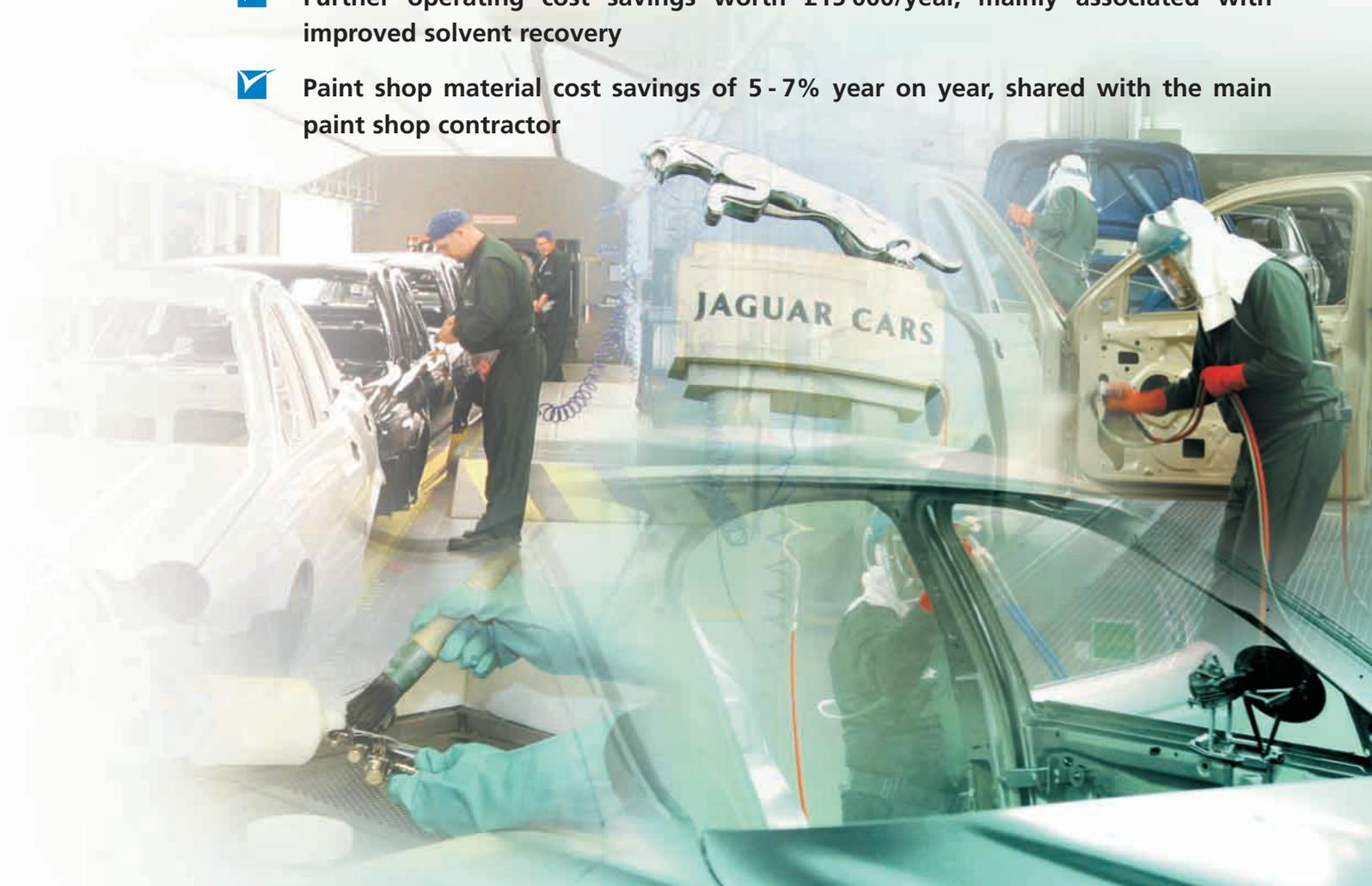


Continuing to profit from computer-based solvent management

A Case Study at Jaguar Cars Limited, Halewood site

In common with other major solvent-using industries, motor manufacturers have to meet strict volatile organic compound (VOC) emission limits. In the mid-1990s, Ford introduced a solvent management system at its Halewood site, to identify opportunities to reduce VOC emissions. By 1997, this system had enabled Ford to reduce emissions by 38%, save around £60 000/year through reduced expenditure on chemicals, solvents and waste disposal, and comply with legislation without major investment in abatement equipment. In 2001, Jaguar Cars Limited, which is part of the Ford-owned Premier Automotive Group, took over production at the Halewood site. Jaguar has continued to use the Ford solvent management system and has achieved significant benefits through a continuous improvement approach:

- ✓ **A further 50% reduction in VOC emissions, taking the company below the Solvent Emissions Directive limit of 60 g/m² for existing processes**
- ✓ **Further operating cost savings worth £15 000/year, mainly associated with improved solvent recovery**
- ✓ **Paint shop material cost savings of 5 - 7% year on year, shared with the main paint shop contractor**



Limiting VOC Emissions During Vehicle Manufacture

Motor manufacturers use considerable amounts of solvent during vehicle coating operations, as a paint component, as a thinner and for cleaning. Volatile organic compound (VOC) emissions have been regulated under the Local Air Pollution Control (LAPC) regime and are now regulated under Local Air Pollution Prevention and Control (LAPPC), as set out in process guidance note PG 6/20 *Paint application in vehicle manufacturing*.

VOC emission limits are expressed as a concentration in air (mg/m^3) from paint shop and oven arrestment plant, and as an overall mass of VOC per unit coated area (g/m^2). Until 1997, the limits were $60 \text{ mg}/\text{m}^3$ for 'solid colours' (medium solids uni-colour) and $120 \text{ g}/\text{m}^2$ for two-pack systems (basecoat plus clear topcoat). The mass emission limit dropped to $60 \text{ g}/\text{m}^2$ in April 2001 and remains the same for existing processes under LAPPC (which incorporates the requirements of the Solvent Emissions Directive).

Applying a Computer-based Solvent Management System

