Sustainable refrigeration
leading the way for Natural refrigerants

1986 – HCFC phase started across the Nestlé organisation

1997 – Nestlé take the leading role in reviving CO2 as an industrial refrigerant

2001 – Ozone depleting substances reduced by 93% of finished goods

2001 – Commissioned the largest carbon dioxide/ammonia system to be built in the last 50 years

2001 - Nestlé position on refrigerants ‘where ever possible, nestle will use natural refrigerants on new industrial refrigeration systems’
leading the way for Natural refrigerants

2002 - Nestlé UK receive prestigious IchemE Cremer and Warner award for the best project paying attention to safety and environment
leading the way for Natural refrigerants

2005 – Nestlé set up working group on sustainable gases

Nestlé accelerate phase out of HydroChlroFlouroCarbons (HCFC’s) well ahead of the Montreal protocol and EU requirements. Approx 112 tons by 2004.

In most R22 phase out projects Nestlé has reduced energy by at least 25% by using more efficient refrigeration systems. The indirect reduction of GWP as a result is note worthy.
24 April, 2008

RE: Reminder on Nestlé Policy on the Use of Natural Refrigerants

Refrigeration is essential in the processing, preservation and transport of Nestlé products.

CFCs (ChloroFluoroCarbons) such as R12 and HCFCs (HydroChloroFluoroCarbons) such as R22, are substances that have been recognised as having a Depletion Effect on the stratospheric Ozone layer (Montreal Protocol - 1987), as well as a high Global Warming effect (Kyoto Protocol - 1997).

HFCs (HydroFluoroCarbons) such as R134a are refrigerants wrongly presented as the long-term alternative to CFCs and HCFCs. Although these substances do not have an Ozone Depleting effect, they have a substantial Global Warming effect and therefore carbon dioxide (CO₂) in combination with ammonia (NH₃) must be used for all low temperature applications. Beyond many technical and economical advantages carbon dioxide is safer for the environment, people and goods.

Water or glycol chillers with ammonia as primary refrigerant must also be used for all positive temperature applications. Nestlé has successfully used these systems for many years in a large range of applications, including PTCs and offices buildings.

Yours faithfully,

NESTLÉ S.A.

José Lopez

Executive Vice President
Corporate Operations
The Consumer Goods Forum

Mission - Manufacturers and retailers “working together to enable the industry to passionately serve shoppers, consumers and communities better, faster, with great value and in a responsible way”.

Nestlé CEO Paul Bulcke represents Nestlé Group on the Board of Directors and co-chairs the Governance Committee.

A unique global platform for knowledge exchange and initiatives on refrigeration
The next step in energy efficiency

10 years after the CO2/ammonia cascade system in Hayes Nestlé UK make the next innovation. Winning the Industrial project of the year for the installation of heat pumps at the Halifax factory.
The Case Study...

In 2008 the Nestlé Halifax site produced circa 30,000 tons of confectionery brands on a site that covers 3.0 hectares and occupies buildings dating back to 1879.
Halifax factory 2008

Site requirements of 3500-4000kg/hr of steam using coal fired boilers.

Environment Agency are likely to impose stricter controls on particulate emissions that will lead to increased operational costs.
Halifax factory 2008

Refrigeration generation is provided by a 5.4 MW system that uses R22 refrigerant.

The system control is unstable and affects production in high ambient conditions.

The holistic assessment

End users

Old Boiler house will be decommissioned

Bowl Wash

Bailey Hall

Bowl wash, Plaque wash and IBC wash

Office and Canteen heating

Office Block

Bowl Wash

E Factory

Calorifiers

E Factory

Cooking

E Factory CIP

E Factory

Cooking

J Factory Plant room calorifiers

J Factory

Cooking

J Factory

CIP system

Stores

Nut Processing Building

Office Block

Bailey Hall

E Factory

H Factory

J Factory

End users

J Factory

CIP system
Halifax Heating demand per user

- Calorifiers: 33%
- Domestic hot water: 3%
- CIP: 5%
- Cookers: 32%
- Bowl wash: 10%
- Various users: 6%
- Losses and missing: 11%
The generally applied principle of installing a new central gas fired boiler house would be the simplest solution.

This would deliver compliance but with little reduction in Environmental impact.
The difficult right! Thermo-coupling

This solution focused on reducing site dependency on steam and capture of the rejected heat from the new refrigeration plant.
Pinch Analysis

A top level Pinch analysis was constructed that identified the major hot and cold streams for the factory.

The stream data used for the Halifax analysis was stream lined to only include CIP water, high temperature closed heating and medium temperature closed heating, a summary of this data is shown below.

Steam to be used for high grade requirements has been excluded as there are no other systems that offer similar heat range to act as recovery.

