:

- *Timeswitches and other self-acting controls failing in the ‘on’ position.*
- *Maintenance errors, such as fitting an oversized replacement motor.*
- *Operating errors, such as running an air compressor against a closed isolation valve*
- *Lax discipline, for example leaving auxiliaries to run when not required.*
- *Leaks*

A management technique called Monitoring and Targeting (M&T) is the most effective defence against these kinds of loss, which a one-off survey would miss. The next best option – a regular programme of routine energy inspections – would be a more costly exercise, and would anyway miss many kinds of energy-wasting fault because they are frequently of an unforeseen nature.

M&T works by combining regular consumption data (usually weekly or monthly) with corresponding data on production throughput, weather, or other driving factors (called ‘variable’ in the older literature). An M&T scheme is primed with targets for each stream of consumption, these targets being related to the relevant driving factor, so that given the level of activity in the facility, a ‘correct’ ration of energy can be estimated at each point of use. The deviation between actual and expected consumptions indicates the extent of any unexpected loss, which can then be converted to its implied cost in order to establish its significance.

When the fault detected in this way proves persistent, the pattern of deviation can be analysed as an aid to diagnosis.

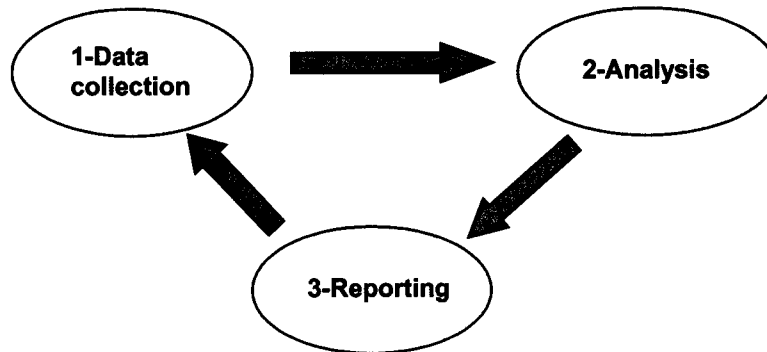
An effective M&T scheme provides, in effect, a continuous review of the site’s performance, and as well as revealing random unexpected losses, it can be used to monitor and verify the effectiveness of other energy conservation measures. Verification is doubly significant if your company is engaged in emissions trading.”

Sustainable Energy Ireland states that “sites using M&T have achieved savings representing 5 and 25% of their annual fuel bill. The important feature of this is that they have been achieved with little or no capital investment. Savings have resulted from improved operating practices, plant adjustments, operator training etc.” The

minimum figure of 5% has been assumed for the energy saving calculations in this report.

The implementation of M&T requires three tasks to be undertaken, all of these are dependant:

Figure 7-2 Three mains tasks in M&T system



At Meadow Meats, it is recommended to monitor at least the main energy consuming systems such as the refrigeration units, boilers, lighting. A detailed example of the M&T process is given in Appendix 6.

At present, the site electricity (whole site) and fuel oil (mean steam boiler) are known through the invoice data and/or regular meter readings. To improve the Monitoring and Targeting, it is recommended that the different energy consumption figures be standardised using appropriate parameters such as the tonnage of meat, the water consumption or the degree-days as it has been done earlier in this report and in Appendix 6. This practice will enable the company to monitor their energy efficiency, identify the major sources of energy/water wastage and take appropriate measures and anticipate their energy/water costs.

Data collection improvement in Meadow Meats:

The electricity consumption is only known for the whole site and it is believed that it would be beneficial to install some sub-meters to monitor and control the electricity usage of the main consuming areas or pieces of equipment such as:

- Lighting
- Air compressors
- Refrigeration compressors
- Refrigeration condensers
- Evaporators
- Main vacuum pumps
- Wastewater treatment plant

For the different boilers on the site, the following sub-metering is recommended:

- Oil-meter on the fuel input to each boiler (as additional boilers could be installed in the future)
- Steam-meter or alternatively water meter on the output of the boilers. For the steam boiler(s), the feed-water to each boiler could be metered as an alternative as there is no condensate return on the site.
- Meters on each different hot water distribution network to determine the demand for each different temperature (45°C, 65°C and 90°C).

Through further investigation, additional sub-metering needs may be identified.

As detailed earlier the implementation of an effective monitoring and targeting system can be expected to yield energy savings in the region of 5% of the total energy used at the site. Details of the cost of implementing a monitoring and targeting system and of the possible savings which can be expected, calculated from current energy usage figures, are given in the table below.

For the calculations, it was assumed that 7 electricity sub-meters (at a cost of €300 per item), 4 oil-meters (at about 1,000€) and 4 water-meters (approximately 1,000€) would be installed.

Table 7-14 Cost & Savings associated with installation monitoring and targeting system

Current energy usage, kWh	12,436,654
Current energy cost, €	650,028
Energy saving, kWh	621,833
Emissions savings, t CO₂	227.5
Energy cost saving, €	32,501
Total cost of project, €	10,100
Cost per annual CO₂ savings, €/t	44.4
Payback, years	0.31

Appendix 1 Energy Billing Details

Table 7-15 Monthly electricity consumption

Month	Electricity Consumption (kWh)	Electricity Cost (\$)	Electricity Rate (\$/kWh)
Jan-04	505,230	30,667	6.07
Feb-04	360,000	28,011	7.78
Mar-04	489,840	30,120	6.15
Apr-04	397,230	26,740	6.73
May-04	389,130	24,877	6.39
Jun-04	512,400	38,889	7.59
Jul-04	329,160	26,292	7.99
Aug-04	434,485	33,290	7.66
Sep-04	512,580	40,486	7.90
Oct-04	405,120	31,889	7.87
Nov-04	407,280	31,591	7.76
Dec-04	573,875	45,910	8.00
Jan-05	326,610	20,867	6.39
Feb-05	367,560	29,616	8.06
Mar-05	437,070	28,211	6.45
Apr-05	362,760	30,487	8.40
May-05	374,220	37,095	9.91
Jun-05	502,890	47,190	9.38
Jul-05	340,680	29,867	8.77
Aug-05	442,380	43,748	9.89
Sep-05	495,960	50,169	10.12
Oct-05	423,480	40,394	9.54
Nov-05	391,040	37,949	9.70
Dec-05	465,970	34,864	7.48
Jan-06	371,280	39,118	10.54
Feb-06	368,050	23,392	6.36
Mar-06	461,850	38,190	8.27
Apr-06	394,440	39,304	9.96
May-06	322,890	35,537	11.01
Jun-06	483,000	46,536	9.63
Jul-06	262,710	22,984	8.75
Aug-06	371,340	38,122	10.27

Table 7-16 Electricity meter readings

	Day (estimated) kWh	Month (estimated) kWh
Jan-04	353,400	177,600
Feb-04	265,000	129,000
Mar-04	351,400	152,800
Apr-04	294,600	123,400
May-04	284,800	126,400
Jun-04	377,800	163,000
Jul-04	242,400	105,000
Aug-04	325,000	133,400
Sep-04	382,800	158,400
Oct-04	309,400	126,600
Nov-04	281,800	129,800
Dec-04	386,800	165,400
Jan-05	149,000	93,200
Feb-05	279,000	124,800
Mar-05	309,000	130,200
Apr-05	250,800	215,400
May-05	277,600	16,400
Jun-05	374,600	155,600
Jul-05	251,200	108,200
Aug-05	306,000	129,200
Sep-05	393,000	121,200
Oct-05	317,200	172,200
Nov-05	269,800	126,000
Dec-05	311,600	
Jan-06	287,800	283,400
Feb-06	280,000	227,760
Mar-06	327,800	165,640
Apr-06	287,000	112,200
May-06	238,600	107,400
Jun-06	359,600	143,600
Jul-06	218,800	100,960
Aug-06	257,200	114,440
Sep-06	391,000	161,800
Oct-06	339,200	141,600

Table 7-17 Fuel oil data for 2006

	Fuel Oil
Jan	729656.7
Feb	688763.6
Mar	870678.1
Apr	745560.9
May	504264.6
Jun	742346.3
Jul	254931.9
Aug	541963.1
Sep	721277.7
Oct	554426.6
Total	6353870