In the mid-1990s, Ford introduced spreadsheet-based mass balance analysis to track solvent consumption and VOC emissions on a monthly basis. This solvent management system is now used at all Ford's European plants, including Jaguar at Halewood. The system identifies all solvent inputs to the process and all waste solvents collected at the end of the process, and offers a cheaper and simpler way to assess the total mass of solvent emitted than continuous stack monitoring. Staff need only enter material amounts and production volumes into the spreadsheet. The system effectively has three stages.

In the first stage, material use is calculated from data on deliveries and stock levels for the period of interest. Electronic tank meters automatically indicate bulk material levels, while amounts held in smaller containers are recorded manually. These data are already recorded as part of stock management procedures.

In the second stage, VOC emissions to atmosphere are calculated in kilograms by applying known material density factors and emission factors to the material use data. Emission factors reflect the proportion of VOCs destroyed by abatement equipment, based on periodic in-house monitoring. Solvent sent for recovery is deducted to give the net emissions for the process (see Table 1).

In the final stage, the number of vehicles painted is entered and multiplied by the vehicle surface area (internal and external), to determine the total area coated in the given period. The spreadsheet then calculates the total VOC emissions per unit area coated (g/m^2), as required to demonstrate compliance (see Table 2). Various graphs can be produced to track progress from month to month.

VOC Emission Reductions

Prior to the change in ownership in 2001, Ford had made very significant reductions in VOC emissions at Halewood, tracking progress with the help of the solvent management system.¹ The measures taken by Ford prior to 1997 included changing paint type and application techniques; improving cleaning practices and equipment; introducing a solvent awareness and education programme; and installing a purge recovery system for the automatic spraying equipment.

These measures between them reduced VOC emissions by 38% and took the site below the existing compliance limits.

¹ Full details of Ford's experience with the solvent management system can be found in 'Profiting from computer-based solvent management' (GC108) available free of charge through the Environment and Energy Helpline on 0800 585794 or via the Envirowise website (www.envirowise.gov.uk).

