

**PEER REVIEW COMMENT TEMPLATE**

A revision to the approved *Methodology for the Quantification, Monitoring, Reporting, and Verification of Greenhouse Gas Emissions Reductions and Removals from Advanced Refrigeration Systems* was prepared by Dentons US, LLP. ACR reviewed the revision to the methodology and provided comments to the authors prior to the public comment period. The methodology was posted for public comment from January 29, 2018 – March 5, 2018.

**Note to reviewers:** This template is organized by section of the methodology. Please insert your review comments in the table for that section. In the first round of review, peer reviewers should insert their comments in the first column, leaving the second column for methodology author responses. This will be followed by an abbreviated second round of review in which the reviewers comment on the authors’ responses and methodology revisions, followed by a second round of responses from the authors.

Please add rows to each table as needed.

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## 1. Definitions

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<p><b>Advanced refrigeration system</b> - It seems that for the purposes of this methodology, "low-GWP refrigerant" means refrigerants with GWPs lower than ~5.</p> <p>For many in the commercial refrigeration industry, "low" can include HFCs with GWPs as high as (or higher than) 1,500. It might be worth adding a footnote or caveat somewhere, or clarifying in the definition what you mean by "low," perhaps with a reference to Table 3 later on.</p>	<p><i>We agree with the suggestion. We will add a reference to Table 3 and further define a "low GWP refrigerant as one with &lt; 15 GWP."</i></p>		
<p><b>Large Commercial Refrigeration</b> - At least for EPA, large means 50 lbs or more of refrigerant at initial charge. Might be worth noting this in the definition, if that threshold is still valid for this methodology.</p>	<p><i>We agree with the suggestion and will add "50 lbs or more of refrigerant at initial charge" to the definition.</i></p>		

## 2. Background and Applicability

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<p><b>Last sentence on page 11</b> - Editorial note: this last sentence is a bit hard to follow. Perhaps revise as: "For example, secondary loop</p>	<p><i>Suggestion accepted and will be included</i></p>		

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
and cascade refrigeration systems used in supermarkets often use HFC refrigerants in combination with refrigerants that have lower GWPs (such as carbon dioxide) or heat transfer medium (such as glycol); these types of systems are eligible within this project activity category."			
<b>Section 1.2 – First paragraph</b> - Editorial note: For the purposes...	<i>Edit accepted</i>		
<b>Section 1.2 – First paragraph</b> – Editorial note: ...with an advanced refrigeration system...	<i>Edit accepted</i>		
<b>Section 1.2 – Bullet III. – mid page</b> – Editorial note: end of paragraph missing a period	<i>Edit accepted</i>		

### 3. Project Boundaries

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<b>Page 16</b> – Editorial note: This first sentence is a bit hard to follow. Suggest: "The GHG emissions sources included in the project boundary are depicted in the dark blue boxes in Figure 1. They include emissions from the operation of the refrigeration equipment and emissions	<i>Edit accepted</i>		

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
resulting from the recharging and servicing of that equipment."			
<p><b>Page 18 – SSR6 – Exclusion of Low GWP Refrigerant</b> - Something to consider: We have seen that advanced refrigeration systems often require more frequent maintenance than traditional systems (e.g., centralized DX systems using HFCs). This is likely due to the newness of the systems (and the fact that technicians are still learning how to work with them), and the fact that they typically operate under higher pressures (and are thus more prone to leaks that need to be fixed). If you accept that advanced refrigeration systems need more frequent servicing, it might make sense to account for the incremental emissions. If you did want to account for these emissions, you could assume that each time you service a system you lose a de minimis quantity of refrigerant. The amount that can be lost during servicing is prescribed by EPA regulations.</p>	<p><i>The "Annual Emission Rates" in Table 4 are the leak rates from the systems and include the leaks (emissions) from servicing of the equipment.</i></p> <p><i>SSR6 in Table 2 has been changed to include to include emissions.</i></p> <p><i>Footnote added to Table 4 noting that servicing emissions are included in annual emission rate.</i></p>		

