Reducing Refrigerant Leakage

Mike Nankivell F.Inst.R
Marketing Director – Space Airconditioning plc
President of HEVAC
Chairman – ACRIB F Gas Group
An Introduction to Real Zero

Information provided by
Cool Concerns Ltd
Real Zero

- Provide information and help to RAC industry to reduce refrigerant leakage
- Funded by Carbon Trust, IoR and industry
- Managed by IoR
- April 2008 to April 2009 with an ongoing impact
- Now part of EU funded European projects
Agenda

1. Introduction to Real Zero
2. Impact of leaks
3. Regulations and standards
4. Leak reduction
   - Design
   - Installation
   - Service and maintenance
5. Leak testing during maintenance
6. Successes
Leakage

- Refrigerant leakage was a problem
  - It’s why CFCs were banned, why HCFCs are being phased out and why HFC may be phased down and in some cases banned.

- Refrigerant leakage is still a problem

- Refrigeration leakage will always be a problem?
Impact of Leaks

Scale of the problem
Environmental impact
Effect on performance
Cost
The Scale of the Problem

<table>
<thead>
<tr>
<th>System type</th>
<th>Direct emissions MTCDe</th>
<th>Indirect emissions MTCDe</th>
<th>Total global warming impact MTCDe</th>
<th>% related to refrigerant emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>9.0</td>
<td>23.0</td>
<td>32.0</td>
<td>28%</td>
</tr>
<tr>
<td>Industrial</td>
<td>3.4</td>
<td>25.0</td>
<td>28.4</td>
<td>12%</td>
</tr>
<tr>
<td>DX AC</td>
<td>2.6</td>
<td>10.0</td>
<td>12.6</td>
<td>21%</td>
</tr>
<tr>
<td>Small commercial</td>
<td>1.8</td>
<td>12.0</td>
<td>13.8</td>
<td>13%</td>
</tr>
<tr>
<td>Chillers</td>
<td>0.7</td>
<td>12.0</td>
<td>12.7</td>
<td>6%</td>
</tr>
<tr>
<td>Other small hermetic</td>
<td>0.3</td>
<td>12.0</td>
<td>12.3</td>
<td>2.5%</td>
</tr>
</tbody>
</table>
# Global Warming Potential

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Type</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>R134a</td>
<td>HFC</td>
<td>1300</td>
</tr>
<tr>
<td>R404A</td>
<td>HFC</td>
<td>3260</td>
</tr>
<tr>
<td>R407C</td>
<td>HFC</td>
<td>1520</td>
</tr>
<tr>
<td>R410A</td>
<td>HFC</td>
<td>1720</td>
</tr>
<tr>
<td>R407A</td>
<td>HFC</td>
<td>1770</td>
</tr>
<tr>
<td>R1234ze</td>
<td>HFO</td>
<td>6</td>
</tr>
<tr>
<td>R32</td>
<td>HFC</td>
<td>650</td>
</tr>
<tr>
<td>R22</td>
<td>HCFC</td>
<td>1500</td>
</tr>
<tr>
<td>R600a, R290, R1270</td>
<td>HC</td>
<td>3</td>
</tr>
<tr>
<td>R744</td>
<td>CO₂</td>
<td>1</td>
</tr>
</tbody>
</table>
What GWP Means

- R404A GWP = 3260
- CO₂ GWP = 1

1 kg R404A has 3260 x impact of 1 kg CO₂
CO₂ and Climate Change

- 1 kWh electricity produces 0.537 kg CO₂
- 1 kg R404A has same impact as 6070 kWh
  \[(3260 / 0.537 = 6070)\]
- Same as running a 1 kW electric heater for 77 weeks
CO₂ and Climate Change

- A typical service van produces 0.3027 kg CO₂ per mile
- 1 kg R404A (leaked) has same impact as 10,770 miles
  \[(3260 \div 0.3027 = 10,770)\]
Other Costs of Leakage

- Refrigerant
- Service time
- Down time
- **Increased energy consumption – 24/7**
- Green image
Effect of Leakage

