Refrigerant Use in the Mobile A/C Service Industry

California Air Resources Board

DIY — MVAC Servicing Workgroup Meeting

February 5, 2008

Sacramento, CA

Environmental and Consumer Cost Impact

- Consequences of improper A/C system servicing
  - Refrigerant used in current mobile A/C systems is a Greenhouse Gas
    - Not repairing a leaking system
      - Releases refrigerant to atmosphere
      - Can result in system damage
    - Incorrect system refrigerant charge
      - System performance problems
      - Potential component failure

Servicing Mobile A/C Systems

- There are two major refrigerant servicing conditions:
  - System has no refrigerant — no cooling
    - Generally the loss of refrigerant is due to a large leak due to a system component failure
  - System has some refrigerant — poor cooling
    - Generally the loss of refrigerant is due to a small leak due to a system component failure

A/C System Refrigerant Charge

- **The amount of refrigerant in any mobile A/C system cannot be determined using DIY servicing procedures**
  - **System pressure or panel outlet temperature:**
    - **Will not identify the amount of refrigerant in system**
    - **Can identify an extreme undercharged or overcharged system**
- **Recommended factory refrigerant charge amount should be within plus or minus 2 ounces or less**

A/C System Refrigerant Charge

- **Problems from an incorrect refrigerant charge**
  - **Undercharge**
    - **Reduced performance**
    - **Temperature spread across outlets**
    - **Ice accumulation on cooling coil — reduced airflow**
    - **Odor problems [due to cooling coil hot spots]**
    - **Damage to compressor [poor oil return]**
  - **Overcharge**
    - **Reduced performance — higher pressure**
    - **Possible system shut off on hot day — no cooling and/or release of refrigerant due to pressure relief valve opening**

A/C System Refrigerant Charge

Temp Spread

Refrigerant Charge Amount Oz. System 1	Ref. Amount Ounces	Panel Temperature Spread Degrees F.	Avg. Panel Degrees F.	High Side Pressure PSIG	Low Side Pressure PSIG
Overcharge 6 oz	21	5.6	54	287	34
Overcharge 3 oz	18	5.5	52	279	34
Factory Charge	15	3.2	52	279	33
Undercharge 3 oz	12	3.4	57	243	39
Undercharge 6 oz	9	13.1	59	222	35

Refrigerant Charge Amount Oz. System 2	Ref. Amount Ounces	Panel Temperature Spread Degrees F.	Avg. Panel Degrees F.	High Side Pressure PSIG	Low Side Pressure PSIG
Overcharge 6 oz	28	8.4	54	267	32
Overcharge 3 oz	25	5.9	54	238	32
Factory Charge	22	6.6	54	238	31
Undercharge 3 oz	19	7.2	54	233	32
Undercharge 6 oz	16	33.6	59	201	29