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Appendix 2 Potential Supplier Details

Relevant area	Company Name	Address	Tel	Web
Electrical Submeter providers	Meters UK Ltd	Whitegate White Lund Trading Estate Lancaster, Lancashire, England LA3 3BT	+44 (0)1524 555929	www.meters.co.uk
Submeters/ data loggers	Dent Instruments (USA) UK suppliers = IMH Technologies	IMH Technologies (UK Supplier) 8 Roach View, Off Millhead Way Purdey's Industrial Estate, Rochford, Essex SS4 1LB	+44 845 8800 240	www.ihm.co.uk www.dentinstruments.com
	ND Metering Solutions	Northern Design (Electronics) Ltd Bolton road, Bradford BD30QW	+44 (0) 1274 750 620	www.ndmeter.co.uk
	Camax Electronic Instruments	Spa Lodge 2 Spa Street Harrogate HG27LE	+44 (0) 1423 880440	www.camax.co.uk
Pipe Insulation	AIC Iso Covers Ltd.	Unit 11-12 Trent Business Park Power Station Road, Rugeley, Staffordshire, WS15 2HS, England	+44 1889575700	
Insulation	Kendrick Insulation Ltd.	Unit 18 Bar Lane Industrial Park Basford, Nottingham, NG6 OJA	+44 115 9423 803	
Insulation	DEM (Direct Energy Management)	D2 Ards Business Centre, Jubilee Road, Newtownards, Co. Down, BT23 4YH N. Ireland	+44 28 91 82655	www.thermal-covers.com
Lighting	Patina Lighting	Unit 14 Sandlyford Office Park, Dublin 18	+353 1 2958890	
Energy Efficient Lighting	Llumarlite Limited	Unit 10, Bridgegate Business Park Aylesbury, Bucks, HP19 8XN	+44 (0) 1296 436666	www.lumarlite.co.uk
Energy Efficient Lighting	Venture Lighting	Trinity Court, Batchworth Island, Church Street, Rickmansworth, Hertfordshire England WD3 1RT	+44 845 230 2222	www.venturelightingeurop e.com
Energy Efficient Lighting	The light bulb company	Thomas Edison House, 74-77 Magdalen Road, Oxford, OX4 IRE		

Energy Efficient Lighting	Bulbs Lamps & Tubes Direct	Unit 9, The Quadrangle Centre, The Drift, Nacton Road, Ipswich, IP3 9QR,	+44 1 473 716418	
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Appendix 3 Quotation for a hot water boiler and steam boiler

24/01/2007 12:04 K B COMBUSTION LTD → 2761561

NO.833 0001

**K. B. COMBUSTION LTD.**

E14/15 South City Business Park,
Whitestown,
Tallaght,
Dublin 24.

Phone: (01) 414 6400
Fax: (01) 4139865
E-mail: info@kbcombustion.com
Website: www.kbcombustion.com

24th January 2007.
Quotation ref: Q 03924.

Environmental Efficiency
Bray,
Co. Wicklow

For the attention of Agnes.

Re. Boilers for Dawn Farm Meats, Rathdowney.

Thank you for your enquiry.

We have pleasure to confirm price and details as follows:

Supply of:

Global Hot water Boiler rated at 1500 Kw.
Boiler is a three pass, wet back flue and fire tube boiler and is designed and manufactured to provide the optimum efficiency with low furnace loads, low furnace temperatures thus ensuring complete combustion of the burner flame. The boilers are designed to achieve low emissions.
Hydraulic pressure 6 bar.
Boiler will be supplied with:
Dunphy TL 37 modulating burner suitable for light oil.

Price € 37,723.00 Plus VAT.

Global Hot Water Boiler rated at 3000 Kw.
Generally as above.
Dunphy TL 410 modulating burner suitable for light oil.

Price € 49,142.00 Plus VAT.

Registered Office: E14/15 South City Business Park, Whitestown, Tallaght, Dublin 24.
Registered in Dublin. Reg No.: 154702 VAT No. IE 8552202 T.

24/01/2007 12:04 K B COMBUSTION LTD → 2761561

NO. 633 0002

Byworth MX 500 Steam Boiler.
Rated output of 454 kg/hr F @A 100°C.
Boiler is a horizontal 3 pass reverse flame wetback design fully packaged
with working pressure of 10.3 bar. complete with
Dunphy TL03.45 Hi/Lo burner suitable for light oil.

Price € 17,926.00 Plus VAT.

Our prices include for delivery to site, others to off load and position.

Commissioning €650 per day plus travel and travel expenses.

You should allow 3 days per unit including travel time.

Payment terms.

30% with order.

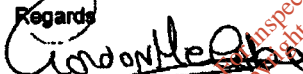
60% when ready to ship.

Balance within 30 days of commissioning date.

Delivery; presently 10/12 weeks from technically cleared order.

We trust we have interpreted your enquiry correctly and await your further instructions.

Regards

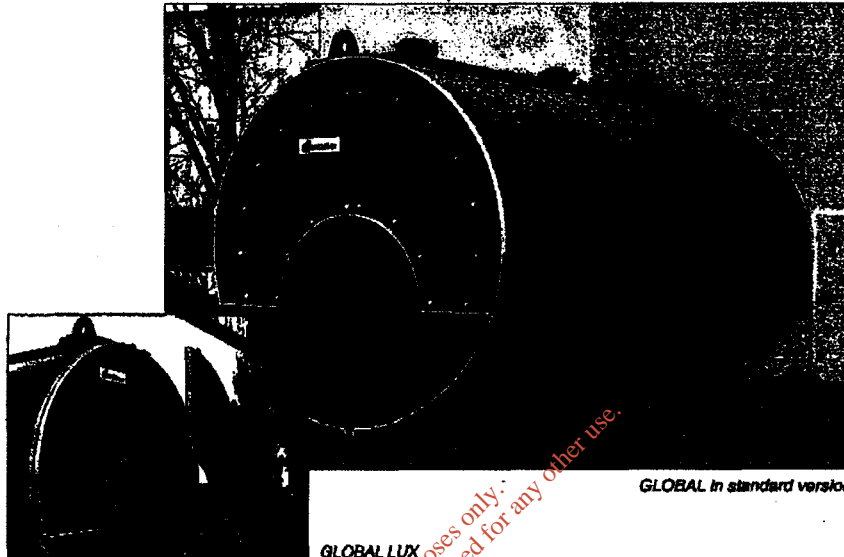

Gordon McCabe.
Projects/Estimating

24/01/2007 12:04 K B COMBUSTION LTD → 2761561

NO.833 0003



GLOBAL Hot water boiler



Capacity range: 1 to 10 MW

The GLOBAL boilers have been conceived and designed on the basis of Danstoker's many years of experience as an international boiler-maker.

As standard these three-pass, wet-back, fire and fire-tube boilers are available in design pressures of 4 barg, 6 barg and 10 barg.

The main principle in the Danstoker policy is to develop and manufacture boilers that, to the greatest possible extent, take the environment and the consumption of our limited resources into consideration.

Therefore, the high-performance GLOBAL boilers have been designed for low furnace loads and furnace temperatures, thereby ensuring complete combustion of the flame before the first reversing chamber and minimizing for example the NO_x emissions.

Danstoker has extensive knowledge of the variety of design codes that a boiler-maker is faced with on the international boiler markets, and the production facilities are approved by several countries' relevant authorities.

The general design of the GLOBAL boilers provides for these requirements and the common EU directives - so rightfully the boiler was given the name of «GLOBAL».

The GLOBAL boiler features the following major advantages :

- High efficiency and low radiation loss
- Outstanding insulation principles
- Low furnace load
- Low flue gas resistance and pressure loss
- Optimized for gas and/or oil-firing
- Easy access to flue gas and water circuits
- Robust construction
- Cladding and saddles without heat bridges
- Service platform
- Allows for flexible installation
- Flexible smoke outlet
- Complies with the EU standards
- Available in 2 design versions (standard and «LUX»)
- Short delivery time

24/01/2007 12:04 K B COMBUSTION LTD + 2761561

NO. 833 0004

THE 'TH' SERIES BURNERS

The 'T' Series of Monobloc burners are custom designed for optimum performance with all liquid and gaseous fuels. They have been developed for use on industrial and process applications. Burners are produced from 12kW to 13MW. Based on the successful turbine principle of air delivery, a constantly controlled pattern of air distribution is assured over the combustion head.

