Refrigeration Reliability, Efficiency and Emissions Reduction

Graeme Maidment

Content

- Why refrigeration systems leak, and its impact
- What is REAL ZERO and how it can help…..
  - Site investigations
  - Tools we have developed
  - Training material and specialist skills

Why systems leak?

Requires

- A pressure difference
- A hole, gap or imperfection in the system

Why refrigeration systems leak

1. Most systems operate above atmospheric pressure
2. The main reasons for leakage
   - poor brazing
   - Poor vibration elimination
   - Insufficient support
   - Use of mechanical joints
   - Wrong pipe thickness

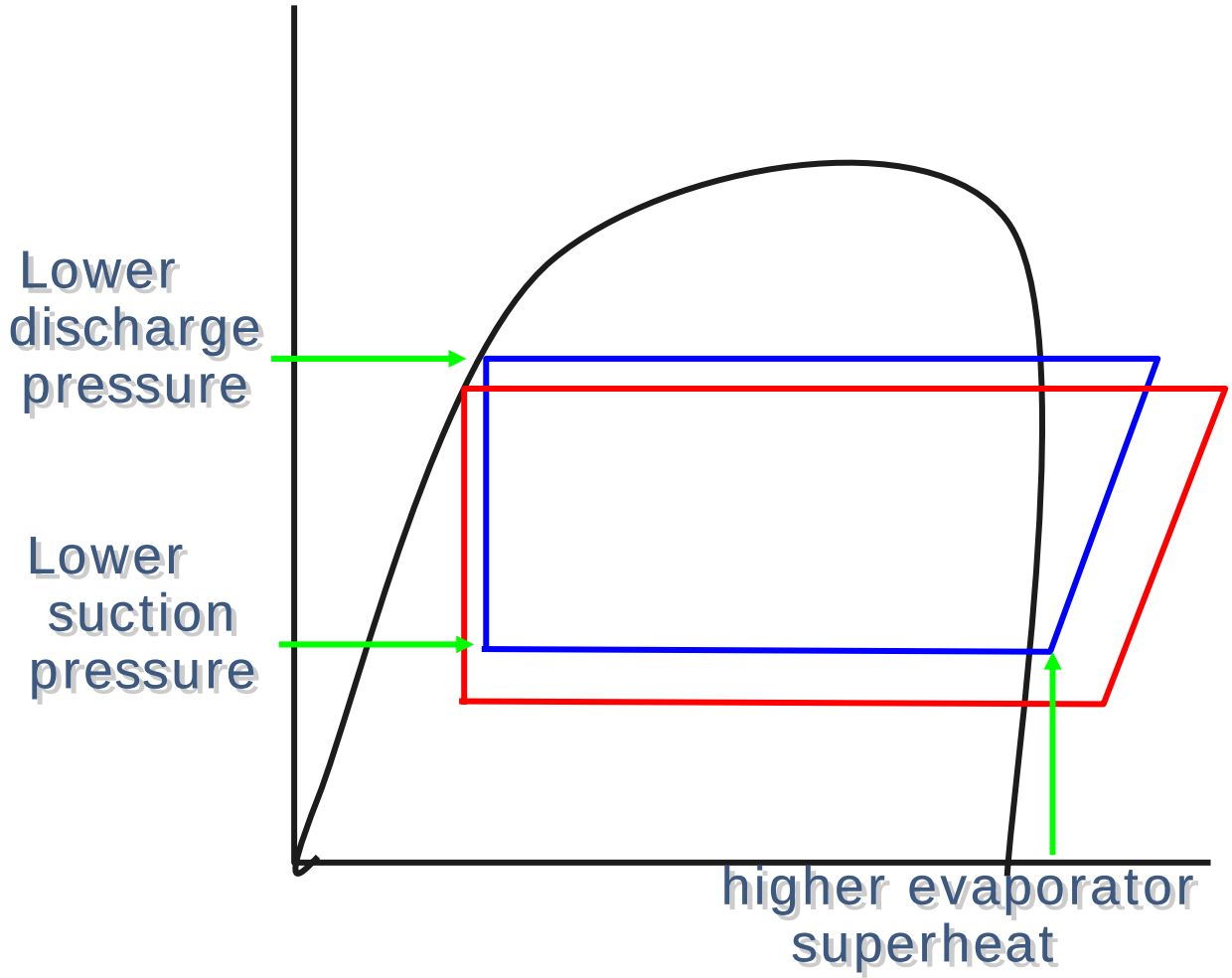
3. Leaks are not identified because……
   - Inadequate pressure testing in commissioning
   - Poor service and maintenance
   - Poor access making service difficult

