

# Specifications for Commercial and Industrial Refrigeration

Commercial/Industrial Refrigeration  
Technical Working Group Meeting  
April 3, 2008

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## Outline

- Objectives
- Brief Review of 2/15 Workshop
- Timeline
- Regulatory Concepts & Costs
- Ongoing Research, Questions
- Preliminary Data
- Next Steps

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## Objectives

- Work together as ARB develops a regulatory strategy for reducing direct and indirect emissions from commercial and industrial refrigeration systems.
  - Engage in an open dialogue as we move through the rulemaking process.
  - Invite stakeholder input and data, discuss options, identify resources and areas needing further analysis.
  - Identify action items and possibly form subgroups to address them.

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## Workshop Review

### • Types of Commercial/Industrial Refrigeration Systems

- Direct expansion (DX) systems used in supermarkets, cold storage warehouses, industrial food processing
- Remote display cases, standalone equipment and refrigerated vending machines



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## Workshop Review

- **Commercial Refrigeration Systems Emissions Sources**
  - Direct refrigerant emissions occur during equipment manufacturing/charging, lifetime (from leaks, ruptures, maintenance), and end-of life (EOL)
  - Indirect emissions (CO<sub>2</sub>E emissions resulting from energy use) occur during equipment manufacture, lifetime operation, and EOL

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## Workshop Review

- **Commercial and Industrial Refrigeration Technological Options**
  - Direct Emissions Reduction
    - Indirect or Secondary Loop (SL) Systems, cascade and transcritical CO<sub>2</sub> systems, possibly others
      - Can utilize low-GWP refrigerants, or significantly reduced quantities of high-GWP refrigerants
        - Charge/GWP reduction important to reduce emissions from ruptures
        - Control of future bank growth as R-404a replaces HCFC-22
      - Automatic leak detection in machine rooms possible
        - Benefits include easier leak detection/repair, fewer refrigerant purchases

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## Workshop Review

- **Commercial and Industrial Refrigeration Technological Options**
  - Indirect Emissions Reduction
    - Machine Room Technologies
      - Evaporative condensers
      - Floating head pressure controls
      - Heat recovery
    - Display Case Technologies (Retail Food Systems)
      - Add doors to display cases
      - Improved air curtains or other barriers
      - Energy-efficient fan motors, compressor systems, lighting
      - Anti-sweat heater controls
      - Hot gas defrost

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## Workshop Review

- **Standalone System and Vending Machine Technical Options**
  - Indirect Emissions Reduction
    - Compressor and component improvements (i.e. efficient lighting, fans/motors, anti-sweat heaters, addition of doors)
    - USDOE is developing energy conservation standards for:
      - Self-contained and remote display cases (ASHRAE 72, 2005, for open and closed display cases)
      - Vending machines (ASHRAE 32.1, 2004)
      - Walk-in coolers and freezers (no test methods yet)

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## Proposed Timeline

March 2008	Working Group/Stakeholder Formation
April 2008	Working Group/Stakeholder Consultation Meeting
Fall 2008	2 <sup>nd</sup> Working Group/Stakeholder Consultation Meeting
Spring 2009	2 <sup>nd</sup> Public Workshop to Discuss Proposed Control Strategies and Options
Summer 2009	3 <sup>rd</sup> Working Group/Stakeholder Consultation Meeting
Winter 2009	3 <sup>rd</sup> Public Workshop on Proposed Strategies
Summer 2010	Regulatory Language and ISOR Finalized
Winter 2010	Board Meeting on Action
January 2011	Charge/GWP Reduction Rule Phase-in for New Commercial and Industrial Systems; Energy Efficiency Rule Phase-in for New Retail Food Stores  Later Phase-in of Energy Efficiency Rule for Existing Retail Food Stores

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## Potential Regulatory Concepts- New Commercial/Industrial Systems

- **Charge Size/GWP/Leak Reduction**
  - Reduce charge sizes/GWP and leak rates (if conventional refrigerants used) for all new systems
  - Or, charge size x GWP < TBD for non-retail refrigeration systems; and
  - Charge size x GWP x energy efficiency < TBD for retail food systems
    - Options include SL systems, cascade and transcritical CO<sub>2</sub> systems, possibly others

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## Potential Regulatory Concepts- New Commercial/Industrial Systems

- Further concepts
  - Full accessibility to all piping
  - Automatic leak detection
- Rationale
  - Charge/GWP reduction more important than leak tightness in future systems
    - Prevents massive losses due to ruptures
    - Decreases bank sizes
    - Will be a significant consideration when carbon price increases

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## Potential Regulatory Concepts- New and Existing Retail Food Systems

- **Energy Efficiency**
  - System and machine room improvements
    - Heat recovery, evaporative cooling, floating head pressure controls, etc.
  - Remote display case, standalone display case, and vending machine improvements
    - Combination of available technology (for which test methods exist) and best available technology (no test methods, voluntary program)

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## Potential Regulatory Concepts- New and Existing Retail Food Systems

- Further concepts
  - Closed cases or store area- reduces heat infiltration from HVAC systems, outdoor air, and indoor standalone/vending equipment
- Rationale
  - Energy savings result in a win-win situation