The mode of operation depending on the model can be on/off, high/low or modulating. The high efficiency can be optimised by the use of electronic fuel /air ratio control, variable speed drives and O₂ trim.

All Monobloc burners are hinged and handed to suit customer needs providing ease of use and serviceability.

TL BURNERS

The TL burner range is suitable for liquid fuels up to a maximum viscosity of 5.5cSt at 40°C.

This range is suitable for use on most types of boilers and process applications, operating in the range of 170kW- 13MW*.

*Dependant on appliance resistance.

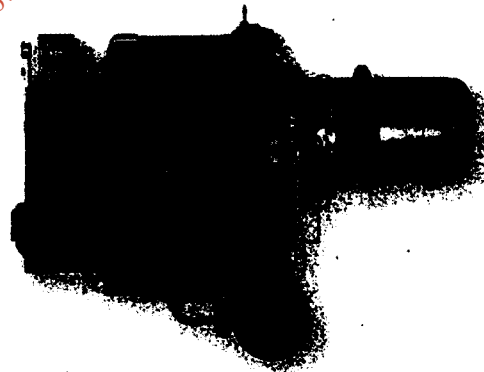


HEAVY OIL BURNERS

The heavy oil burner range is suitable for fuel oils up to a maximum viscosity of 40 cSt at 100°C.

The range is suitable for use on most types of boilers and process applications, operating in the range of 160kW- 13 MW*.

* Dependent on appliance resistance.



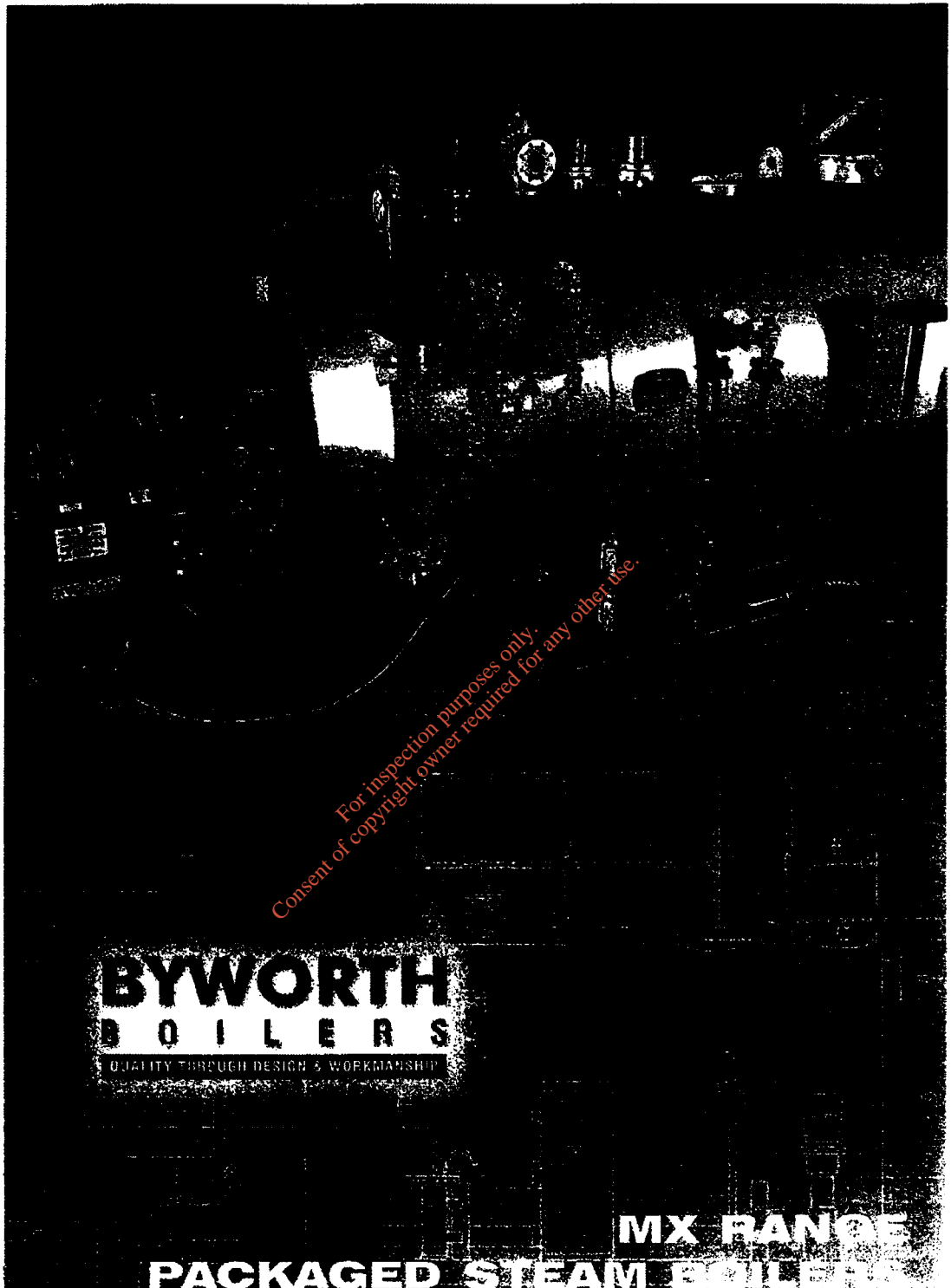
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AIR ATOMISATION

Air atomisation is available as an option on all liquid fuel burners. Air atomisation gives the added advantage of higher turndown ratios and the ability to burn higher viscosity fuels on the 'TH' Series.

24/01/2007 12:04 K B COMBUSTION LTD → 2761561

NO. 833 0005



Appendix 4 GPSC 92 Automatic air purging on a cold store refrigeration plant

May 1992

BEST PRACTICE PROGRAMME

Good Practice – Case Study

92

Case Study Objective

To demonstrate the energy savings and other benefits of using an automatic air purging system compared with purging manually on a weekly basis.

Potential Users

Operators of refrigeration systems with compressors drawing more than 100 kW.

Investment Cost

£8,980 (1989 prices)

Savings Achieved

630 GJ/year valued at £8,800. Saving in maintenance costs of £2,400/year (1991 prices).

Payback Period

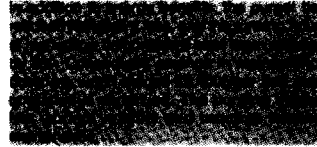
10 months.

Case Study Summary

Purging non-condensable gases from a refrigeration system's condenser and receiver reduces system head pressure. This has the simultaneous effect of reducing compressor power consumption and increasing refrigeration capacity. High pressure cut-out problems are avoided.

In September 1989, Exel Logistics installed a five-point automatic purger to the evaporative condenser and receiver of their ammonia refrigeration system. The plant was previously manually purged on a weekly basis. Test work has shown that when the automatic purger is switched off, the head pressure increase during the course of one week causes an 18% increase in compressor shaft power requirements from 60 kW to 71 kW under test

conditions. The duty of the condenser fan operating under head pressure control also increases by around 70%.