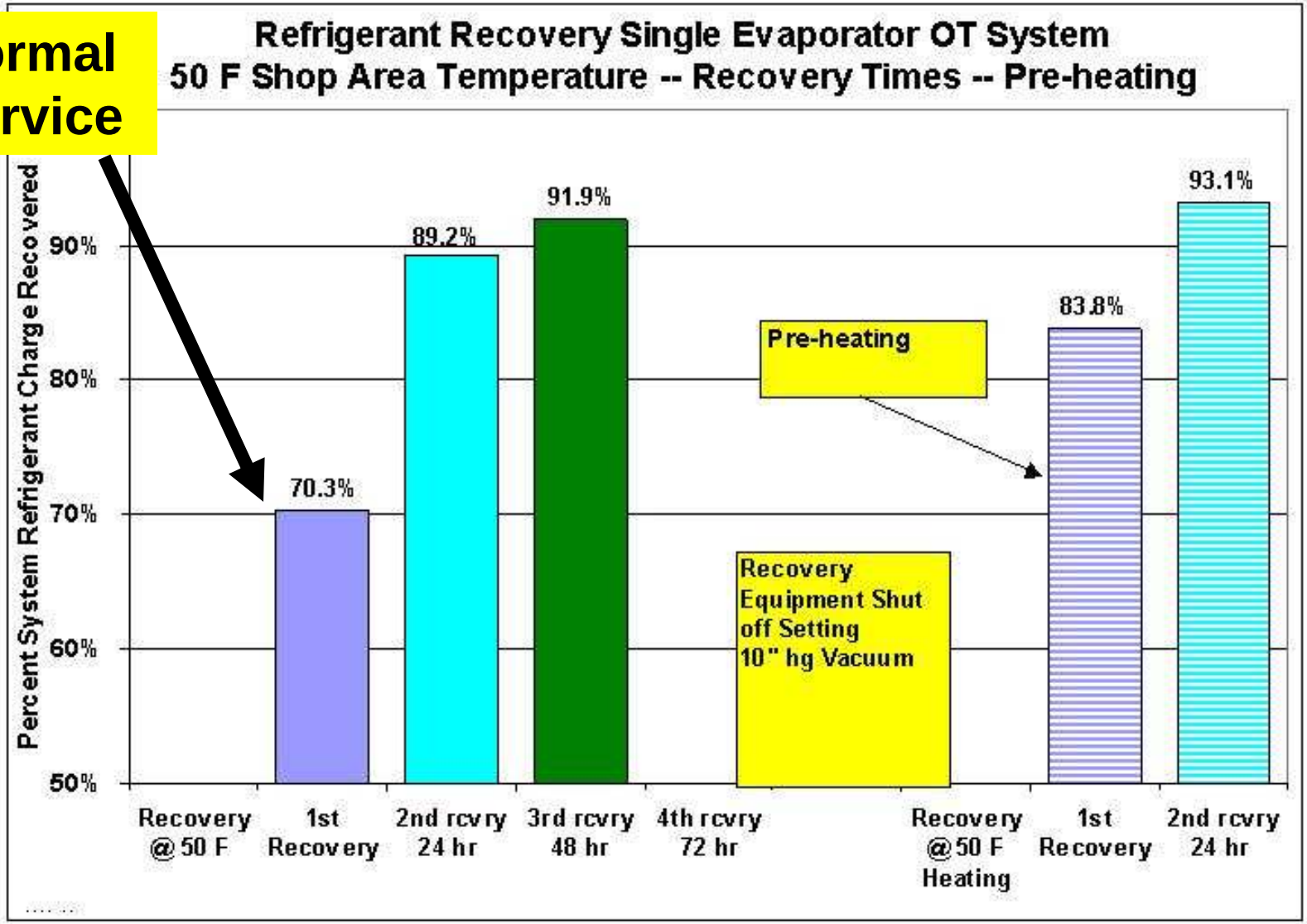
6 oz. Spread

System Pressure Does Not Indicate Charge Amount

Recovering Refrigerant

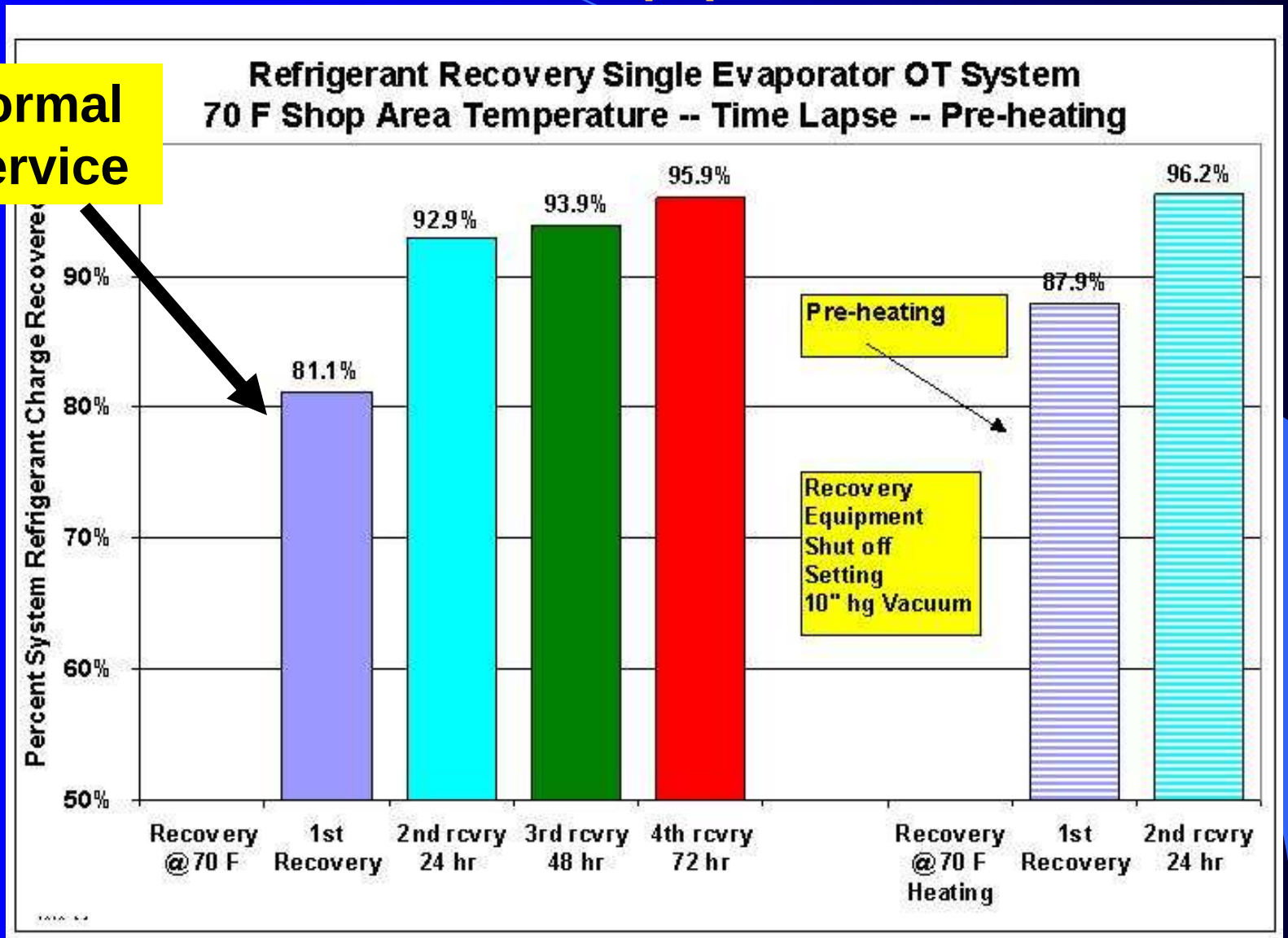
J2210 Equipment

Normal Service



Recovering Refrigerant

J2210 Equipment



A/C System Refrigerant Charge

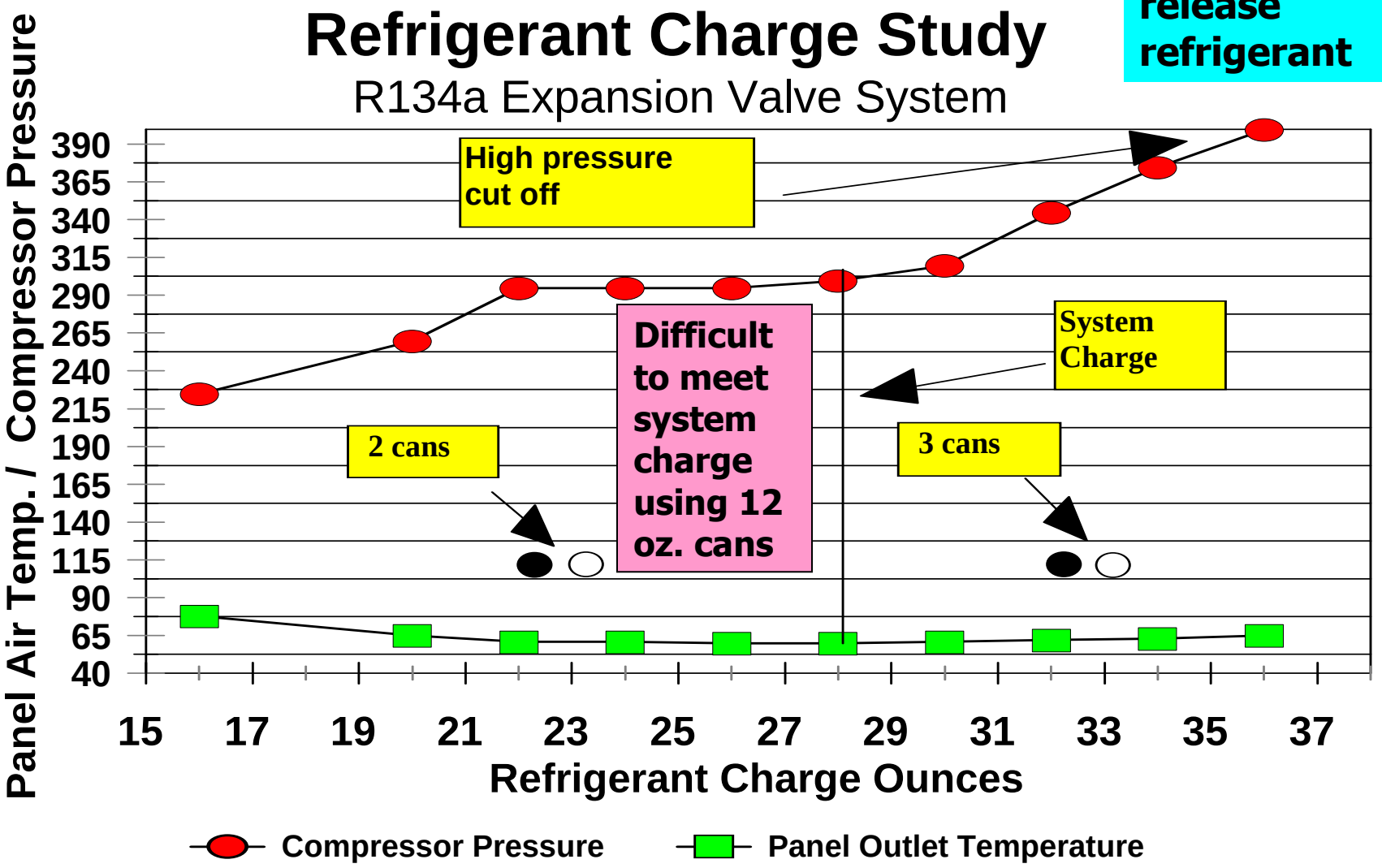
- **The only way to know if system has correct refrigerant charge is to use service equipment:**
  - **Remove all refrigerant – recovery equipment [meeting SAE J2788 standard]**
    - **Evacuate system to remove air and any remaining refrigerant**
  - **Charge the exact amount of refrigerant [using SAE J2788 certified equipment]**