Impact of leakage

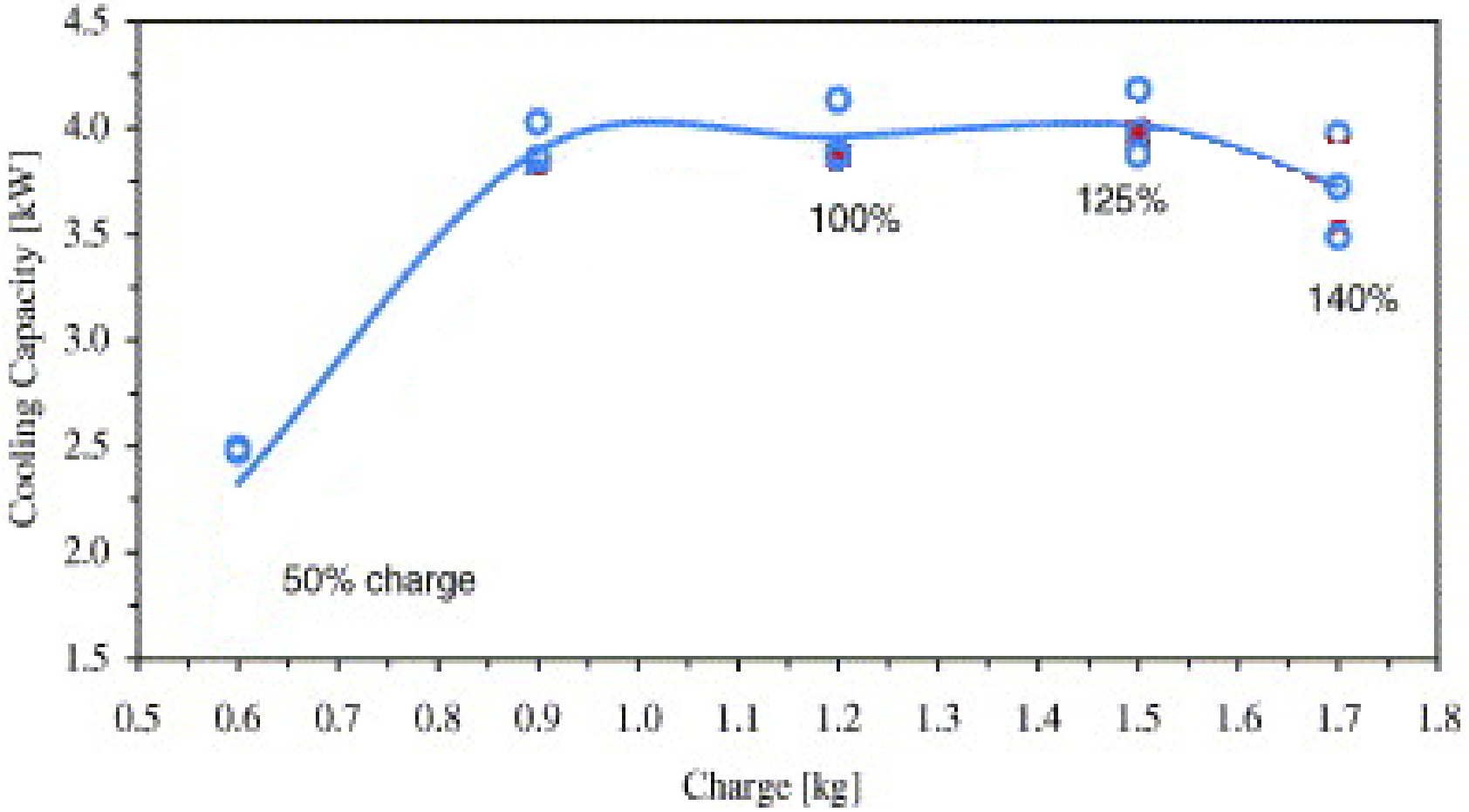
Leakage may result in

1. Reduction in reliability,
2. Down -time
3. Reduced efficiency
4. Increased environmental impacts
5. Increases in costs

Impact of leakage - reliability

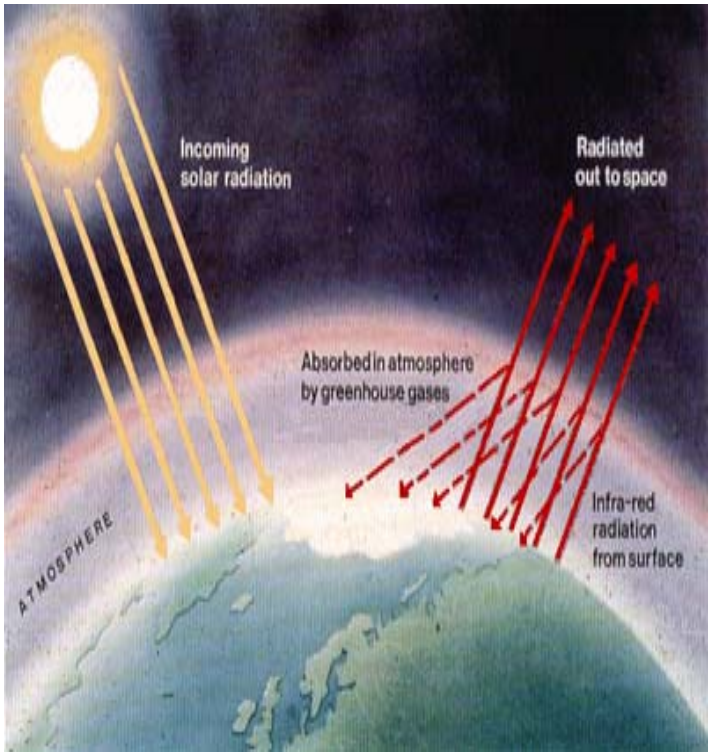


Impact of leakage - reliability



Grace et al, 2005

Impact of leakage – environment



- Refrigeration produces 10% of total radiative force (IIR, 1992)
  - 20% direct; 80% indirect (IIR, 2007)
- How will this change after R22 phase out?