**Host Organisation**

Exel Logistics Temperature Controlled Services Ltd
350 Renfrew Road
Sheildhall
Glasgow
G51 4SP

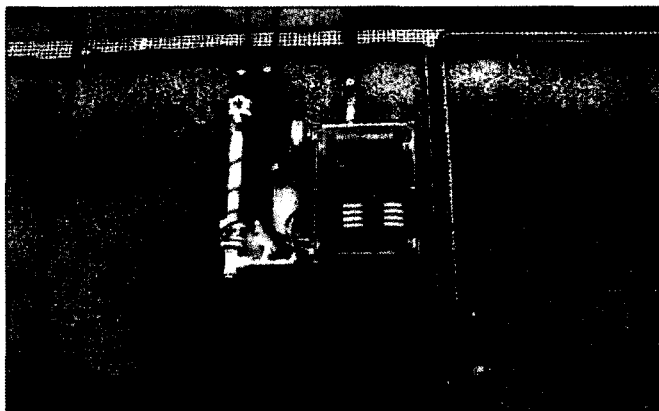
Monitoring Contractor

March Consulting Group
March House
13 Park Street
Windsor
Berkshire
SL4 1LU
Tel 0753 866346
Mr J R Graham

Equipment Supplier

Hansen Technologies Corp
98 Manor Road
Barton-le-Clay
Bedfordshire
MK45 4NS
Tel 0582 881281
Mr S P Wilson

AUTOMATIC AIR PURGING ON A COLD STORE REFRIGERATION PLANT



Air Purger



Energy Efficiency (Mk)re
DEPARTMENT OF THE ENVIRONMENT

T/14

The Refrigeration System

Refrigeration for 16 cold store chambers (using a volume from 190 m³ to 2,800 m³) is provided by pumped liquid ammonia from a two-stage plant. Room temperatures vary according to clients' requirements between approximately +4°C and -30°C. System pressure levels are varied according to store temperatures, with the low side typically being under slight vacuum.

Five high-stage reciprocating compressors of two different sizes are installed, typically one large and one small compressor operate, discharging to a single evaporative condenser. Ammonia drains from the condenser to a horizontal liquid receiver.

Purging Background

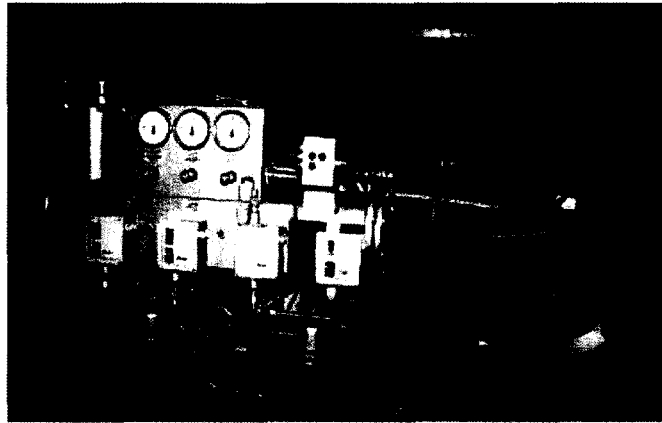
The presence of non-condensable gas in the condenser and receiver increases system head pressure in two ways:

- the partial pressure of non-condensable gases adds to the partial pressure of refrigerant to increase the total system head pressure;

- non-condensable gases impede heat transfer making a high condensing temperature (and hence pressure) necessary for a given condensing duty.

The increased system head pressure causes excessive compressor power consumption and reduces system capacity. Coefficient of performance (COP) is reduced.

To avoid these performance penalties, Exel



Small High-Stage Compressor

manually purged their condenser on a weekly basis. This was found to be a time consuming process and some refrigerant loss was always experienced. Also, it was never certain that all non-condensables were removed. Air ingress caused head pressure to increase between manual purges and so the weekly average head pressure was always above the minimum attainable.

Automatic Purger Installation and Commissioning

To overcome the problems associated with manual purging, Exel installed an automatic purging system containing the purger itself together with all controls necessary to govern the operation of up to eight purge points. Purge pipe connections were taken from five points:

- each end of the liquid receiver;
- the upper part of each of two condenser outlets;
- the hot gas line.

A high-pressure liquid refrigerant supply was taken from the ammonia receiver. The purger suction connection was made to the low-stage compressor discharge line.

Exel installed the purger themselves in two days and found installation straightforward. The particular mode of purger was chosen because it is a completely packaged unit.

Purger Maintenance and Reliability

Routine maintenance is limited to six-monthly inspection and cleaning of seven strainers used to protect solenoid valves. These valves serve the five purge points and the high-pressure liquid and low-gas inlets to the purger.

One purger failure has occurred due to a fault in a solenoid coil. Replacement was simple and cost only £15.

Energy Savings

The purger was operated one week on, one week off between October 1990 and January 1991. During weeks in which the purger was switched off, the system head pressure increased. As a result, power consumption also increased proportionately. The curve on the graph shows the mean monitored trend with which compressor power consumption increased during those weeks when the purger was switched off. In fact, consumption increased from 69 kW to 89 kW, an average of 71 kW for the period.

For the conditions under which the refrigeration plant was operating at that time, the operation of the purger effectively reduced the weekly



Air Purger (Top Left) and Receiver (Foreground)

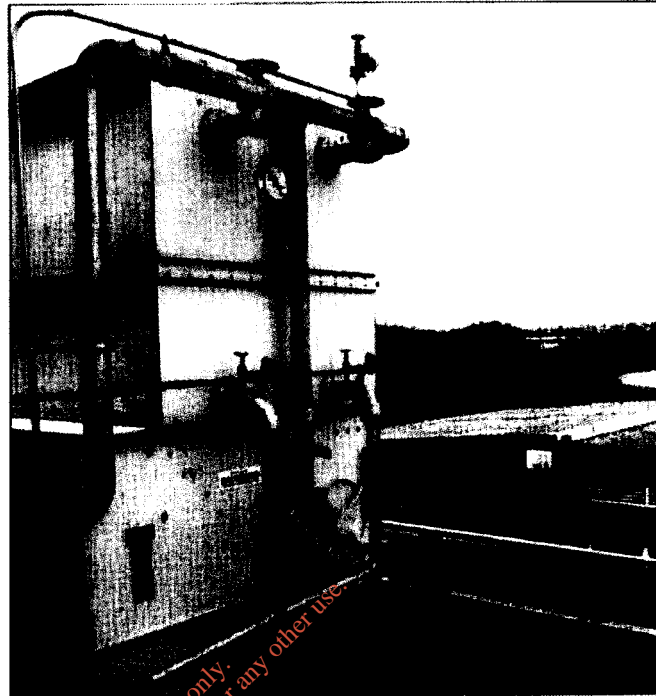
average compressor shaft power consumption from 71 kW to 60 kW - a saving of 15%. Allowing for losses in the compressor motor and drive, and for changing load conditions throughout the year, it is estimated that the purger has reduced compressor energy consumption by 120,000 kWh/year, worth £6,000/year to Exel at 1991 electricity prices. The condenser fan operation is governed by a head pressure control system, cutting in at 10.5 barg) and out at 6.5 barg). When the purger operates, the fan cycles as head pressure fluctuates. When the purger is off, the head pressure never falls enough to turn off the fan. The purging system has reduced the annual energy consumption of the condenser fan by around 56,000 kWh, worth £2,800/year to Exel at 1991 electricity prices. Hence, the total energy saving achieved by the purger is 176,000 kWh, worth £8,800/year.

Other Benefits

The automatic air purging system has brought substantial non-energy benefits. Routine manual purging is now no longer necessary. System purging after compressor maintenance is taken care of by the automatic purger; previously it might have been necessary to purge the system manually several times. As air purging cannot now be overlooked, it is not possible for air accumulation to reach a level which causes compressor high pressure cut-off. This used to occur three or four times a year, usually when cold weather was suddenly followed by a hot day. The increase in system capacity and COP has enabled high-stage compressor running time to be reduced by 6% with consequent savings in maintenance costs of £2,400/year. Loss of refrigerant associated with purging is all but eliminated.

Economic Analysis

The total installed cost of the purger was £8,980 in September 1989. Total annual energy savings are £8,800, hence the simple

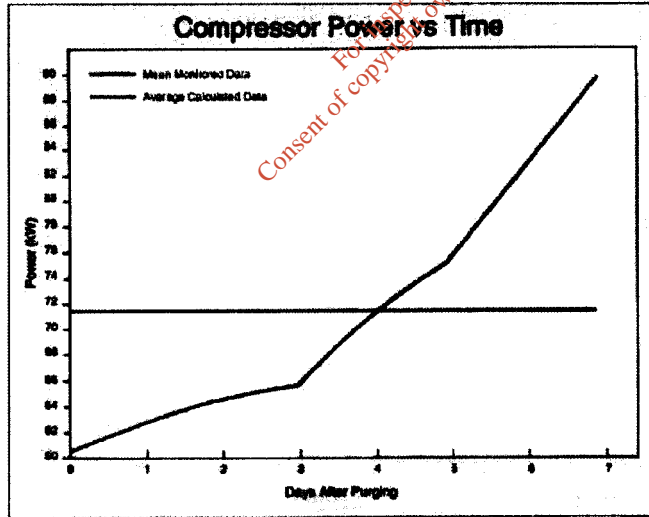


Evaporative Condenser

payback of the installation is just over 12 months in energy terms. When maintenance cost savings are included the payback falls to 10 months.