#### 4. Baseline Determination and Additionality

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<p><b>Default Emission Factors</b> Table 4 entries for annual emission rates should be updated to be consistent with current US EPA default values – see ICF (2016) Accounting Tool to Support Federal Reporting of Hydrofluorocarbon Emissions: Supporting Documentation. Prepared for Stratospheric Protection Division, Office of Air and Radiation, US EPA. Prepared by ICF, October 2016. <a href="https://www.epa.gov/sites/production/files/2015-09/documents/hfc_emissions_accounting_tool_supporting_documentation.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/hfc_emissions_accounting_tool_supporting_documentation.pdf</a>.</p> <p>This report is used by EPA and other federal agencies in conducting GHG reporting and inventories. The default values are derived from EPA’s current version of the Vintaging Model which is continuously updated based on the latest technical and market information. Table 3-3 of the ICF (2016) report presents the following default for emission factors (% of capacity/year):</p> <ul style="list-style-type: none"> <li>• Supermarket refrigeration and condensing units:25%.</li> </ul>	<p><i>For Large Commercial Refrigeration, we will modify Table 4 to reflect the ICF October 2016 reference for Large Units at a 25% loss rate.</i></p> <p><i>We will also note that for Stand-Alone units, data obtained from EPA’s GreenChill partnership demonstrates that the 8% value used is appropriate. See May 2, 2018 e-mail from Tom Land (EPA) to Charles Hon, with "GreenChill Partnership_Small System Data_2008-2017.xlsx"</i></p>	<p>For stand-alone units, table 3-3 of ICF (2016) suggests a 1% loss rate. The 8% loss rate that is suggested is based on GreenChill data for systems with charge sizes under 50 pounds. However, the eligible equipment included in the methodology is on the smallest end (in terms of charge size) of this range. The cited email from Tom Land to Charles Hon does not contain a specific loss rate. This 8% loss rate should be substantiated.</p> <p>Many stand-alone units have small charges closer to that of a kitchen refrigerator and are hermetically sealed like residential refrigerators. Indeed, the charge sizes for eligible stand-alone equipment in the methodology range from .55-1.7 kg. The nature of the eligible equipment call into question the 8% loss rate suggested in the methodology. The GreenChill partnership data, when removing the outlying years of 2011 and 2012, would suggest an average loss rate of 8%, however, this may not be indicative of the eligible equipment that is allowed per the methodology.</p>	<p>The 2016 ICF report was developed for federal facilities to report GHG emissions and defines “stand-alone retail refrigerators and freezers” as having a 0.4 kg charge size and a 1% per year leak rate. The ARS Methodology has a charge size range from 0.55 kg – 1.7 kg which is above the 0.4 kg used to determine 2016 ICF emission factor.</p> <p>Both the ICF report and the US EPA’s GHG Inventory use the 2006 IPCC data (Table 7.9) where the IPCC defines stand-alone as having a charge size range of 0.2 – 6 kg and an annual emission factor range from 1% - 15%.</p> <p>In addition to the 1% annual emission rate cited for stand-alone units, Table 3-3 of the ICF 2016 report states that stand-alone units have a 25% recovery efficiency. This means that 75% of units are disposed of without</p>

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<ul style="list-style-type: none"> <li>• Medium and large cold storage equipment:25%</li> <li>• Walk-in refrigerators and freezers:12%</li> <li>• Stand-alone retail refrigerators and freezers: 1%</li> </ul>			<p>the refrigerant being recovered. Using this information to include end-of-life (EOL) emissions in the methodology and the annual leak rate of 1%, a more appropriate emission factor is determined by amortizing refrigerant losses over the 10-year crediting period. Using this method, we arrive at an annual leak rate, for purposes of methodological quantification, of 7.75% for stand-alone units. Below is the method used to determine this leak rate with all information derived from table 3-3 and table 3-6 (equipment lifetimes) of ICF 2016:</p> <p>Data – Stand-alone units</p> <ul style="list-style-type: none"> <li>• 1% annual leak rate,</li> <li>• 90% refrigerant remaining at disposal,</li> <li>• 25% refrigerant recovery</li> <li>• 10-year equipment lifetime</li> </ul> <p>Calculation</p> <ul style="list-style-type: none"> <li>• 1% annual leak rate * 10 years = 10% refrigerant loss</li> <li>• 90% refrigerant remaining at disposal with a 75%</li> </ul>

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			<p>loss rate (25% is recovered) = <math>90\% * 75\% = 67.5\%</math> loss at EOL</p> <ul style="list-style-type: none"> <li>• 10% refrigerant loss + 67.5% end of life loss /10 years = 7.75% annual emission rate</li> </ul> <p>Data – Large Commercial Refrigeration</p> <ul style="list-style-type: none"> <li>• 25% annual leak rate,</li> <li>• 90% refrigerant remaining at disposal,</li> <li>• 85% refrigerant recovery</li> <li>• 18-year equipment lifetime</li> </ul> <p>Calculation</p> <ul style="list-style-type: none"> <li>• 25% annual leak rate * 18 years = 450% refrigerant loss</li> <li>• 90% refrigerant remaining at disposal with a 15% loss rate (85% is recovered) = <math>90\% * 15\% = 13.5\%</math> loss at EOL</li> <li>• 450% refrigerant loss + 13.5% end of life loss /18 years = 25.75% annual emission rate</li> </ul>
<p><b>Default Baseline Refrigerant</b> The original version of the Methodology was written when EPA SNAP regulations were anticipated to</p>	<p><i>For Stand-Alone Refrigeration, HFC-134a does not work for all applications [e.g. freezers] and</i></p>		