Table 1 Determining net process emissions to atmosphere - worked example

Process	Monthly usage (kg or litres)	SG for materials (litres)	VOC (%)	Solvent (kg)	Emission factor	Emission or emission reduction (-)
	A			A x B x C = D	E	D x E = F
Electrocoat	18 500 kg		C	3 015	0.395	1 191
Sealer and PVC	10 020 kg		C	381	0.166	63
Primers	9 500 litres	B	C	6 450	0.5	3 225
Enamels	11 500 litres	B	C	1 517	0.8	1 213
Clearcoat	7 800 litres	B	C	2 641	0.53	1 400
Waxes	200 kg	B	C	60	1	60
Repairs	300 litres	B	C	218	1	218
Solvents/other materials	20 400 litres	B	C	20 486	-	20 486
Collected materials	16 822 litres	B	C	15 981	-	-15 981
Total emission (F)						11 875 kg

Note: specific figures for B and C are not shown as these consist of mixtures of sub-components, each with different values.

Upgrading the paint shop facilities

With the transition to Jaguar scheduled for January 2001, Ford anticipated the need to upgrade the paint shop facilities to meet Jaguar standards and also comply with the stricter VOC emission limits to be imposed from April 2001. Employees used the spreadsheet to evaluate various solvent reduction options, and identified the best option as a move to water-based, low-VOC basecoat.

To accommodate this change, the two primer lines and the basecoat and clear topcoat lines were completely replaced at a cost of approximately £48 million. The new paint lines have reduced solvent use, VOC emissions and water use by having:

- Colour-dedicated manual lines and high volume low pressure (HVLP) spray guns that reduce the need to clean the lines between colour changeovers.
- The colour changer closer to the automatic spray heads, reducing wastage of paint and cleaning materials at changeover.
- Water-based basecoat lines that can be cleaned using de-mineralised water with around 10% solvent.
- A chemical solution in the wet scrubbers that keeps the paint pigment in suspension, hence stopping sludge formation. The scrubber water is recirculated via an ultrafiltration system, the filtered concentrate being sent for treatment off-site.

The company was also able to eliminate a number of old VOC incinerators, significantly reducing gas usage and maintenance costs, and saving an anticipated £150 000/year.



Continued improvements in solvent use

Jaguar continues to strive for further reductions in solvent use through a continuous improvement approach. Data on performance are communicated to the production workgroups. Recent improvements include:

- purge optimisation, using air jets and cleaning agents alternately, with each colour having its own purge cycle;
- greater control over solvent use in manual spraying, with a set amount dispensed for use during the shift;
- regular checks for leaks in pipes, valves, etc;

Table 2 Relating emissions to production - worked example

Number of units built, by model	Surface area of units (m ²)	Total area (m ²)	Plant emissions (g/m ²)
G	H	G x H = J	F x 1 000/J
2 620	94	246 280	48.2

- recovery of wash solvents from the dedicated gun cleaning sinks;
- improved car batch scheduling, allowing same-colour cars to be taken through the line together, reducing the need to purge.

The paint materials are managed and supplied to the point of use by a single source supplier, DuPont. This supplier is paid by the completed vehicle, providing a clear incentive to minimise material wastage and get the job right first time.

These new measures have produced a further reduction in VOC emissions (see Fig 1), bringing the site below the latest compliance limits.