Future Potential

The savings which an automatic purger will achieve are site specific. They depend, principally, on plant size and on the extra non-condensables which the automatic purging system can remove compared with the existing purging method. Large quantities of air were drawn into the Exel refrigeration low-stage system which was continuously under vacuum. Many plants which do not operate continuously under vacuum nevertheless experience vacuum from time to time - when defrosting or if a low pressure cut-out system is used to control operation, for example. Non-condensables can also accumulate in refrigeration systems for reasons other than leakage into evacuated pipework systems. Air may be introduced during plant maintenance or charging, refrigerant can be contaminated, and refrigerant and oils can dissociate at high temperatures. The less frequently a system is purged the higher will be the savings achieved by automatic purging. This Case Study shows, however, that automatic purging can be economic even when a refrigeration plant is purged regularly. The typical installed cost of a multipoint purging system is likely to be £10,000. To achieve a two-year simple payback, and assuming 15% savings, implies a typical annual compressor running cost of £33,000. For continuous operation, this means a compressor power consumption of around 100 kW.



Comments from Exel Logistics

The air purger fitted at this store has now been in operation for almost two years. During this period, the planned maintenance on the unit has consisted of a six-monthly examination of starters and filters, with a purger down-time of approximately six hours on each occasion. In the two years of operation, one breakdown occurred due to a faulty solenoid coil. The maintenance and fault diagnosis of these units is relatively simple.

Plant efficiency has improved and substantial energy savings are evident. Compressor running hours have been reduced by 6%, therefore maintenance costs have also decreased by £2,400/year. With the absence of air or non-condensables in the system, the full plant design capacity is available and the minimum power costs are achieved.

In an ammonia plant, manual purging can be hazardous and time consuming and a certain amount of refrigerant escapes to the atmosphere. If an excessive amount of air is present in the system, increased wear on compressor parts will occur and chemical breakdown of the lubricating oil is also possible.

Generally, the amount of energy and maintenance savings will depend on the efficiency of the plant prior to being fitted with a purger. Most companies employ a minimum of maintenance staff and, in some cases, proper control of non-condensables is impractical. In these circumstances, the payback period could be a few months only.



W.M. McCreary

W.M. McCreary
Chief Engineer
Exel Logistics

**Exel Logistics**

Exel Logistics, an NFC company, provides a contract cold storage and refrigerated distribution service to a variety of commercial organisations. The company has 22 cold stores nationwide.

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The installation described here was selected as an example of Good Practice, which is one element of the Energy Efficiency Office's (EEO) Best Practice programme, an initiative aimed at advancing and promoting ways of improving the efficiency with which energy is used in the UK.

For further information on this or other industrial projects, please contact the Energy Efficiency Enquiries Bureau, the Energy Technology Support Unit (ETSU), Harwell, Oxfordshire OX11 0RA. Tel No: 0235 436747, Fax No: 0235 432923, Telex No: 83135.

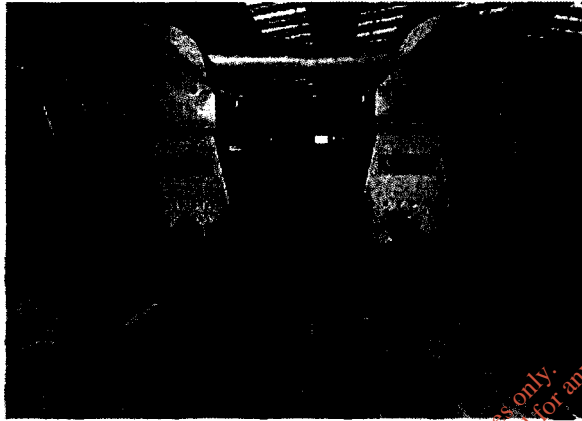
For information on buildings-related projects, please contact the Building Research Energy Conservation Support Unit (BRECSU), Building Research Establishment, Garston, Watford WD2 7JR. Tel No: 0623 864258, Fax No: 0623 864097, Telex No: 923220.

Information on participation in the Best Practice programme and on energy efficiency generally is also available from your Regional Energy Efficiency Office.

Appendix 5 High efficiency motors of fans and pumps

Case Study 102

Higher efficiency motors on fans and pumps



Meeatharm furnace

Case Study Objective

To demonstrate the savings that can be made by using higher efficiency motors.

Potential Users

Industry and commerce where electric motors are running for long periods.

Investment Cost

The total marginal cost between the five higher efficiency motors and standard motors was £670 (1992 prices).

Delivered Energy Savings

11.66 MWh/year (42 GJ/year), worth £408/year (1992 prices).

Payback Period

1.64 years. The estimated payback for 1993 prices would be 1.4 years.

Case Study Summary

Higher efficiency motors are usually justified in applications where a motor, which is new or requires replacement, is running for long periods at high load. The cost premium in such cases can normally be recovered within two years by the extra efficiency these motors offer over standard motors.

At Delta Extrusion five motors were replaced with higher efficiency motors to give a reasonable cross section of the

range of cast iron motor ratings. Three of the motors were running continuously; the remaining two ran on a 5-day, 3 shift operational pattern.

Measurements of average load and data on motor efficiency were used to compare the running costs of the new higher efficiency motors with the equivalent standard motor. A comparison was also made with the running costs of the motors which had originally been installed.

Host Organisation

Delta Extruded Metals Company Limited
Greets Green Road
West Bromwich
West Midlands
B70 8ER

Equipment Supplier

Brook Compton
St Thomas' Road
Huddersfield
HD1 3LJ
Tel No: 0484 422150

Monitoring Organisation

The Clifford Talbot Partnership
206 Penn Road
Wolverhampton
West Midlands
WV4 4AA
Tel No: 0902 331101
Mr S J Clifford

Supporting Organisation

Copper Development Association

Environmental Efficiency Consultants (Ireland) Limited

CONSULTING ENGINEERS

Tel: 01-276 1428 Fax: 01-276 1561
E-mail: energy@eol.ie
48 Main Street, Bray, Co. Wicklow

“ ... higher efficiency motors can be justified as cost effective ... ”

The energy consumption of a new standard motor with an identical mechanical load was calculated and hence the energy savings. Previous independent motor tests by the Energy Efficiency Office (EEO) have demonstrated close agreement of motor tests with type test results. Type tests on an individual motor provide specific data on a motor's efficiency and can be requested from the manufacturers.

Summary of Savings

The electrical energy savings are converted into financial savings by applying an average electricity cost of 3.5p/kWh. This figure is the average annual electricity cost to Delta Extrusion. The figure is built up from the pool price which fluctuates with

Table of Savings Summary					
Rating (kW)	Average load (%)	Running hours	Savings (£)	Premium (£)	Payback period (years)
30.0	49	4,704	80.87	271.60	3.37
18.5	27	4,704	110.38	179.90	1.63
7.5	87	8,760	78.65	94.50	1.23
5.5	60	8,760	110.38	85.40	0.77
1.1	77	8,760	30.66	36.89	1.20
TOTALS			408.74	688.29	1.64

On many sites the benefit in improved power factor would result in financial savings. For example, on a site with a maximum demand tariff, the lowered kVA would result in additional savings of £380/year.