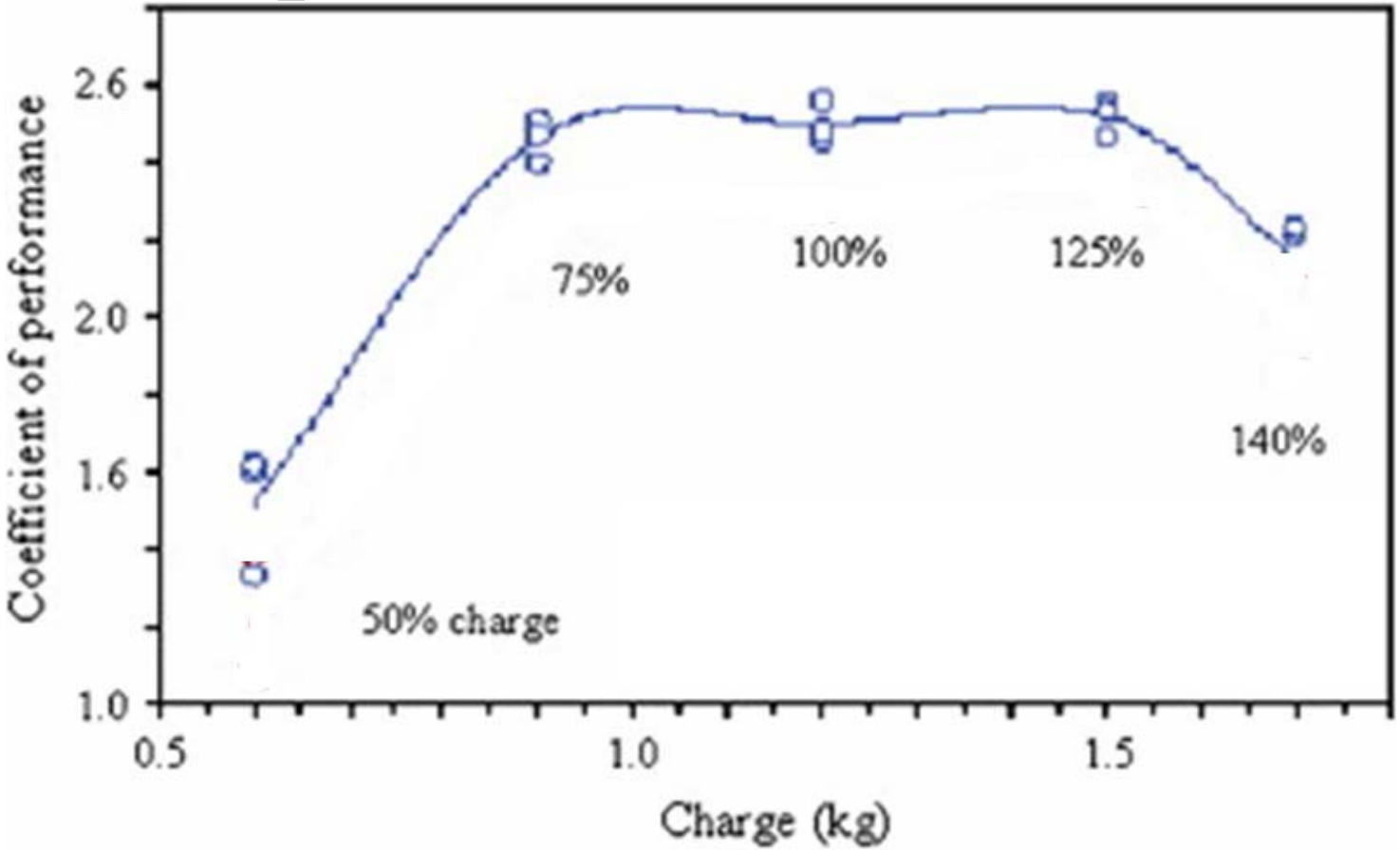
Annual EU Emission (MTCO2e) for HFC Systems

System type	Direct emissions $MTCO_2e$	Indirect emissions $MTCO_2e$	Total global warming impact $MTCO_2e$	Direct % related to total emissions
Retail	9.0	23.0	32.0	28%
Industrial	3.4	25.0	28.4	12%
DX AC	2.6	10.0	12.6	21%
Small commercial	1.8	12.0	13.8	13%
Chillers	0.7	12.0	12.7	6%
Other small hermetic	0.3	12.0	12.3	2.5%

Source HEAP, R.D. 2001-5

Impact of leakage – environment

- Charge level also influences CoP



From Grace et al, 2005

Impact of leakage – revenue cost

Leakage results in cost due to

1. Refrigerant cost
2. Service engineer cost
3. Down-time cost
4. Increased energy cost

And in the future.....

5. Carbon cost... £15/tonne of CO_2, 1kg R404a costs £55

What is REAL ZERO and how it can help.....

- IoR initiative funded by the Carbon Trust et al.
- Objective based upon 30 case studies to develop
  - Best practice guidance
  - Tools to keep track of and value the carbon case for refrigerant management
  - Training and specialist skills
- Today's presentation introduces this

The Site Survey

Site Surveys

30 surveys – range of systems:

- Retail, industrial, leisure

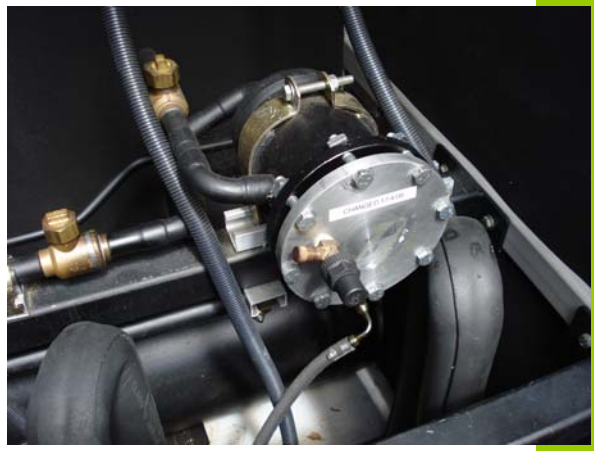
Consistent survey format

- Log system and operating conditions
- Visual check of system
- Leak test – easily accessible joints only
- Check F Gas log