- Consequential losses
- Additional energy costs
- Repair cost
- Refrigerant loss

Operator’s business is now affected

Leak Starts
Buffer of refrigerant is used, efficiency tails off
System can no longer support cooling load

Costs (£)

Time

1 2 3 4 5 6 7 8 9 10

Refrigerant Emissions and Leakage ZERO
Example of Cost of Leakage: Cost to a Retailer of Leaks

• To pay for a leak repair of 2 x R404A cylinders the retailer needs to sell:
  – 26,500 litres of milk
  or
  – 5,300 Big Macs

(Greenchill website stats - USA)
Summary – Impact of Leaks

- £££££££££££££££
  - More energy consumed
  - Refrigerant and service
  - Stock loss
  - Contractor profit

- Environmental
  - Energy and refrigerant
Regulations and Standards

ODS regulation
F Gas Regulation
EN378
F Gas Regulation

All about containment:

- Leak test
  - Frequency
  - Method
- Qualifications
- Labelling
- Records (systems > 3kg HFC)
Standards and Codes

- IoR Codes of Practice (A1 and A2/A3 refrigerants)
EN378
Refrigerating systems and heat pumps – Safety and environmental requirements

- Joint type
- Maximum pressure (PS)
- Pressure testing for strength and leak tightness
- Over pressure protection
- Leak detection
Summary

- F Gas requires leak testing and repair
- It sets a minimum standards
- F Gas and EN378 – an essential part of leak reduction
Leak Reduction

Design
Installation
Service and Maintenance
13 Common Leak Points

- Uncapped valves
- Schraders
- Flared joints
- Pressure switches and connections
- Seals

... and more
Key

• Design, install and commission to appropriate standards – actually DO IT!

• Time to
  – Install
  – Pressure test
    • To fail and re test
  – Evacuate
  – Pre commission
  – Run and commission
Refrigerant Type and GWP

- Do not select on basis of GWP only
- Consider
  - Pressures
  - Performance
  - Material compatibility
  - Safety
LOW GWP Refrigerants: Hydrocarbons (R290, R1270) GWP 3

- Flammable
  - Limits charge sizes therefore limits application (EN378)
- Performance better than HFCs in some applications
- Can be up to 20% increase in efficiency
- Good materials compatibility
- Many UK engineers already trained
HC Example - Waitrose

- Water cooled integrals
  - HC in cabinets and chillers
- 80 kg total on site
- Max single charge < 10 kg
- Most systems < 5 kg
- Leakage < 2%
  - Factory processed systems
  - Minimum leak potential
  - More care due to use of flammable refrigerant

This is a success story for leakage reduction.
LOW GWP Refrigerants: Carbon Dioxide (R744)
GWP 1

• Very high pressures
• Very high refrigerating effect
• Efficiency lower than HFC
• New components required
• Training a significant issue
• Wide range of systems types
• Higher production costs
R744 Systems Leak

- Use of R744 has not solved leak problems.
- Perception R744 leaks do not matter (GWP = 1)
- Typically > 100% leakage rate / year
  - High pressures
  - Greater system complexity
  - Installed to same poor level as HFC systems

This is NOT a success story for leakage reduction
LOW GWP Refrigerants: HFOs, e.g. R1234ze
GWP 6

- Mild flammability (A2)
- Capacity lower than R134a
- New compressors needed
- Still at development stage
- Expensive at present
R32 (Difluoromethane)

- Mild flammability (A2)
- Proposed for use in low charge AC systems
  - Daikin
  - Mitsubishi
- Performance and operating conditions similar to (slightly better than) R410A
- Used as a component in R407C and R410A
- GWP = 650
Reducing the Charge Amount

- Minimise the load
  - Do not oversize the system
  - Split the load
- Indirect systems
- Receiver size
- Pipe size, including evaps and conds
- E.g. micro bore heat exchangers
Keeping Pressures Low

- Consider water cooled or evaporative condensers
- Reduce head pressure control
- Air cooled condensers:
  - No air flow restriction
  - No air recirculation
- Consider refrigerant options, e.g. R134a vs R404A
Pipe Work