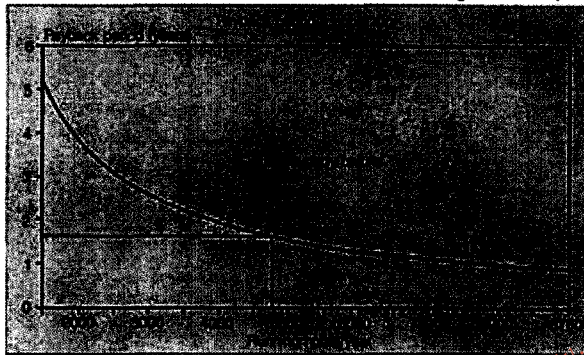
Conclusions

Overall the savings achieved from the fitting of higher efficiency motors provided paybacks on the differential cost between standard and higher efficiency motors, of between 9 months to 3.4 years. Across the group of five motors the savings were £408.74 with a payback of 1.64 years. Thus higher efficiency motors can be justified as cost effective where a motor is new or requires replacement.

As Delta Extrusions is a large organisation it benefits from being able to negotiate cheap electricity costs and also discounts when purchasing electrical motors etc. Care must therefore be taken when generalising on payback periods for higher efficiency motors as other users will undoubtedly have different costs in both electricity and capital purchasing prices.

Bearing this in mind, as a general rule the differential cost of the higher efficiency motor will be returned within two years if the motor is running on high load with long running hours. This payback period is considered as reasonable for energy conservation programmes.

When considering the use of higher efficiency motors it is essential that basic information such as the number of hours the motor is running per year and the average and peak electrical load of the motor is known before the decision is taken to fit higher efficiency motors.



18.5 kW motor

demand over each half hour during the year. The average of 3.5p is, therefore, made up of 17,520 individual half hour costs and includes transmission and availability charges.

These results show that the best paybacks are achieved on the motors which run for long hours at higher loads. It is also apparent that some of these motors appear to be oversized for their applications.

Measurements were also taken on the original motors before installation of the higher efficiency motors. The most notable feature when comparing the measurements is the load variation. As mechanical loading varied between the two test periods, due to production fluctuations and rebalancing of fans, the effect of the higher efficiency motor is difficult to establish directly. Further, the efficiencies of the original motors was unknown. However, where loading of the new and old motors are similar, paybacks agree well with predictions from the type test certificate.

Additional Potential Savings

Additional benefits include the improved power factor of each higher efficiency motor, for example the power factor of the 30 kW motor improved to 0.78 from 0.55.

However, the benefits depend upon the electrical tariff in use and the amount of

Alternatively, where excess reactive power is charged for, additional savings of £200/year may be achieved. Such savings would improve the payback significantly.

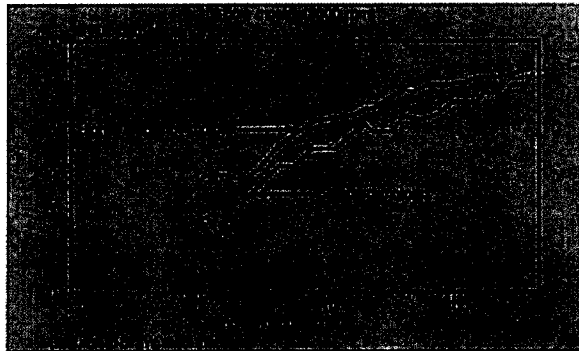


Extrusion Machine and two Motors

Background

Higher efficiency motors are usually manufactured from a higher quality material than standard motors. More care is also taken with the design and geometry of the motor construction. The higher efficiency motors used in this project have been improved in four areas which results in their higher running efficiencies:

- Longer core lengths of low loss steel laminations reduce flux densities and iron losses;
- Copper losses are reduced by maximum utilisation of the slots and by providing generous conductor sizes in the stator and rotor;
- Stray losses are minimised by careful selection of slot numbers and tooth/slot geometry;
- A more energy efficient motor generates less heat so the cooling fan size is reduced. This leads to lower windage losses and therefore less wasted power.



Comparison of full load efficiencies

Motor Selection

The motors selected for comparison on this project were chosen for their long running hours, and to provide a reasonable cross section of the range of cost for higher efficiency motors.

Motors tested				
RATING (KW)	RPM	FRAME SIZE	APPLICATION DESCRIPTION	RUNNING HOURS/YEAR
30.0	1485	D200L	Mecatherm billet reheat furnace exhaust fan	4704
18.5	2950	D180L	Mecatherm billet reheat furnace combustion air fan	4704
7.5	2870	D132S	Induction furnace cooling fan	8760
5.5	2870	D132S	Induction furnace coil cooling pump	8760
1.1	2800	D80	Induction furnace capacitor pump	8760

The table details the selected motors, their application and their running hours.

Methods of Tests

The power consumption of each motor was monitored with clip-on current transformers to measure individual phase currents. Voltage probes on each phase enabled measurements of apparent power (KVA).

Monitoring periods of 30 minutes were set up on the system to mimic the supply authorities charging periods. Each phase was sampled every second and the readings averaged over the monitoring period.

Each motor was monitored for one week to ensure that the complete production pattern was monitored.

Comparison with New Standard Motors

In the majority of cases the use of higher efficiency motors should be considered for new plant or when an existing motor is to be replaced. The comparison was therefore between a new standard motor and a new higher efficiency motor.

To demonstrate the savings available, calculations have been carried out using the monitored power input to the higher efficiency motors and motor test certificate information to calculate the mechanical load on the shaft.

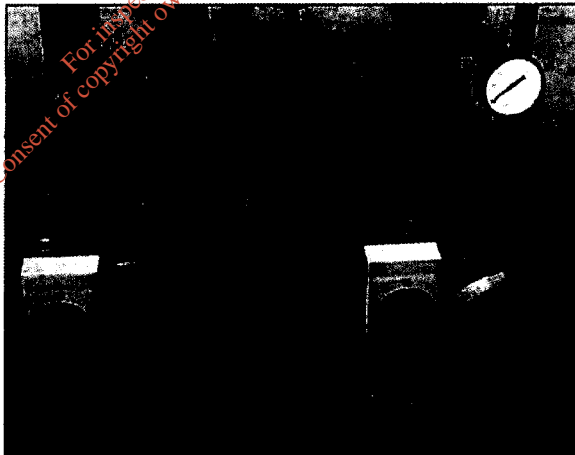
Installation

The installation of the new motors was a reasonably simple undertaking as the mounting feet and fixing holes are identical to those of the standard motor. The table below shows the differential cost between the higher efficiency motors and the standard motors equivalent for 440 V operation, 440 V being the standard voltage at this site. Installation costs, labour etc. are not included as these would have been incurred whether a new standard or higher efficiency motor was fitted.

The higher efficiency motors are longer at the non-drive end. However this did not cause any problems on the installations at Delta Extrusion.

MOTOR RATING	DIFFERENTIAL COST
30.0 KW	£271.00
18.5 KW	£179.00
7.5 KW	£ 94.50
5.5 KW	£ 85.40
1.1 KW	£ 36.00
TOTAL	£665.90

true power (kW), and therefore power factor, to be made.