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Stream Name</th>
<th>Hot/Cold</th>
<th>TS (Supply)</th>
<th>TT Target temp</th>
<th>Flow rate kg/s</th>
<th>Specific Heat Capacity</th>
<th>Heat Cap. Flow kW/C</th>
<th>Enthalpy Change kW</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Closed Heating M</td>
<td>Cold</td>
<td>42</td>
<td>59</td>
<td>4.5</td>
<td>4.18</td>
<td>18.81</td>
<td>-319.77</td>
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<tr>
<td>2</td>
<td>Closed Heating H</td>
<td>Cold</td>
<td>80</td>
<td>95</td>
<td>7.65</td>
<td>4.18</td>
<td>31.977</td>
<td>-479.655</td>
</tr>
<tr>
<td>3</td>
<td>CIP</td>
<td>Cold</td>
<td>12</td>
<td>90</td>
<td>4.6</td>
<td>4.18</td>
<td>19.228</td>
<td>-1499.784</td>
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<tr>
<td>4</td>
<td>Heat Pump 1</td>
<td>Hot</td>
<td>60</td>
<td>40</td>
<td>6</td>
<td>4.18</td>
<td>25.08</td>
<td>501.6</td>
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<tr>
<td>5</td>
<td>Heat Pump 2</td>
<td>Hot</td>
<td>60</td>
<td>10</td>
<td>4.6</td>
<td>4.18</td>
<td>19.228</td>
<td>961.4</td>
</tr>
</tbody>
</table>
Composite Curves & Pinch Point

![Composite Curves & Pinch Point Diagram]

- **Hot Stream**
- **Cold Stream**

- **Energy available for recovery**

- **220 kW Refrigeration**
- **1130 kW Heat Recovery**
- **1100 kW Gas fired**

- **ΔT_{min} Pinch point**
The difficult right! Thermo-coupling

Waste heat warms towns water & supplies Cleaning and Jacketed systems

High efficiency water heaters lift the temp to required levels

Steam reduced by 70% and only used on cooking processes

High temperature Jacketed Heating supplied from High efficiency water heaters

Waste heat warms towns water & supplies Cleaning and Jacketed systems

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High temperature Jacketed Heating supplied from High efficiency water heaters
Purpose Built Refrigeration Building

£2.2 Mil Investment
3.2 MW Innovative heat pump design
40% reduction in energy

Refrigeration total KW/h

Ammonia
Total
KW/h
R22
KW/h
2009
Heat pump operation - Energy

- Existing R22 elec. load
- NH3 elec. load
- NH3 elec. load
- Heat pump
- COP of 5.6

40% Reduction
28% Reduction
Heat pump operation – Cost & CO2

Cost

Costs based on £0.03 kWh Gas and £0.08 kWh Electricity

CO2

CO2 based on 0.185kg kWh Gas and 0.32kg kWh Electricity
2.2 MW Gas fired steam plant for cooking process

£1.7 Mil Investment
Gas fired boiler and distribution system dedicated to cooking processes
Two consolidated Hot water systems
## Financial Benefits

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2011</th>
<th>Reduction</th>
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<tbody>
<tr>
<td>Capital Investment</td>
<td>-</td>
<td>£3,900,000</td>
<td>-</td>
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<tr>
<td>Energy Cost</td>
<td>£1,800,000</td>
<td>£860,000</td>
<td>£940,000</td>
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<tr>
<td>Operational Cost</td>
<td>£380,000</td>
<td>£80,000</td>
<td>£300,000</td>
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<tr>
<td>C0₂ Cost</td>
<td>£330,000</td>
<td>£165,000</td>
<td>£165,000</td>
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<tr>
<td>Water</td>
<td>£72,000</td>
<td>£47,000</td>
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<tr>
<td>Total Costs</td>
<td>£2,510,000</td>
<td>£1,105,000</td>
<td>£1,430,000</td>
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</table>
# Environmental Benefits

<table>
<thead>
<tr>
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<th>2008</th>
<th>2011</th>
<th>Reduction</th>
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<tr>
<td>Production Volume</td>
<td>29,000 t</td>
<td>29,000 t</td>
<td>0</td>
</tr>
<tr>
<td>GJ / tonne</td>
<td>5.20</td>
<td>2.89</td>
<td>2.33</td>
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<tr>
<td>Absolute Energy</td>
<td>171888 GJ</td>
<td>81637 GJ</td>
<td>90251 GJ</td>
</tr>
<tr>
<td>C02</td>
<td>20,000 t</td>
<td>9650 t</td>
<td>10350 t</td>
</tr>
<tr>
<td>HCFC</td>
<td>1184 kg</td>
<td>138 kg</td>
<td>1046 kg</td>
</tr>
<tr>
<td>Particulates</td>
<td>1760 kg</td>
<td>0 kg</td>
<td>1760 kg</td>
</tr>
<tr>
<td>Water</td>
<td>52,337 m³</td>
<td>34,426 m³</td>
<td>17,911 m³</td>
</tr>
</tbody>
</table>