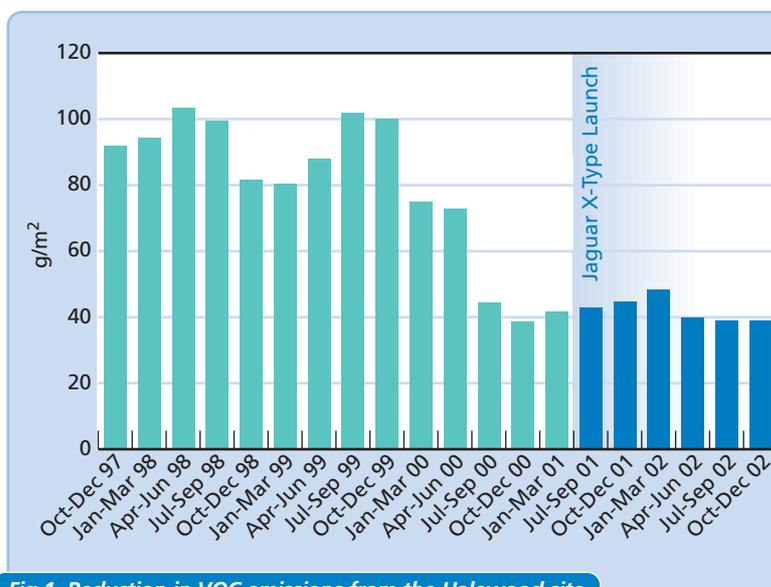


Fig 1 Reduction in VOC emissions from the Halewood site

Financial Benefits

Since Jaguar took over production at Halewood in 2001, action taken to reduce VOC emissions has realised cost savings and other benefits. Improved solvent recovery and reclaim alone is saving the company around £15 000/year. Paint shop material costs are falling by 5-7% each year, the benefits being shared with DuPont. These benefits have been achieved for little or no investment, offering immediate payback.

Jaguar also continues to benefit from improvements made possible through development of the new £48 million paint shop, such as dedicated paint lines and water recirculation. It is not, however, possible to separate out the costs and benefits associated with individual measures, although the removal of old VOC incinerators is expected to save over £150 000/year in gas usage and maintenance costs.

Jaguar's Future Plans

The solvent management spreadsheet has proved a useful tracking tool, fitting in well with Ford and Jaguar's continuous improvement approach. Jaguar is now trialling a global Data Management System (DMS), developed by Ford in the USA, which should allow simpler benchmarking between plants worldwide. The DMS uses the same mass balance principles, but uses a database rather than a simple spreadsheet and incorporates self-diagnostic features which ensure that data entries fall within specified ranges. The DMS also offers a wide range of graphical and text-based reports.



Jaguar Cars Limited

Jaguar employs some 12 000 people across its four UK sites in Halewood, Whitley, Castle Bromwich and Browns Lane. The Halewood plant has the capacity to manufacture around 100 000 X-Types a year. Jaguar is part of the Ford Motor Company's Premier Automotive Group.

Comments from Jaguar Cars Limited

Jaguar Cars Limited and Ford Motor Company together believe that the solvent management work has, over the years, proved an asset to our company, evolving into a robust, flexible and reliable compliance tool that enables the identification of cost savings, assists in predictive solvent reduction planning and supports ISO certifications. The shared vision of Jaguar Cars, and its lead suppliers DuPont and Gage Products (single source supplier of solvents), is to reduce impact on the environment through the efforts of a cross-functional team, using the solvent management tool.



Bob Graham (Jaguar Cars), Roy Donga (Jaguar Cars), Tony Ferguson (Gage Products) and Ian Kitching (DuPont)

“...our shared vision is to reduce impact on the environment and save costs.”

Host Company:

Jaguar Cars Limited
Browns Lane
Allesley
Coventry
CV5 9DR



Useful publications from Envirowise

(GG28) - *Good housekeeping measures for solvents*

(GG203) - *Monitoring VOC emissions: choosing the best option*

(GC108) - *Profiting from computer-based solvent management*



Harwell International Business Centre | Didcot | Oxfordshire | OX11 0QJ
E-mail: helpline@envirowise.gov.uk Internet: www.envirowise.gov.uk

Envirowise - Practical Environmental Advice for Business - is a Government programme that offers free, independent and practical advice to UK businesses to reduce waste at source and increase profits. It is managed by Momenta, an operating division of AEA Technology plc, and Technology Transfer and Innovation Ltd. This publication was prepared with assistance from Enviros.



© Crown copyright. First printed October 2003. Printed on paper containing a minimum of 75% post-consumer waste. This material may be freely reproduced in its original form except for sale or advertising purposes.

For further information
please contact the

**Environment
and Energy
Helpline**
0800 585794