Domestic Air Conditioner Test Standards and Harmonization: Summary of Findings

Jessica DeWitt, Cadeo Group
Overview and Goal of Research Project

• Test procedures are foundational to national regulatory energy efficiency programs.

• This project’s goal was to identify key differences to facilitate potential harmonization efforts and areas for improvement.

• Improved harmonization can reduce test burden, share best practices internationally, and allow for better comparison of equipment across countries.

• Cadeo and Stem Integration Services reviewed and compared a selection of international test methodologies for domestic air conditioners designed to provide cooling or heating and cooling.
Test Procedure Review & Findings

This research reviewed and compared the test procedures shown in this table, with primary focus on:

• Scope of Products Covered
  – Ductless Split System Air Conditioners

• Test Method
  – Two test methods allowed in almost every test procedure

• Secondary Energy Uses Tested
  – All test procedures rated some form of secondary energy use

• Ability to Rate Fixed & Variable Capacity Equipment
  – All test procedures had a method for testing and rating both fixed and variable capacity equipment.

<table>
<thead>
<tr>
<th>Country</th>
<th>Referenced Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>GB/T 7725-2004</td>
</tr>
<tr>
<td>EU</td>
<td>BS EN 14511:2018</td>
</tr>
<tr>
<td>Japan</td>
<td>JIS B 8615-1:2013 JIS B 9612:2013</td>
</tr>
<tr>
<td>Korea</td>
<td>KS C 9306 2017</td>
</tr>
<tr>
<td>US</td>
<td>10 CFR 430 Subpart B Appendix M/Appendix M1</td>
</tr>
<tr>
<td>International</td>
<td>ISO 5151</td>
</tr>
</tbody>
</table>
Efficiency Metrics & Test Conditions Findings

- Most countries require some form of seasonal energy efficiency metric to rate equipment efficiency
- Seasonal metrics rely on multiple temperatures
  - Test condition temperatures
    - High temperature test condition is nearly fully aligned with ISO 5151 across all test procedures studied
    - Low temperature (part load) test conditions vary, with some countries calculating energy consumption at temperatures lower than the low temperature test condition
      - Extrapolation of performance to low temperatures can be inaccurate
  - Local climate rating temperatures
    - Since local climates vary, these temperatures are not standardized
    - Regional weighted temperatures used to calculate SEER don’t appear to directly correlate to SEER values
Harmonization opportunities

Standardization of low temperature test conditions represents an opportunity for harmonization.
• May also help seasonal efficiency metrics be more relatable between countries
• A lower test temperature would minimize extrapolation of load curve during seasonal energy efficiency calculation

Standardize secondary energy uses considered
• Results in more comprehensive and consistent assessment of energy performance

Other opportunities for harmonization:
• Standardize refrigerant line length and/or charge
• Standardize equipment nomenclature & terms
Opportunities for Improvement

All countries include Variable Capacity Testing, but approaches could be improved to better characterize performance, especially at part load conditions.

• Current procedure fixes compressor speed at part load condition
  – Does not accurately represent field operation
  – Load-based test procedures have been developed to dynamically test variable capacity equipment
    ▪ Questions about ensuring reproducibility of results

• Current seasonal efficiency calculations vary between fixing degradation coefficient and measuring it
  – Accurately characterizing degradation coefficient is important for correctly anticipating seasonal efficiency
Summary

• Reviewed test procedures from 6 countries + international standard
• Generally aligned, but some opportunities for harmonization of test methods
• Also opportunity to improve testing of variable capacity equipment
• Improved harmonization can reduce test burden, share best practices internationally, and allow for better comparison of equipment across countries

Next Steps: Further evaluating test methodologies for variable speed air conditioners and heat pumps