1.1 kW induction furnace cooling pump motor

Appendix 6 Example of the M&T Process for the steam system

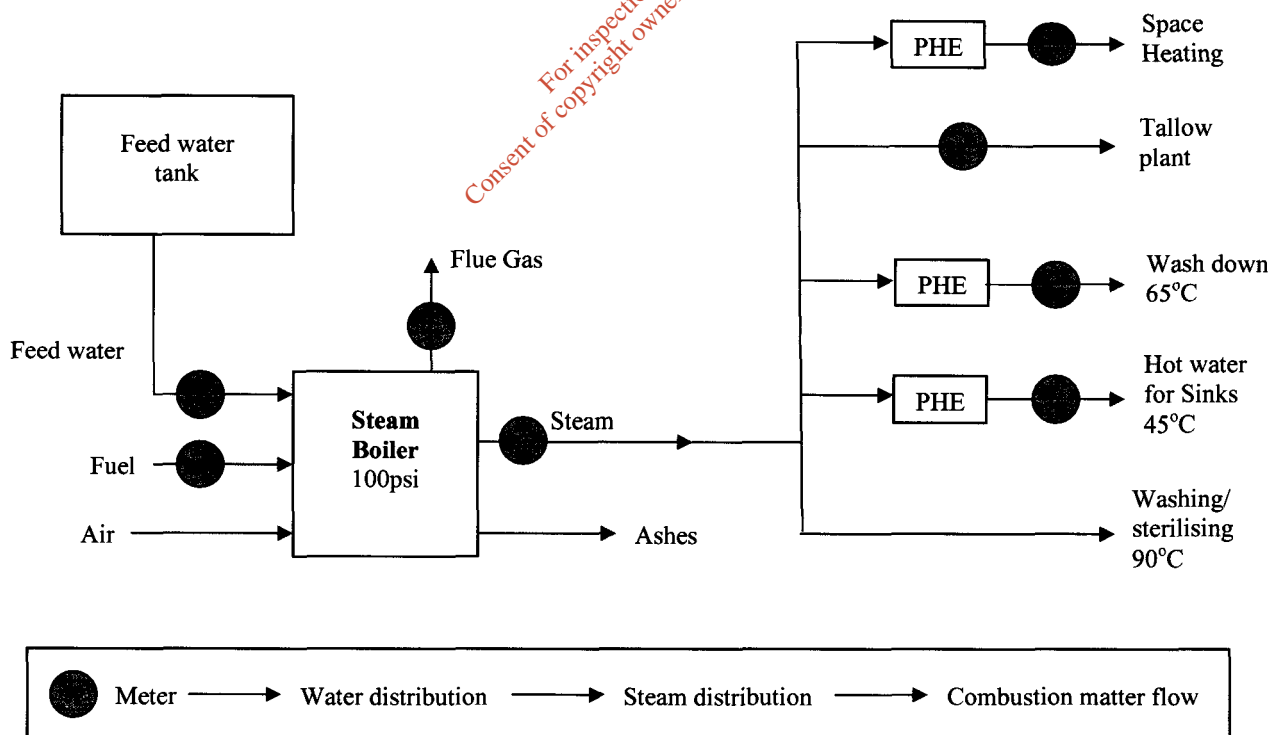
Concerning the benefits of steam metering, Good Practice Guide 18 states that ‘The data supplied will enable management to:

- Improve existing steam operation;
- Maintain that improvement;
- Target further projects that will reduce steam consumption;
- Determine costing for individual elements of the operation;
- Make appropriate decisions on future expansion or changes in operating procedures.’

The first step in M&T is **data collection**. The figure below presents the steam system, the different matter flows simplified and the meters for basic measurements.

Data collection implies the measurement of both energy used and output. The energy used by each unit should be regularly measured with sufficient accuracy to minimise errors when calculating performance. The measurement of output involves measuring, again a sufficient degree of accuracy, what has been achieved for this energy expenditure. The parameters chosen should be those which have the main influence on energy consumption. In certain systems it is necessary to take into account secondary influencing factors.

Figure 7-3 Steam system at Meadow Meats if the current system is kept



Flow rate meters should be set on the fuel supply and the steam output (or alternatively on the feed water input). Flue gas composition (CO₂, O₂, CO) and stack temperature should also be metered (this is already done through the combustion Environmental Efficiency

control system).. The data could be logged on a main computer in order to be exploited and analysed.

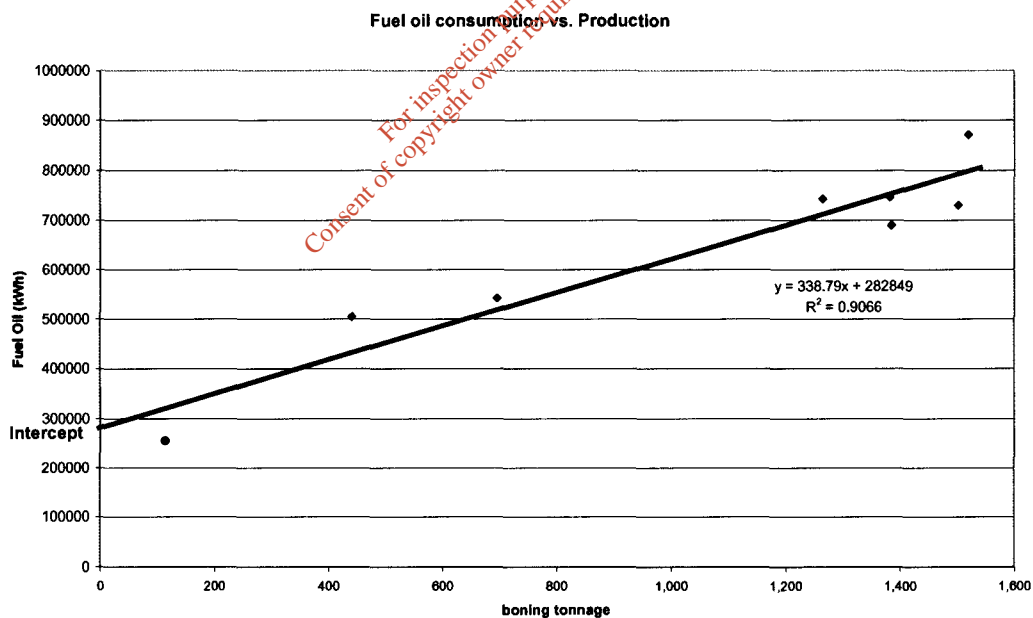
Additional measurements as steam or water flow rates at each distribution could also be considered for next improvements of M&T system.

As steam is used for tallow plant, to produce hot water for the sterilizing, the sinks, the wash-down and the space heating in the offices, it is recommended to log meaningful output indicators to relate the fuel consumption to output. These indicators could be tallow production, quantity of meat boned, degree-days... If it is not possible to get these data, the fuel consumption should be compared to the global meat production. However that may be, it is important that the time at which energy meter readings and production records are taken are the same.

Once the different data gathered, it is necessary to analyse them. Indeed, a monitoring system is useful only if the data collected is standardised against appropriate parameters and benchmarked. This is the second step, **analysis**.

According to Good Practice Guide 18, 'Once data is being regularly collected the first task is to determine the relationship between production and consumption.' As an example, the fuel oil consumption of the steam boiler was plotted against production, such as in Figure 7-4

Figure 7-4 Fuel oil consumption vs. Meat Production (boning)



This typical graph contains three main elements:

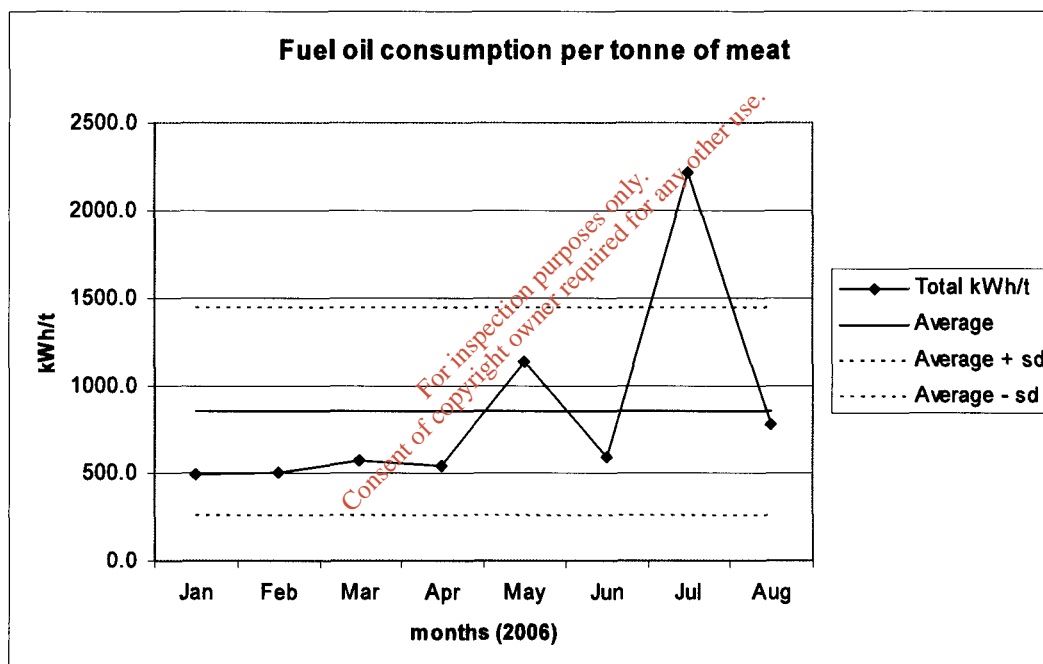
- The intercept is the gas consumption value corresponding to zero production (about 282,849kWh). This is the energy that would be required if the process ran but did not produce anything.
- The slope is the amount of fuel required at any given level of production to process each additional tonne of meat (338.8kWh/tonne in this case). The efficiency of the process can be established from the slope.