Survey Key Findings

Leak points as expected:

- uncapped valves / stems
- flanges, flares
- Schraders
- rotolock flanges

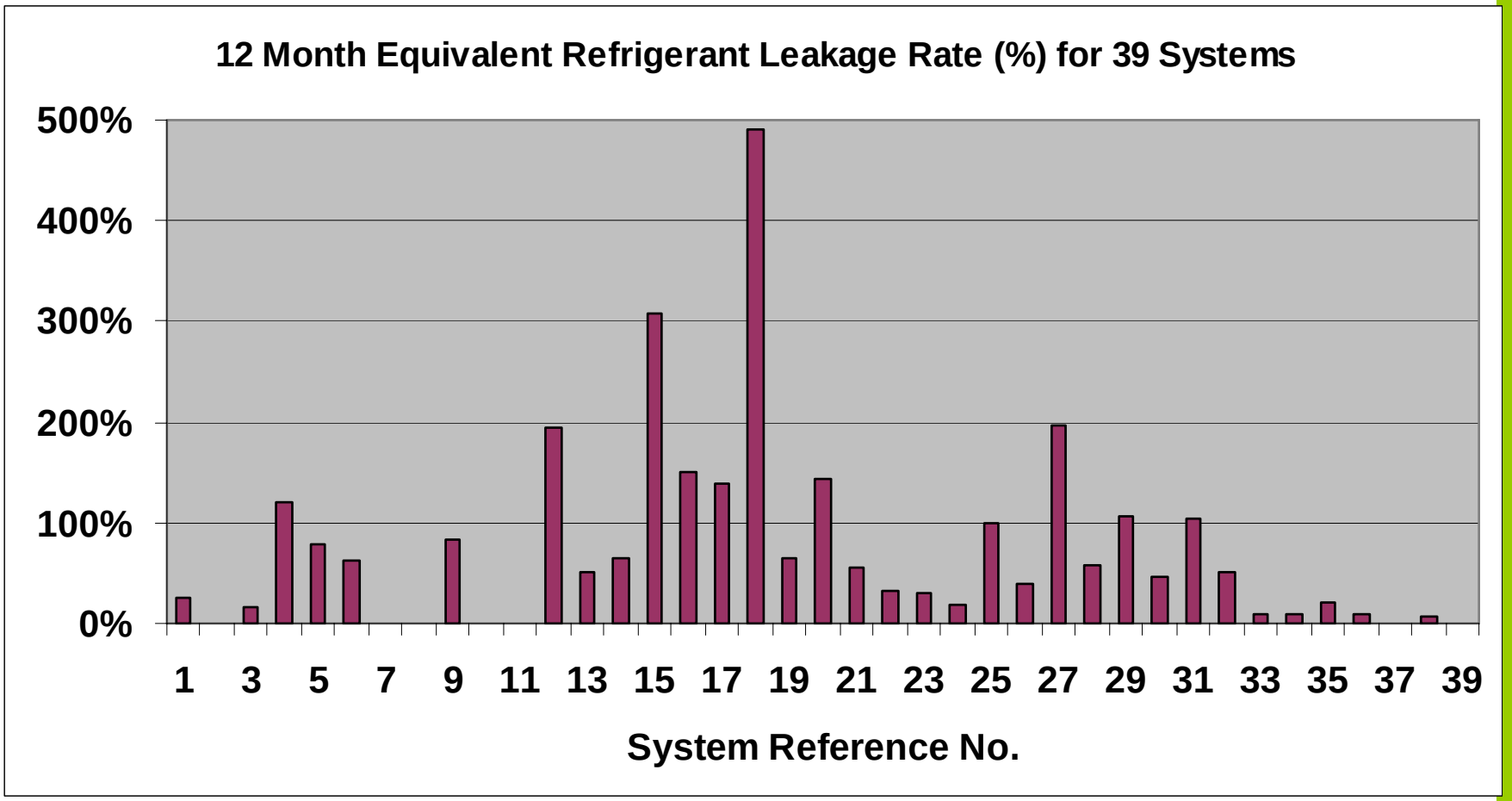


Survey Key Findings

F Gas reporting poor

- Logs not on site
- Available logs questionable
- System charges not available so % leak rate not possible to estimate