Refrigerant Recovery

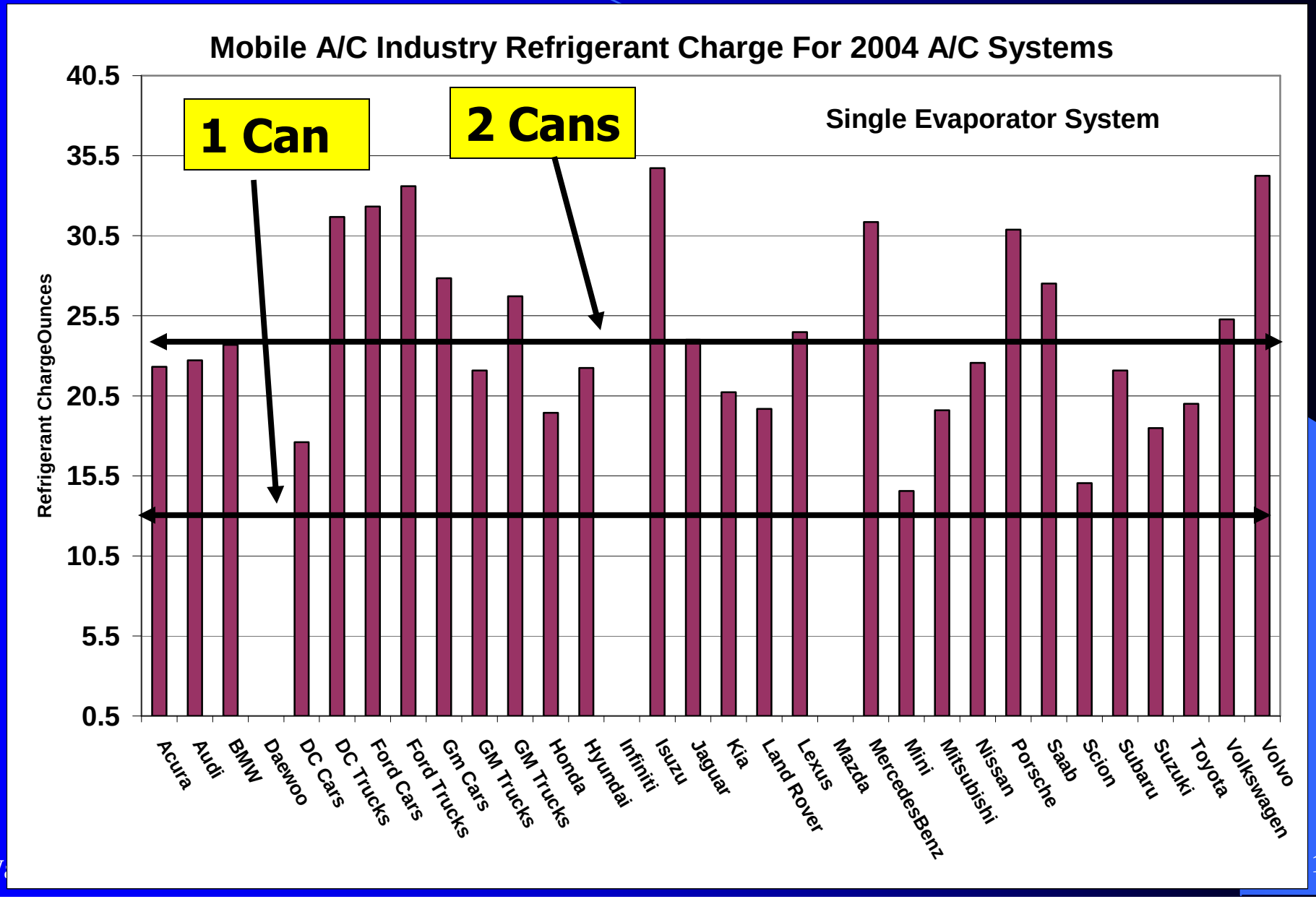
- **Improper Recovery Can Result in**
  - **System over charge**
  - **Venting of refrigerant to the atmosphere**
  - **Improper System Operation**
- **New J2788 Certified Equipment is required to assure refrigerant removal**