- The scatter is the amount by which the energy used for any one level of production varies from one period to another. This tends to be governed by operational factors. The scatter can be assumed by the R-squared value, which is about 0.9096 for the figure above. The R-squared should be as close to 1 as possible.

Another way to analyse the energy consumption and corresponding production data is the standard deviation. Standard deviation is the most common measure of statistical dispersion, measuring how spread out the values in a data set are. If the data points are close to the mean, then the standard deviation is close to zero. If many data points are far from the mean, then the standard deviation is far from zero.

The graph below represents the specific fuel oil consumption over a period of 8 months, the corresponding mean, the mean plus the standard deviation determined by a statistical tool and the mean minus the standard deviation.

Figure 7-5 Standard deviation of specific fuel oil consumption



If the production process were completely under control, then the actual consumption per unit of output would be a straight horizontal line similar to the line labelled 'average' in the figure above. Because of variations due to a multiplicity of factors, there are variations in the fuel consumption per unit of output. These variations are shown by the line labelled kWh/t.

The key to reducing energy consumption lies in determining which variations are due to causes which can be controlled (termed 'assignable causes') and those for which no known explanation exists or is possible – 'unassignable causes'. In general variations due to 'assignable causes' will lie outside the upper and lower control lines (which are each one standard deviation apart from the mean line). In addition, those variations that cannot be controlled will lie inside the control lines. In this particular case, the fuel consumption per tonne of meat produced appeared to be quite consistent until

April 2006 and then significant fluctuations are observed. This could be due to the occurrence of the fire in April 2006 that could have greatly disturbed the activity of the site. It should be ensure that the specific consumption is now back to its normal level (this level should even be lower than this one as the boning hall was refurbished with electrical knife sterilizers after the fire). If this is not the case, the reasons for this should be investigated.

Considering the data available, benchmarking can also be used to evaluate the current energy performances as done in Section 5.3.

Other analyses can be achieved, depending on the energy utilization. For example, the degree day is the most appropriate measure of the weather for monitoring the heating and cooling needs of a building.

Performance should be reported regularly to those who are responsible for energy use. The **reports** should be produced in a form which is of most use to the recipients, and should indicate areas requiring attention.

Examination of the reports will usually show variations in performance. Investigation into the reasons for these variations can reveal the scope for improvements in energy performance.

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Attachment N^o E1
Statutory Requirements

Attachment N^o E1 Statutory Requirements

Meadow Meats Ltd. operate best environmental practices to ensure that control of diffuse emissions from the installation eliminated or controlled in such a way as to prevent environmental impact. Compliance with the range of relevant legislation is detailed below.

Ref.	Legislation	Compliance
(a)A	A specification prepared by the Agency in accordance with Section 5 of the <i>Environmental Protection Agency Act 1992</i> as amended by Section 7 of the <i>Protection of the Environment Act 2003</i>	<p>Meadow Meats Ltd. have applied BAT to the management of their processing operations at the Rathdowney facility as follows:</p> <p>The site operates an Environmental Management System (EMS) which applies management control, through documented procedures over all aspects of site activities which may potentially interact with the environment.</p> <p>Specific projects for improvement are addressed through the <i>Schedule of Objectives and Targets</i> in the Environmental Management Programme. Progress in meeting targets is reported to the Agency on an annual basis in the AER. The EMS addresses BAT issues of training, process control to minimize waste and reduce water and energy consumption throughout the process.</p> <p>Specifically with respect to wastewater treatment, BAT is applied at the site as follows:</p> <ul style="list-style-type: none">• Prevent stagnant waste water through the use of sufficient gradients in the collection system and in the waste water treatment plant (WWTP) (see BREF Section 4.1.43.3)• Pre-screen solids at the slaughterhouse (see BREF Sections 4.1.11 and 4.1.43.4), followed by a solids screen within the WWTP.• Remove fat from waste water, using a fat trap (see BREF Section 4.1.43.9)• Use of a flotation plant for fat and solids removal, such as dissolved air flotation (DAF), air flotation or mechanical flotation (see BREF Section 4.1.43.10)• Use of a waste water equalisation tank for the feed to the biological treatment system (see BREF Section 4.1.43.11)• Use of biological treatment systems to biodegrade organic substances, and in certain cases to remove nitrogen:<ul style="list-style-type: none">○ anaerobic pre-treatment (see BREF Section 4.1.43.14)○ treatment of waste water and waste (• Use of tertiary treatment systems to remove phosphorus, such as addition of coagulants and precipitation (see BREF Section 2.3.1.3).

Ref.	Legislation	Compliance
(b)	<i>Urban Waste Water Treatment Regulations 2001 (S.I. No. 254 of 2001) as amended by the Urban Waste Water Treatment (Amendment) Regulations 2004 (S.I. No. 440 of 2004) or any future amendment thereof;</i>	The Erkina River is not designated a Sensitive Area under the Urban Wastewater Treatment Regulations 2001 (S.I. 254 of 2001).
(c)	<i>European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2009 (S.I. No. 101 of 2009) or any future amendment thereof</i>	<p>The requirements of SI 101 of 2009 are addressed through the land spreading of activated sludge in accordance with the specifications of a Nutrient Management Plan (NMP).</p> <p>The NMP is updated on an annual basis and specifies the locations, rates of application (based on land soil values and nutrient content of the wastes) and defines all buffer zones and exclusion periods required for the protection of surface and ground water bodies during application of wastes.</p>
(d)	<i>Local Government (Water Pollution) Act, 1977 (Control of Cadmium Discharges) Regulations 1985 (S.I. No. 294 of 1985);</i>	Cadmium is not used at the installation; therefore, there is no potential for discharges containing cadmium from the site.
(e)	<i>Local Government (Water Pollution) Act, 1977 (Control of Hexachlorocyclohexane and Mercury Discharges) Regulations 1986 (S.I. No. 55 of 1986);</i>	Hexachlorocyclohexane and mercury are not used at the Meadow Meats installation.
(f)	<i>Local Government (Water Pollution) Acts, 1977 and 1990 (Control of Carbon Tetrachloride, DDT and Pentachlorophenol Discharges) Regulations 1994 (S.I. No. 43 of 1994)</i>	These substances are not used and accordingly, would not form part of any discharge to the receiving watercourse.
(g)	Measures or controls identified in a pollution reduction plan for the river basin district prepared in accordance with Part V of the <i>EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009</i> for the reduction of pollution by priority substances or the ceasing or phasing out of emissions, discharges and losses of priority hazardous substances.	Management of WWTP to ensure that current emission limit values are not exceeded. Commitment to reducing water consumption at the facility which in turn reduces the process waste water generated at the facility.

There are no direct emissions to groundwater and inadvertent indirect emissions will be prevented by bulk tanks, segregation, bunding and correct material handling protocols. These measures will ensure compliance with S.I. No. 271 of 1992.

Bunding of bulk storage tanks, of liquid material storage areas and procedures to ensure that bunding is adequate and of good integrity are in place at the site. Integrity testing of bunding structures is carried out on a 3-year cycle. Tank integrity testing is also carried out.

There is adequate designated space within the plant for storage of waste awaiting disposal off-site in areas that are suitably constructed to prevent a risk of surface and groundwater pollution.

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Attachment N° F1
Approved Adjustments & Conditions

Attachment N^o F1

Approved Adjustments & Conditions

The EPA undertook a review of the Licence in November 2005 and issued Amendment A to the IPPC Licence. Amendment A deals solely with the incorporation of Energy and Resource Use Efficiency (Condition 2.9), Accident prevention and Emergency Response (Condition 12.1) and Decommissioning and Residuals Management (Condition 7.9) by insertion of these conditions into the original licence.

There are no other approved Adjustments or Conditions to this Licence.

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