Survey Key Findings



Survey Key Findings

Both leak detectors worked well

- Infra red
- Heated diode

Common Leak Points

Make sure gland is tightened

Fit caps and seals

Remove core when brazing

- ensure cool before replacing

Tighten core correctly

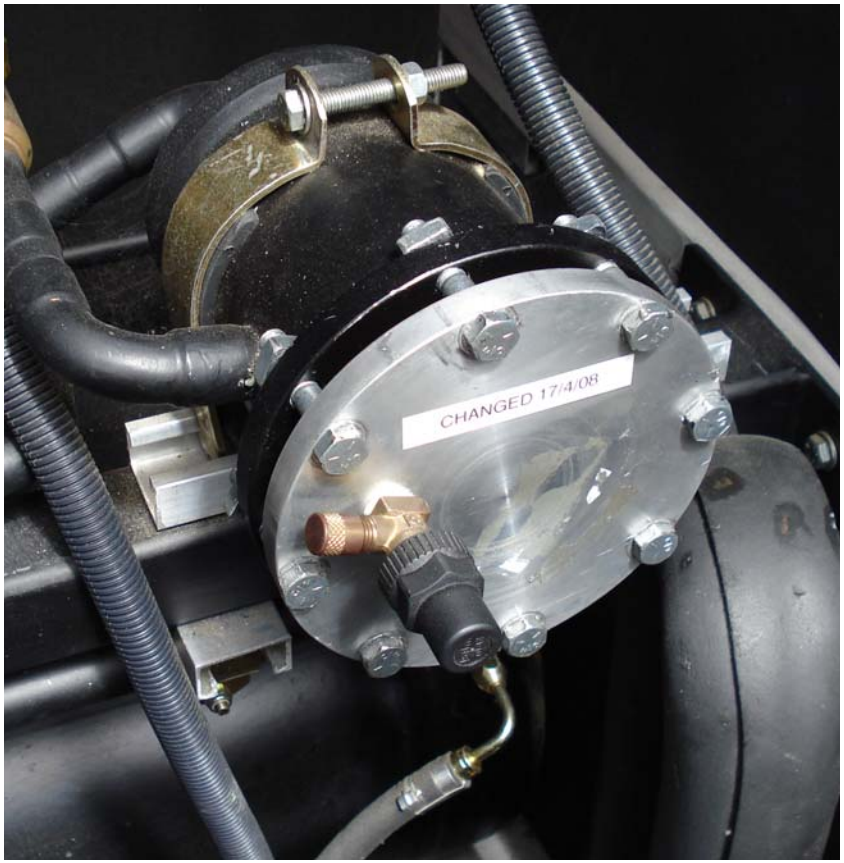
Ensure cap has good seal

Use flare solder adaptors

Or eccentric flaring tool

Lubricate

Tighten to correct torque



Replace gaskets

Tighten flanges evenly

Use correct torque

Check and change seals if necessary (especially during retrofit)

Use oil on seals

- Use correct size
- Use only for initial access to system, then fit Schrader
- Leak test line taps found on system – replace if possible

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some tools to help

The F-Gas Logging tool

FGas Support Guidance

- FGas Support - RAC1
- FGas Support - RAC2
- FGas Support - RAC3
- FGas Support - RAC4
- FGas Support - RAC5
- FGas Support - RAC6
- FGas Support - Sample Log

Welcome to the REAL Zero Leak Reduction & FGas Guidance page. You will find a number of useful links and guides produced by the REAL Zero project!

Useful Web Links

Institute of Refrigeration	www.ior.org.uk
Real Zero	www.realzero.org.uk
Defra (FGas Support)	www.defra.gov.uk/fgas
The Carbon Trust	www.carbontrust.co.uk
ACRIB	www.acrib.org.uk
BSI	www.bsi-global.com

Real Zero - Guides

- GN1 - Good Leak Testing
- GN2 - 13 Leak Points
- GN3 - Designing Out Leaks
- GN4 - S&M Contractors
- GN5 - Equipment Owners

Refrigerant GWP's

R404A	3780
R407C	1650
R408A	3020
R409A	1540
R410A	1980
R134a	1300
R22	1700
R403A	3000
R403B	4310
R422D	2620

FGas Support Guidance - Index

RAC1	Overview
RAC2	Usage
RAC3	Key Obligations
RAC4	Getting Started
RAC5	Qualifications & Certificates
RAC6	Practical Guidance

Get ADOBE READER

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Real Zero Guides - Index

GN 1	Guide to Good Leak Testing
GN 2	Illustrated Guide to 13 Leak Points
GN 3	Designing Out Leaks
GN 4	Leakage Matter - For Service & maintenance Contractors
GN 5	Leakage Matters - For Equipment Owners

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The log

Microsoft Excel - FGas Log Ver 2.50.xls

File Edit View Insert Format Tools Data Window Help

Arial 11

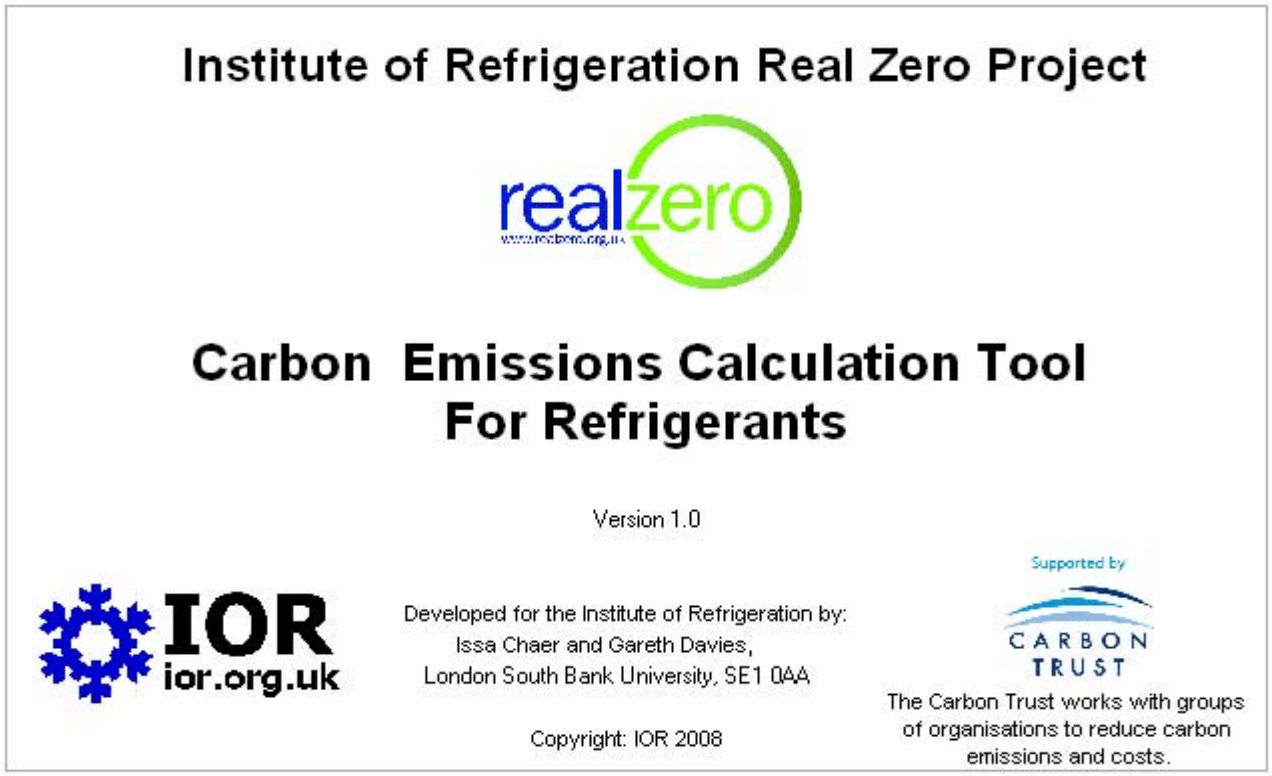
Reply with Changes... End Review...