A/C System Refrigerant Charge

Overcharge can stop cooling on hot day and/or release refrigerant



A/C System Refrigerant Charge

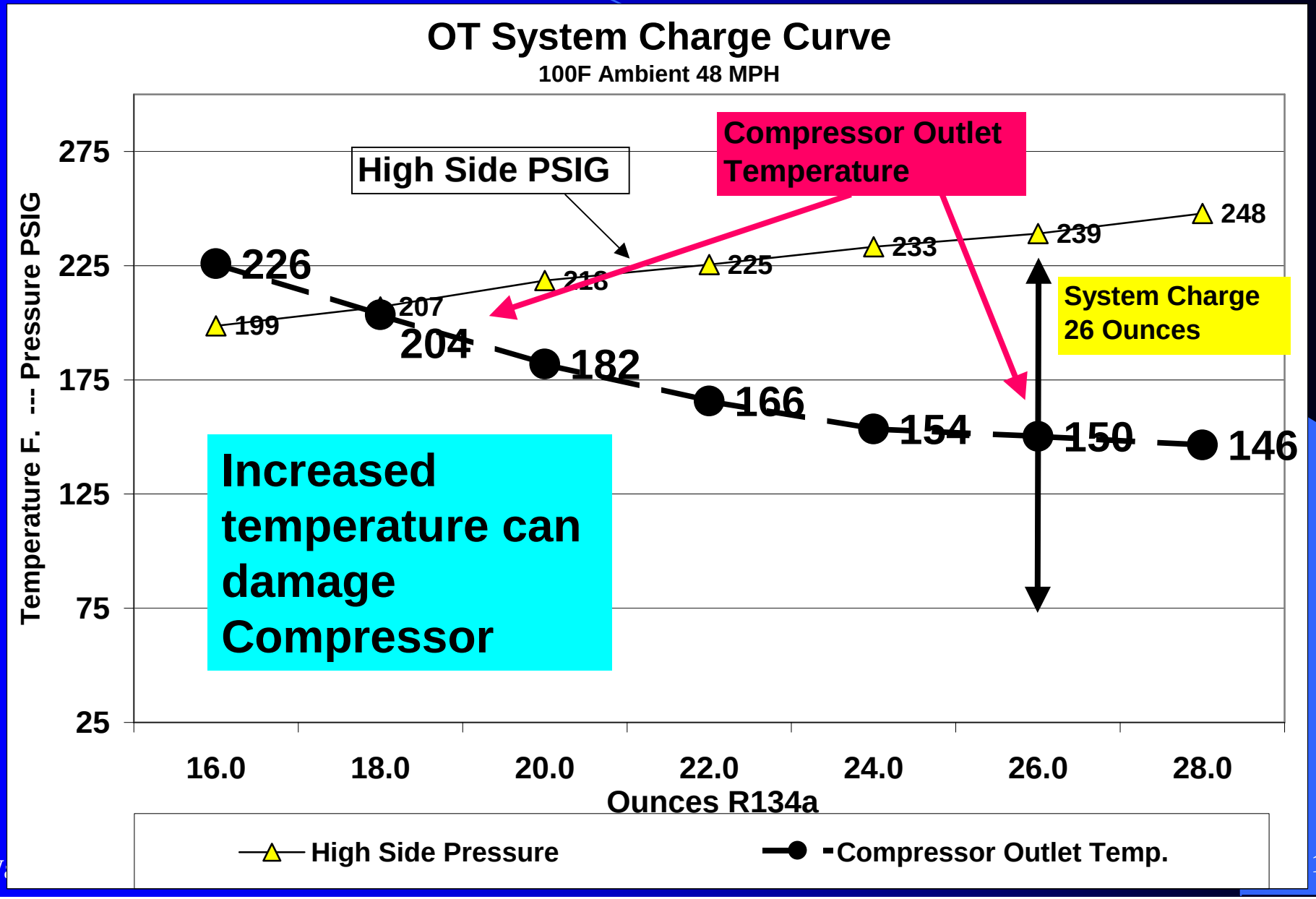


A/C System Refrigerant Charge
System Charging

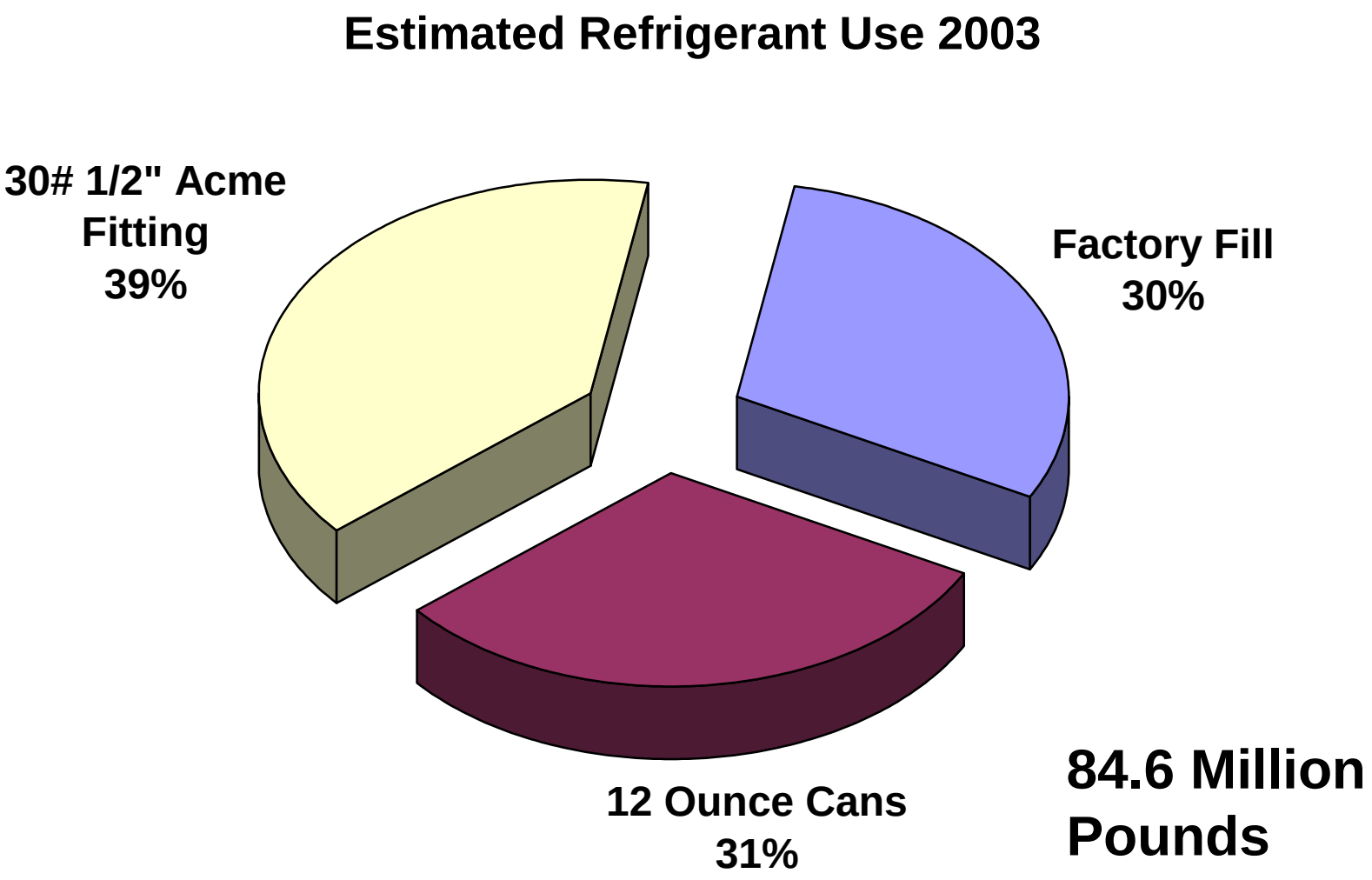
MAC Refrigerant Emissions Have Been Reduced

- **Reduced System Charge Amounts**
  - **Reducing Charge Tolerance**
- **Average Single Evaporator Factory Charge**
  - **2000 26.9 ounces (.76Kg)**
  - **2004 24.3 ounces (.69Kg)**
  - **2006 22.3 ounces (.63Kg)**
- **System Charges Starting at 10-14 ounces**

A/C System Refrigerant Charge



HFC-134a Use


Estimated Refrigerant Use 2003
30# 1/2" Acme Fitting 39%
Factory Fill 30%
12 Ounce Cans 31%
84.6 Million Pounds