- HP / LP switch connections
- Pipe gauge
- Pipe support
- Anti vibration
- Jointing
Installation and Commissioning

- Wet rag ball valves and solenoid valves
- Strip globe valves
- Remove Schrader cores, replace correctly
- Pressure test for strength and leak tightness
  - Allow time for pressure testing and for problems
- Evacuate
- Charge correct amount
Installation: Split AC

- Indoor unit – remove flares and braze directly
- Outdoor unit – use flare solder adaptors
Servicing to Stop Leaks

- Valves
- Flanges
- Joints
- Seals
- Pressure switches
- Appropriate maintenance
Schrader Valves

- Use correct core
- Remove core when brazing
- Tighten core to the correct torque
Cap Valves

- Uncapped valves are a major source of leakage
- “Real Zero” cap
Flanges

- Remove old gasket
- Fit new gasket
- Torque flange bolts
Flared Joints

- Avoid using where possible
- Where flares are necessary:
  - Use flare solder adaptors
  - Tighten to correct torque
Seals

- Check and change seals if necessary (especially during retrofit)
- Oil seals
Pressure Switch Couplers

- Use flexible couplers - ensure not under tension / twisted and appropriate for the oil type
- Avoid oil logging in lines
- No vibration or chafing
- Support switch
- Don’t use manual made flare
Maintenance to Reduce Leak Potential

- Reduce head pressure by:
  - Cleaning condensers
  - Ensuring head pressure control is not too high
  - Checking condenser fans / pumps work

- Reduce vibration effects:
  - Compressor and fan motor mountings
  - Pipe support
  - Effectiveness of vibration eliminators
  - Pipes not chafing
Summary – Leak Reduction

- Design, installation and service specification is important
- Standards (e.g. EN378) help
- Most is common sense and good practice
- Commitment to leakage reduction is needed
Leak Detection
For Effective Leak Testing (1)

- Check logs
- Be methodical
- Use the appropriate method(s)
- Check the whole system
  - Remember most common leak points
For Effective Leak Testing (2)

- Check high side while running at highest pressure possible, check low side when off if possible
- Switch off fans if possible
- Don’t assume the first leak is the only leak
- Repair all leaks found immediately, re check within 30 days
- Treat leak testing as a priority activity
Leak testing Success Story

Asda / City Refrigeration

- Bacharach leak detector
- Monthly leak tests
- Sharing information
- Leak reduction a high priority for all
- 54% leak rate in 2000, 7.9% leak rate in 2011
See Booklet – Pocket Guide to Good Leak testing
Summary, Leak Testing

- Use the appropriate method or combination of methods
  - Ensure it works!
- Do a thorough leak test
- Repair all leaks found
And Finally ...
Are Surveys Worthwhile?

Real Zero surveyed 30 sites – mix of retail, industrial and AC

- 30% were leaking
- 41% low on refrigerant
- Incomplete F Gas records
  - Leak rate range as % of charge
  - Position of leaks
- Insufficient leak testing
- Range of practical recommendations
Leakage

- Refrigerant leakage was a problem
  - It’s why CFCs were banned and HCFCs are being phased out and now HFCs will be phased down or banned
- Refrigerant leakage is still a problem
- Will refrigeration leakage always be a problem?
  - Leaks can be eliminated by prioritising leak reduction appropriately
Summary of What Reduces Leaks

- **System design**
  - Waitrose example virtually eliminates site install and used small charge systems

- **Thorough leak testing**
  - Asda regime and leak detection

- **Prioritising leak reduction**
  - Awareness
  - Technician training
www.realzero.org.uk
www.coolconcerns.co.uk

Next Real Zero courses:
One day sessions - 1\textsuperscript{st} October & 4\textsuperscript{th} November
Half day session for technicians - 2\textsuperscript{nd} & 24\textsuperscript{th} October
Also can be scheduled to suit
Reducing Refrigerant Leakage

Thank you for listening!

Mike Nankivell F.Inst.R
Marketing Director – Space Airconditioning plc
President of HEVAC
Chairman – ACRIB F Gas Group