O11

General Information			
Plant Name:	INstREF	Reference No.	222
Location of Plant:	Carshalton		
Plant Operator (name, address, telephone):	Miriam Rodway, Instref		
Operator Contact:	Miriam Rodway		
Cooling Loads Served:			
Refrigerant Type:		Refrigerant Quantity (Entrained Volume) kg:	500.00
Plant Manufacturer:		Year of Installation:	

Refrigerant Additions			
Date	Technician/Company	Amount Added (kg)	Reason for Addition
20/09/2007	YYY Ltd	20.00	schrader leak
15/06/2008	xxxx Ltd	15.73	vibration problem
16/010/2008	AAAA Ltd	122.00	fractured pipe

The Economic and Carbon Case



So what is it?

- A tool for the rapid calculation of the equivalent CO_2 emissions resulting from the direct release of refrigerants into the environment.

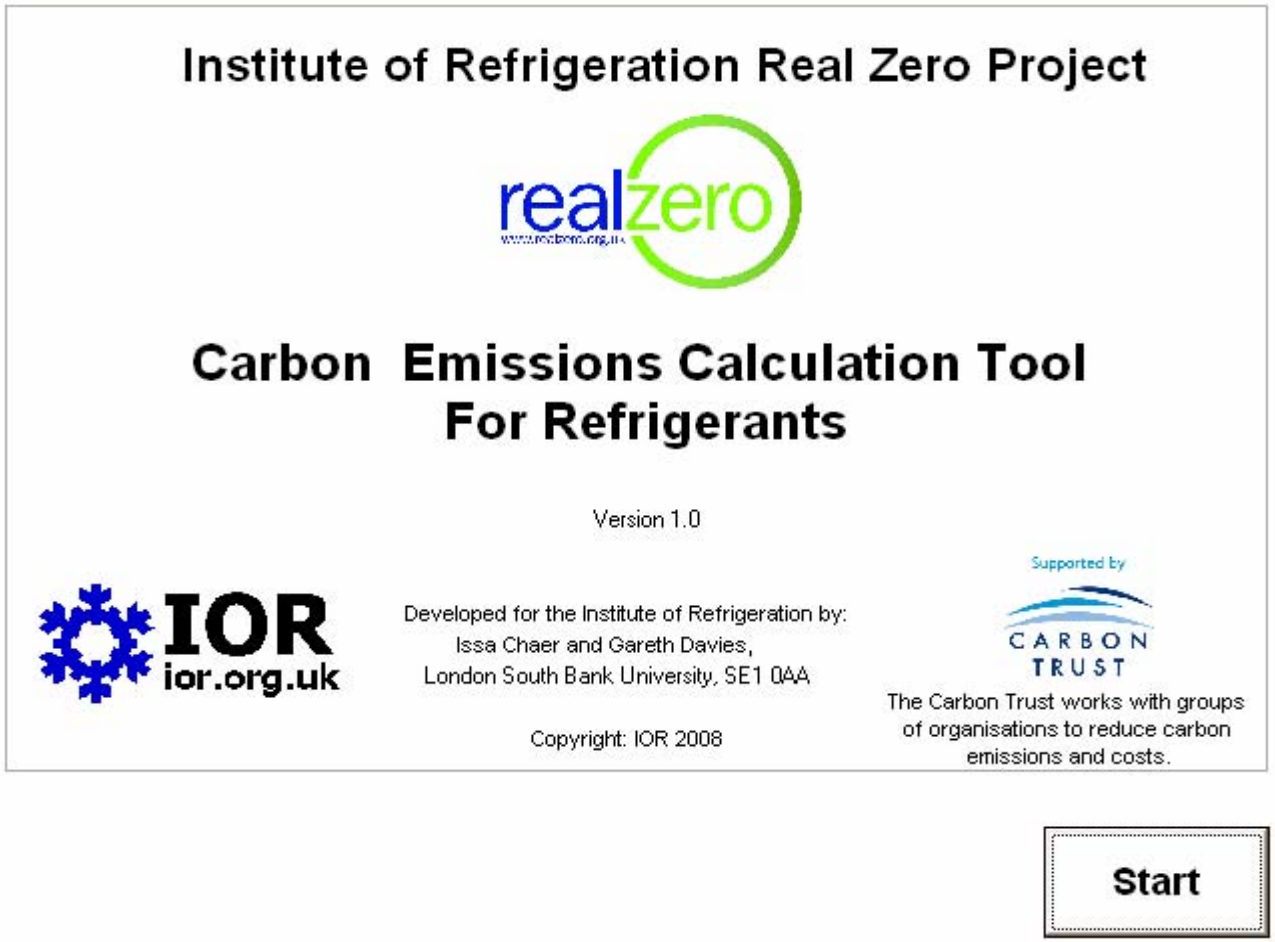
- The tool also calculates the cost implications of refrigerant leakage, including:
  - cost of refrigerant
  - cost of repair

Who is the tool for?