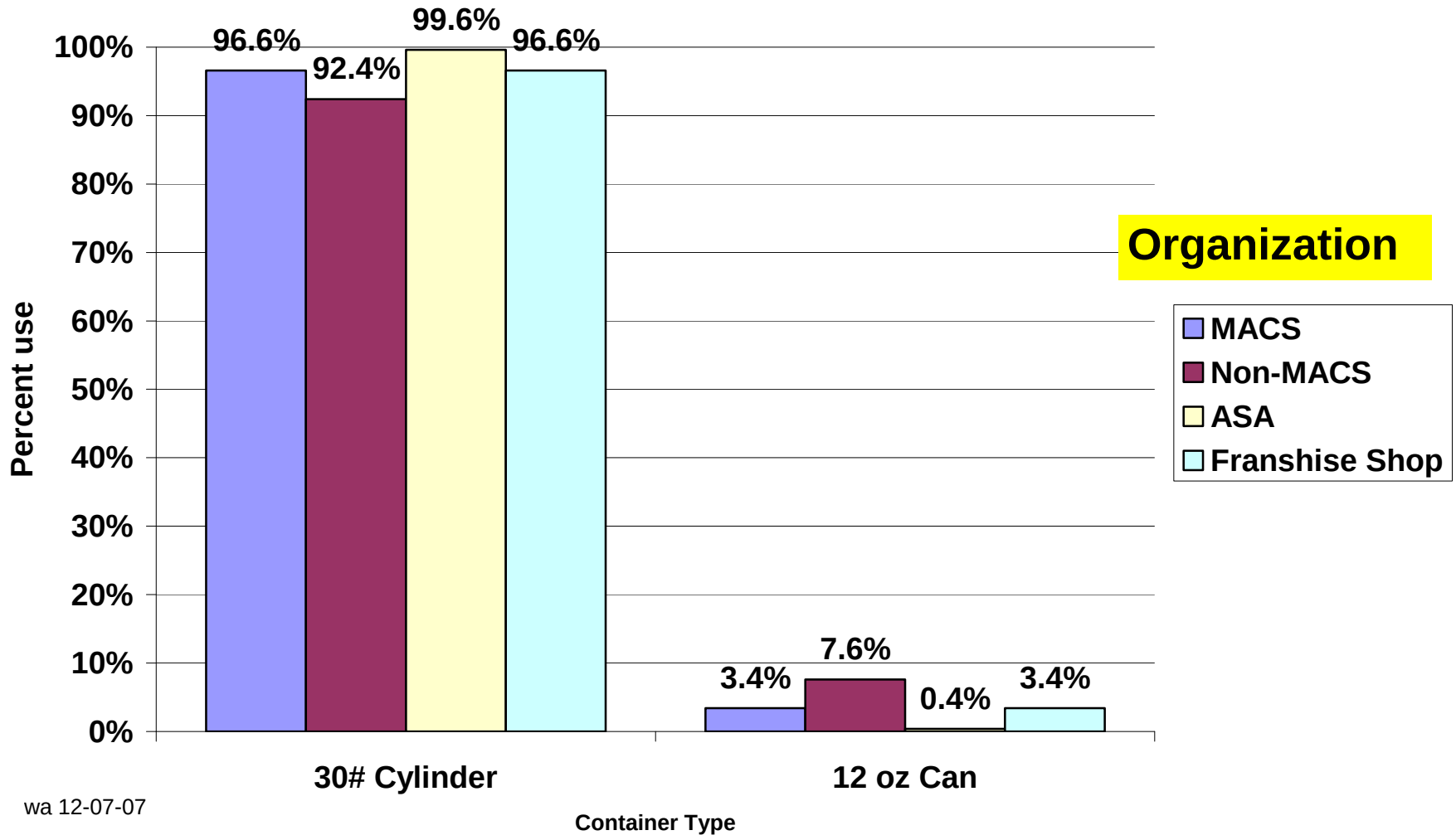
Refrigerant Container

- U.S. EPA Service Equipment Requirements
  - Recovery/recycle equipment requires compliance to SAE standards:
    - Unique service hoses
    - Unique 30 pound HFC-134a refrigerant container fitting

Refrigerant Container

- **Typical 12 ounce can of refrigerant**
  (currently available)
- **No standards to cover usage**

Type of Refrigerant Container Used By Professional Service Industry (2004 MACS Survey)



Disposable Container Heel Testing

Study Report

Prepared for:

United States Environmental Protection Agency

Stratospheric Protection Division

March 21, 2007

EPA Disposable Container Heel Testing Study Report

- Refrigerant remaining in a small can is dependent on transfer method and time
  - Time can range from 5 minutes to over 30 minutes
  - Potential refrigerant heel can range from 1.4% to 74.7%