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<p>result in “de-listing” of several HFC refrigerants. For large commercial refrigeration, the Methodology listed R-407A as the default baseline refrigerant primarily because supermarkets were shifting to that refrigerant in anticipation of EPA SNAP delisting of R-404A. Even though the SNAP rules are in question, this is still a reasonable assumption given market momentum towards R-407A and because California is working to adopt EPA’s SNAP regulations that have been challenged.</p> <p>For stand-alone refrigeration equipment, the original version of the Methodology assumed a baseline where R-404A and HFC-134A would have an equal share of the market. This was based on then-current EPA Vintaging Model defaults. The EPA SNAP rule was not a consideration at the time and is not a factor today. In the interests of consistency with EPA’s most recent default values, the Methodology should use HFC-134a as the default refrigerant for stand-alone refrigerators and freezers – as listed in Table 3-6 of the ICF (2016) report noted above.</p>	<p><i>manufacturers prefer to use a single refrigerant rather than a blend.</i></p> <p><i>To better account for share of usage in the market, we modified the default BAs to be 75% HFC-134a and 25% R-404a. This yields a default GWP of 2,053 instead of the 50/50 average currently used (GWP of 2676).</i></p>		
<p><b>Section 3.1 – 2<sup>nd</sup> paragraph</b> – editorial note: extra comma after “installed”</p>	<p><i>Edit accepted</i></p>		



1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<p><b>Section 3.1 – 4<sup>th</sup> paragraph</b> - Note that the EPA (2010) reference is outdated. It is from a past EPA rulemaking that was updated with a new rule in 2015. The new rule is currently being revisited, but the rule text and the supporting documentation that was prepared for the 2015 rule is probably a better reference than the 2010 rule.</p> <p>The 2015 rule is available here:  <a href="https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0453-0125">https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0453-0125</a></p> <p>Rather than mentioning the 15-35% range, you might say the following based on the 2015 rule language:</p> <p>"The EPA assumes an industry-wide average leak rate for commercial refrigeration systems of 25%, but many systems achieve emissions rates much lower than that. For example, stores that achieve GreenChill Platinum Certification have leak rates at or below 5%."</p>	<p><i>Reference will be updated. The suggested quote will be added and the numbers of stores in GreenChill will also be updated.</i></p> <p><i>Additionally, language will be modified in Section 3.1 and Appendix A to better explain how baseline defaults were determined.</i></p>		
<p><b>Section 3.1 – 5<sup>th</sup> Paragraph</b> - It is true that nearly all food retailers still use R22 or HFCs. The most recent publicly available data from the GreenChill program is here:  <a href="https://www.epa.gov/greenchill/greenchill-partnership-impact">https://www.epa.gov/greenchill/greenchill-partnership-impact</a></p>	<p><i>Thank you for your input and reaffirmation.</i></p>		

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
<p><b>Section 3.1 – Paragraph beneath table</b>  - The last sentence is outdated. There are approximately 38,500 food retail stores in the US total. See <a href="https://www.fmi.org/our-research/supermarket-facts">https://www.fmi.org/our-research/supermarket-facts</a></p> <p>GreenChill does not necessarily provide certification for having advanced refrigeration systems. Certification is awarded based on specific criteria. <a href="https://www.epa.gov/sites/production/files/documents/gc_storecertprogram08232011.pdf">https://www.epa.gov/sites/production/files/documents/gc_storecertprogram08232011.pdf</a></p> <p>It seems that this figure (8 certified stores) refers to the number of stores that were certified at the platinum level as of July 2015. The number of stores that are currently certified as GreenChill Platinum is 74 (as of December 2017). See <a href="https://www.epa.gov/greenchill/greenchill-store-certifications">https://www.epa.gov/greenchill/greenchill-store-certifications</a></p> <p>But one could say that any store that achieves GreenChill certification at any level is using an advanced refrigeration system. As of December 2017, there are 238 stores currently certified by GreenChill.</p>	<p><i>We will update the number of stores to 38,500 total stores and 74 Platinum certified stores.</i></p> <p><i>Additionally, we will modify the language in Section 3.1 (paragraph beneath Table 3) and Appendix A to clarify that GreenChill’s “platinum” certification is used as a representative for the adoption rate of advanced refrigeration systems (GWP &lt;15), as defined by this Methodology.</i></p>		
<p><b>Section 3.1 – Footnote 9</b> - GreenChill partners now account for roughly 29% of the industry.</p>	<p><i>Footnote 9 will be deleted because we are not referencing the Gold and</i></p>		