- Refrigeration engineers to transfer information related to RAC systems and refrigerant leakage back to end users.

- End users to evaluate the performance of their systems and to determine CO_2 emissions and costs from refrigerant leakage.

How does it work?



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Instructions

Carbon Emissions Calculator For Refrigerants

Institute of Refrigeration (IOR) Real Zero Project

Introduction

This software tool calculates the direct CO_2 emissions equivalent to the quantity of refrigerant leaked from air conditioning or refrigeration systems.

The user enters details of refrigerant additions/top-ups over a period of time, including the date of each addition; the net quantity of refrigerant added (i.e. total quantity added less the quantity recovered); and the type of addition (i.e. select from one of the following options: (i) routine maintenance top-up; (ii) emergency repair top-up; or (iii) recharge following catastrophic repair).

Direct costs include replacement refrigerant, engineer call-out charges and any repair materials. Indirect costs are consequential costs of equipment downtime. The user can either accept the default values offered or enter alternative figures.

The rate of refrigerant loss is then calculated, together with the equivalent CO_2 emissions associated with the leakage. The cost of replacing the leaked refrigerant and total costs associated with the refrigerant loss are reported.

The results sheet summarises both the main inputs provided by the user and the financial costs and CO_2 emissions resulting from the leakage.

Under the F-Gas Regulations (2006), you are obliged by law to keep a record of all refrigerant additions to your system. You should therefore hold sufficient information to provide the brief details of refrigerant additions requested on the following screens.

Exit Next

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Site details

Carbon Emissions Calculator For Refrigerants

Institute of Refrigeration (IOR) Real Zero Project

System Details

Site name: graeme

System name: gg

Select refrigerant: R409A

Confirm

Corresponding GWP: 1540

Indicative estimated price, as at 2008 (£ per kg): 23

Either enter actual cost, if known, use default indicative value or leave blank.

Enter number of refrigerant additions for which data is available (up to 6) and then input details of these additions as indicated on the following screens.

2

Exit | Restart | Return to Previous Screen

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Addition 1

Carbon Emissions Calculator For Refrigerants

Institute of Refrigeration (IOR) Real Zero Project

Refrigerant Additions

Enter details of additions in chronological order, starting with the earliest addition and continuing with successive additions, up to the most recent.

N.B. Net quantity refrigerant added = (total refrigerant added - refrigerant recovered)

Addition Number	Date of Earliest Addition (dd/mm/yy):	Net Quantity of Refrigerant Added (kg):	Reason for Addition:
1	25/07/07	20	Routine maintenance top-up

Confirm

Details of Routine Service Top-Up

Cost of Routine Maintenance Top-up

(£ per top-up): 250 **Click Next to continue.**

Default value zero (since service costs are assumed to be covered by a maintenance contract.) However please enter a cost value above, if required.

Summary of additions

Addition Number	Date of Addition	Refrigerant Added (kg)	Reason for Addition
1	25/07/07	20	Routine

Click on any Addition Row in Table to see details or to make any changes.

Exit | Restart | Return to Previous Screen | Next

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Addition 2

Carbon Emissions Calculator For Refrigerants

Institute of Refrigeration (IOR) Real Zero Project

Refrigerant Additions

Enter details of additions in chronological order, starting with the earliest addition and continuing with successive additions, up to the most recent.

N.B. Net quantity refrigerant added = (total refrigerant added - refrigerant recovered)

Addition Number	Date of Most Recent Addition (dd/mm/yy):	Net Quantity of Refrigerant Added (kg):	Reason for Addition:
2	30/08/08	48	Emergency repair top-up

Confirm

Details of Emergency Repair

Indicative cost of emergency repair

(£ per repair): 700

Click Next to continue.

(The price shown above is indicative only. Please enter a figure for the actual cost, if known. Otherwise, use the default value provided or leave blank.)

Summary of additions

Addition Number	Date of Addition	Refrigerant Added (kg)	Reason for Addition
1	25/07/07	20	Routine
2	30/08/08	48	Emergency

Click on any Addition Row in Table to see details or to make any changes.

Exit | Restart | Return to Previous Screen | Next

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Carbon Emissions Calculator For Refrigerants

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Results

Results

Inputs

Site name:	graeme		
System name:	gg		
Report for 1.1 Year Period Ending:	30/08/2008		
Refrigerant:	R409A	GWP:	1540
Indicative Cost of Replacement Refrigerant:	£ 23 per kg		

No. of Routine Maintenance Additions:	1
No. of Emergency Additions:	1
No. of Catastrophic Leak Additions:	0
Total No. of Additions:	2

Refrigerant Loss:

Total Refrigerant Lost (for 1.1 Year Period):	**68 kg**

Estimated Costs

Cost of Replacement Refrigerant (for 1.1 Year Period):	£ 1,564
Estimated Cost of Repairs (for 1.1 Year Period):	£ 950
Estimated Cost of Downtime (for 1.1 Year Period):	£ 0
Total Cost of Refrigerant Loss (for 1.1 Year Period):	**£ 2,514**
Projected Cost of Refrigerant Loss Over Next 10 Years:	£ 22,854

Emissions

Direct CO_2 Emissions for Last 2 Years (per annum):	In Last Year:	Previous Year:
	67 tonnes	Not Available
Total Direct CO_2 Emissions (for 1.1 Year Period):	**104 tonnes**	
Projected CO_2 Emissions Over Next 10 Years:	951 tonnes	

Total direct CO_2 emissions due to refrigerant losses for a 1.1 year period are equivalent to those for travelling 418,880 miles in a van.