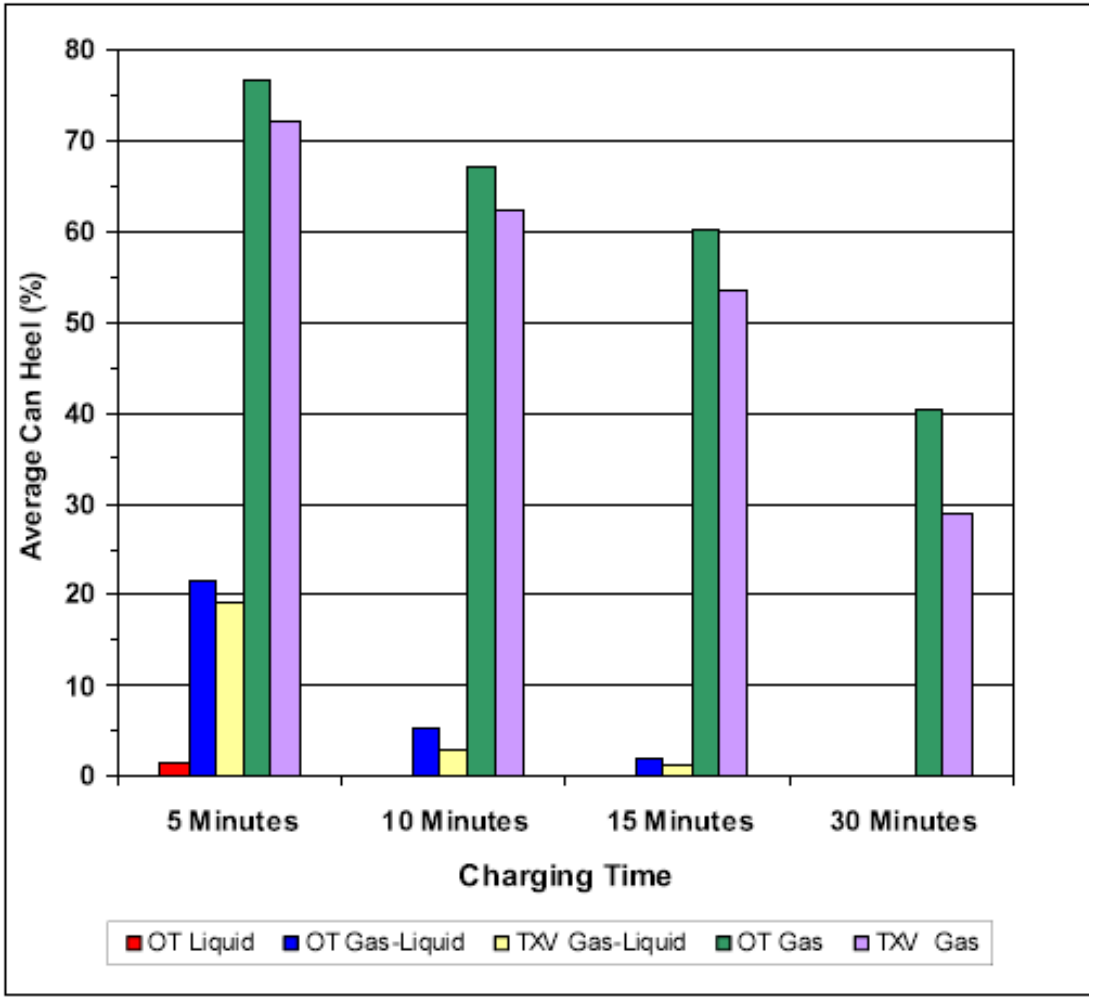


Figure 5: Comparison of Can Heels by Charging Method and MVAC Type

EPA Disposable Container Heel Testing Study Report

Table 5: Annual Emission Estimate Scenarios

DIYer Charging Assumptions	Annual Emission Estimates (pounds/year)
Scenario 1 - All liquid and all gas charging: 25% of refrigerant charged upside down for 5 minutes, 75% charged upright for an average of 5 to 10 minutes	$[1.40\% \times 0.25]_{\text{upside down}} + [0.75 \times (74.7\% + 65.1\%)/2]_{\text{upright}} = 52.8\%$ average heel 52.8/100 x 11,833 tons x 2,000 pounds/ton = 12,496,000 pounds emitted
Scenario 2 - All liquid and mixed gas-liquid charging: 25% of refrigerant charged upside down for 5 minutes, 75% rotated 0 to 90° for an average of 5 to 10 minutes	$[1.40\% \times 0.25]_{\text{upside down}} + [0.75 \times (20.4\% + 3.94\%)/2]_{\text{rotated}} = 9.5\%$ average heel 9.5/100 x 11,833 tons x 2,000 pounds/ton = 2,248,000 pounds emitted
Scenario 3 - Mixed gas-liquid charging: 100% rotated for an average of 5 to 10 minutes	$[(20.4\% + 3.94\%)/2]_{\text{rotated}} = 12.2\%$ average heel. 12.2/100 x 11,833 tons x 2,000 pounds/ton = 2,887,000 pounds emitted

Note: The annual 11,833 tons/year HFC-134a sales figure for the DIY market is from 2004 sales data from AAIA (Thundiyil, 2005).

EPA Disposable Container Heel Testing Study Report

- "Absent that data, the estimates in Table 5 indicate the potential for significant emission reductions if DIYers follow best practices to minimize heels."

"Another important consideration is that the annual emission estimates in Table 5 are only for small can heel emissions and do not include emissions from

  - refrigerant charged into a leaking system,
  - refrigerant released by improper opening of the system,
  - releases due to overcharging,
  - and leaks from charge kit hoses and connections. Estimates for those emissions are outside the scope of this report."

EPA Disposable Container Heel Testing Study Report

User	Container	Time to Charge	Container Heel	Annual Refrigerant Emissions To Atmosphere
DIYer Scenario 1	12 ounce can	5 to 10 minutes	52.8%	12.5 million pounds
DIYer Scenario 2	12 ounce can	5 to 10 minutes	9.5%	2.3 million pounds
DIYer Scenario 3	12 ounce can	5 to 10 minutes	12.2%	2.9 million pounds
J2210 Service Equipment	30# cylinder	Disposal Procedure	1.85%	0.4 million pounds

EPA Disposable Container Heel Testing Study Report

- **"If a DIYer stopped charging based on the kit gauge readings, he/she would not have a properly charged system and might also discard a can with a large heel."**

Figure 2: Small Can with Charge Kit and Adapter Installed on the Ford Focus Accumulator Service Port

Charging A Leaking System

HFC-134a is a global warming gas

- Charging A Leaking System
  - Releases Refrigerant to Atmosphere
  - Can Damage System
    - Resulting in a more expensive repair
- Without Removing Refrigerant
  - Actual Refrigerant Amount In System Cannot Be Determined