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
	<i>Silver certification status as a factor in the market penetration rate.</i>		
<p><b>Section 3.1 – Footnote 9</b> - As noted above, EPA assumes 25% is the average leak rate standard.</p> <p>From the 2015 rule: EPA's standard presumption, based on CARB data, is that the average leak rate for all commercial refrigeration is 25 percent.</p>	<i>Footnote 9 will be deleted, as it is not relevant to the methodology.</i>		
<p><b>Table 4 – Baseline refrigerant column – Large commercial refrigeration:</b> As shown in the charts here, R-404A is still the most common refrigerant in commercial systems for GreenChill partners. R-407A will soon be the next most common.</p> <p><a href="https://www.epa.gov/greenchill/greenc-hill-partnership-impact">https://www.epa.gov/greenchill/greenc-hill-partnership-impact</a></p>	<i>Thank you for the comment. To better express industry adoption rates, we will use a 50/50 blend of R-404a and R-407a, an average of 3,014 GWP.</i>		
<p><b>Table 4 – Annual Emission Rate column –</b></p> <p><b>1. Large commercial refrigeration:</b> Again, you might consider using 25% here.</p> <p><b>2. Stand-alone commercial refrigeration:</b> Based on experience, I can confirm that this 8% figure is reasonable (cannot provide a citation).</p>	<p><i>We will modify the large refrigeration emission rate to 25%.</i></p> <p><i>Thank you for the confirmation on the Stand-Alone emission rate. Here is the citation:</i></p> <p><i>For Stand-Alone units, data obtained from EPA GreenChill partnership demonstrates that the 8% value used is appropriate. See May 2, 2018 e-mail from Tom Land (EPA) to Charles Hon, with "GreenChill</i></p>		

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
	<i>Partnership_Small System Data_2008-2017.xlsx"</i>		

## 5. Quantification of GHG Emission Reductions

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
Agree with the revisions	<i>Thank you</i>		

## 6. Monitoring and Data Collection

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
Agree with the revisions	<i>Thank you</i>		

## Appendix A: Performance Standard Development and Baseline Data Inputs

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
See comments above for updating the baseline emission factors and baseline refrigerants to be consistent with current US EPA Vintaging Model and GHG Inventory Modeling guidance for HFCs. References and listing in the relevant tables in the ICF (2016) report should be added.	<i>Per the above comments, for the emission rates we are using GreenChill information for Stand-Alone units (8%) and ICF (2016) estimates for Large Commercial Refrigeration (25%).  For the default refrigerants we are using a 50/50 blend of R-404a and R-407a (3,014 GWP) for Large</i>	See above comment regarding 8% loss rate for stand-alone units.	See above response.

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
	<i>Commercial Refrigeration and 75% HFC-134a and 25% R-404a (2,053 GWP) for Stand-Alone units.</i>		
<b>Section A.1</b> – 38,500 food retailers, according to FMI, now. Not 37,000.	<i>Will revise</i>		
<b>Section A.1</b> - Again, I assume this 8 store figure refers to the number of stores achieving GreenChill platinum. As noted above, the data as of December 2017 show that there are 74 stores currently certified at the platinum level. But again, the stores that are achieving silver and gold certification (238 at present) are also using advanced refrigeration systems. Need to be clear here why we are focusing on the platinum certified ones.	<i>Will revise to 74 stores.</i> <i>References to GreenChill are made in context of justifying low adoption rate for "low GWP refrigerants." Only the Platinum certification has the use of a low-GWP (&lt;150) refrigerant as part of its qualification criteria and, therefore, is relevant to the definition of an advanced refrigeration system as it applies to this methodology.</i> <i>In addition, we are aware of only two manufacturers of stand-alone units which are using any low-GWP refrigerants as defined in this Methodology.</i>		
<b>Section A.2 – Table 5</b> - See comments above on Table 4 regarding baseline refrigerants and emissions rates.	<i>Per the above comments, for the emission rates we are using GreenChill information for Stand-Alone units (8%) and ICF (2016) estimates for Large Commercial Refrigeration (25%).</i> <i>For the default refrigerants we are using a 50/50 blend of R-404a and R-407a (3,014 GWP) for Large Commercial Refrigeration and 75%</i>	See above comment regarding 8% loss rate for stand-alone units.	See above response.

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
	<i>HFC-134a and 25% R-404a (2,053 GWP) for Stand-Alone units.</i>		

**Appendix B: References**

1 <sup>st</sup> Peer Review	Author Response	2 <sup>nd</sup> Peer Review	Author Response
No comment			