Exit | Restart | Return to Previous Screen | Print | File Save

What are the benefits?

- Can provide end users with feedback related to :
  - the carbon footprint of refrigerant leakage
  - the financial cost of refrigerant leakage
- Can illustrate the potential to achieve significant CO_2 and costs savings, by reducing refrigerant losses.
- Could help to reduce CO_2 emissions related to refrigerant leak on national level.

Training and Specialist skills

Training for Leak Reduction

4 modules:

- Environmental, cost and legal aspects of refrigerant leakage
- Reducing leakage – site specific surveys and advice
- Reducing leakage through appropriate maintenance and service
- Minimising leakage in new systems

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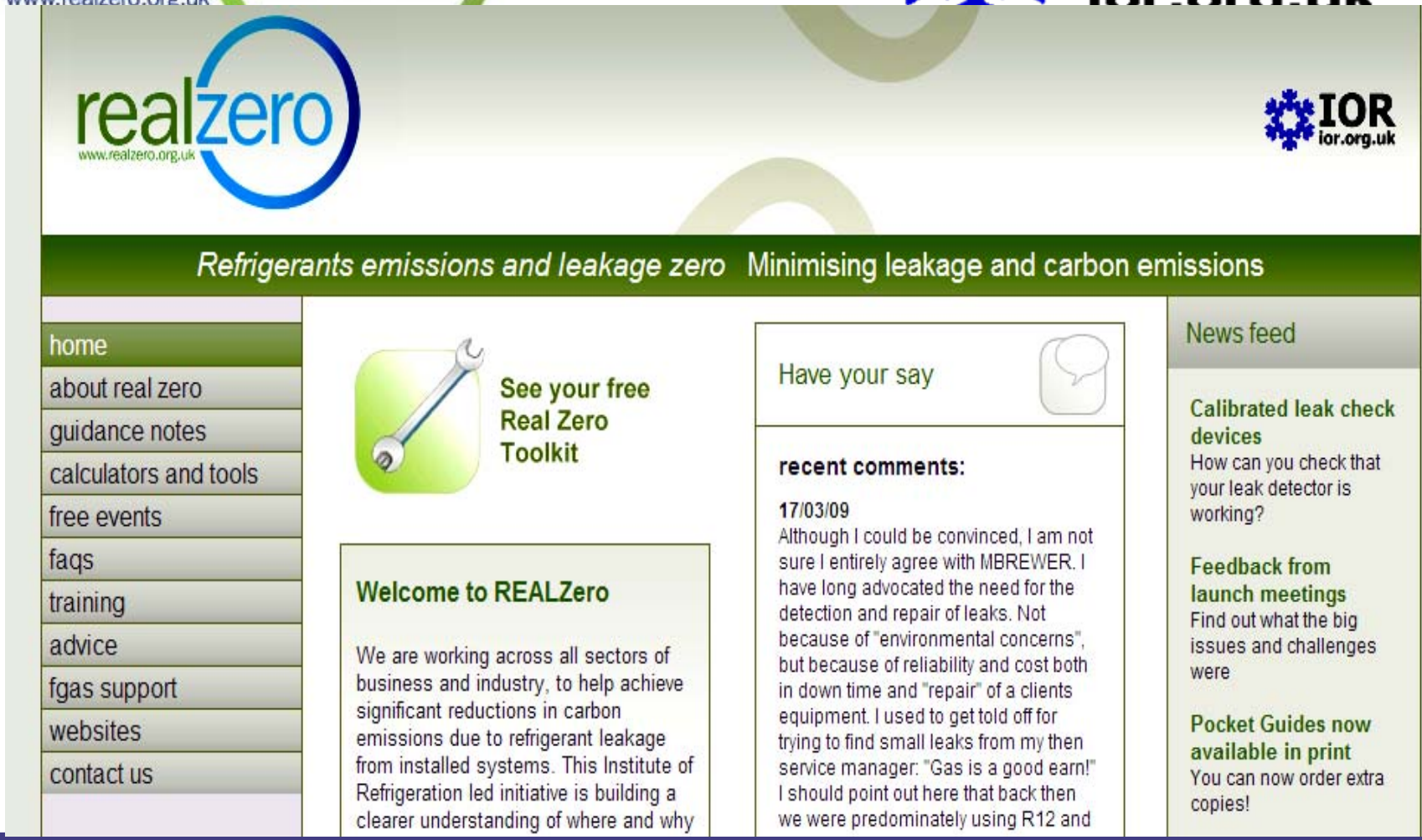

Refrigerant Emissions And Leakage **ZERO**

Future Developments

1. To understand the generic influence of refrigerant charge on system performance
2. Include indirect emissions estimation subroutines.

Conclusions

- Leakage costs!
- Site surveys identified large leakage and good practice
- Tools and specialist skills are available
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Questions

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the Carbon Trust, The IoR, M&S,
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Star Technical Solutions

That's all folks.....