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## Ongoing Research, Questions

- **Ongoing Research- Denis Clodic/ARMINES**
  - Quantification of LCCP benefits/penalties
    - Direct emissions benefits from reduced charge/GWP systems
    - Energy penalties/benefits from reduced charge/GWP systems
    - Energy benefits from component changes/upgrades

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## Ongoing Research, Questions

- Costs, benefits, and payback periods associated with installing new systems and upgrading existing systems
  - First costs
    - System design and installation
    - Upgrading cases/standalones
  - O&M costs
    - Refrigerant costs
    - Energy costs
    - Other maintenance costs (technician and other system costs)

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## Preliminary Cost and LCCP Data- ARMINES

### Total Installed Cost Comparison (Component Prices and Installation Costs Note: Refrigerant Costs not Included)

Components	Refrigeration system				
	DX	Distributed	SL MPG+ SL CO2-	SL CO2 + -	Cascade CO2- MPG+
Compressors	195,510	+30%	+38%	+38%	+20%
evaporators	47,460	+8%	+14%	+14%	+14%
condensers	64,050	+45%	0%	0%	0%
Misc electronics	92,190	+38%	+25%	+25%	+25%
Pipelines	67,305	-42%	+76%	+41%	+64%
Display Cases	505,575	0%	0%	0%	0%
Walk in	77,910	+1%	0%	0%	0%
<b>Total cost (\$)</b>	<b>1,050,000</b>	<b>1,149,540</b>	<b>1,204,770</b>	<b>1,181,040</b>	<b>1,162,770</b>
<b>Increase% Conventional DX</b>	<b>0%</b>	<b>+9%</b>	<b>+15%</b>	<b>+12%</b>	<b>+11%</b>

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## Preliminary Cost and LCCP Data- ARMINES

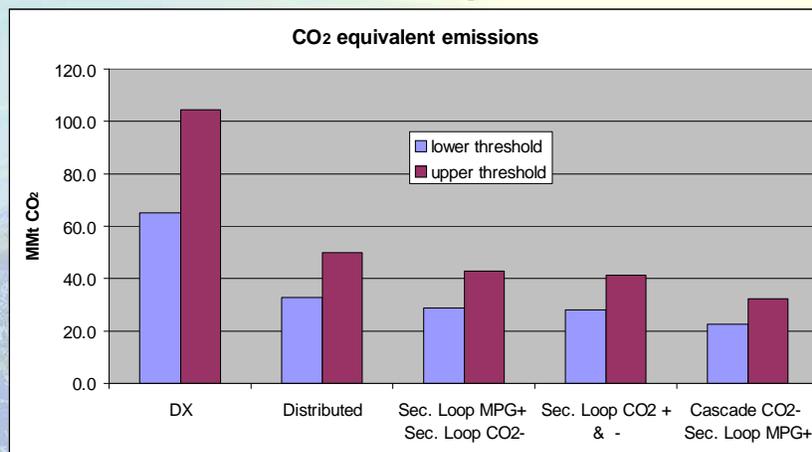
### Energy Consumption Comparison

Components	Refrigeration system				
	DX	Distributed	SL MPG+ SL CO2-	SL CO2 + -	Cascade CO2- MPG+
Compressors	863,995	-9%	+10%	+7%	-10%
Pumps		0%	+10%	+2%	+8%
Condensers	94,254	0%	0%	0%	0%
Display Cases	471,270	0%	0%	0%	0%
Walk in	141,381	0%	0%	0%	0%
<b>Total energy consumption (kWh/year)</b>	<b>1,570,900</b>	<b>1,493,140</b>	<b>1,743,699</b>	<b>1,648,659</b>	<b>1,553,620</b>
<b>savings % Conventional DX</b>	<b>0%</b>	<b>-5%</b>	<b>+11%</b>	<b>+5%</b>	<b>-1%</b>

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## Preliminary Cost and LCCP Data- ARMINES

### TEWI Comparison



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## Preliminary Cost and LCCP Data- ARMINES

### CO<sub>2</sub> Savings Cost Comparison

	DX	Distributed	Sec. Loop MPG+ Sec. Loop CO <sub>2</sub> -	Sec. Loop CO <sub>2</sub> + & -	Cascade CO <sub>2</sub> - Sec. Loop MPG+
LCCA per supermarket (\$)	3,129,341	3,168,385	3,471,194	3,350,382	3,210,353
Additional cost (\$)	0	39,044	341,853	221,040	81,012
CO <sub>2</sub> emission savings (tonnes)	0	-16,040	-18,148	-18,588	-21,145
Cost of 1 tonne CO <sub>2</sub> saved (\$/metric tonne)		2.4	18.8	11.9	3.8

### Example of Door Installation with Cascade CO<sub>2</sub>/SL Systems

LCCA Savings ~15%  
CO<sub>2</sub> Emission Savings ~75 – 80%

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## Next Steps

- Identify additional data needs
- Form necessary subgroups
- Conduct surveys or collect data
- Reconvene to discuss results, draft regulation
- Present results at second public workshop

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## Contact Information

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– **More Information**

- Visit: <http://www.arb.ca.gov/cc/commref/commref.htm>
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