

Legal Text for Annex 36

Quality Installation / Quality Maintenance Sensitivity Studies

(Avoiding Efficiency Degradation due to Poor Installations and Maintenance)

1. Background

A significant opportunity for improving heat pump operating performance (capacity, efficiency, etc.) is related to how well the equipment is actually installed and subsequently maintained in the field. A difficulty in promoting sound installation and maintenance practices is that the marketplace often incentivizes ‘cutting corners’ so as to keep first-cost pricing low, resulting in poorly performing equipment and poor value received by the customer. Generally, an underlying cause of this predicament is that the various industry participants (e.g., OEMs, distributors, designers, installers, etc.) – as well as the ultimate building owners/operators/customers – do not appreciate how small deviations in installation and maintenance impact equipment performance.

It is generally recognized that heat pump equipment suffers significant performance loss depending on how the equipment is installed and subsequently maintained. Some commonly noted problems caused by incorrect installation and maintenance practices for both air-to-air and water-to-air heat pumps in the US are:

- improper refrigerant charges (up to 15% off),
- incorrect airflow over the coil (up to 50% off design),
- oversized equipment (routinely, 50% oversized ... and often considerably more),
- leaky ducts (up to 50% of airflow),
- etc.

This causes heat pumps to operate inefficiently and waste considerable energy. However, it is unclear whether small variances within a given field-observed practice are significant, whether the deviations have an additive effect on heat pump performance, and whether the attribute deviations (in various equipment applications and geographical locations) have a larger impact than others. If this information is known, better attention, resources, and effort can be focused on those parameters that are most important in the installation, and maintenance of heat pump equipment.

Additionally, improved understanding will help position consumers and building owners / operators to consider the complete value-to-cost equation, not merely the “first price,” when making HVAC equipment purchasing, installation, and maintenance decisions. Customers who select high performance HVAC equipment – along with quality installation (QI) and quality maintenance (QM) practices – enjoy enhanced comfort, reduced energy usage, improved occupant productivity, and enhanced occupant safety.

2. Description of Technical Sector

The HVAC industry does not have a good set of quantitative information on the relative value and importance of one field installation (or maintenance) aspect over another. There have been isolated studies that looked at existing equipment in the field and the impact that corrective fixes provide. However, these result in anecdotal data that provided limited real information on the trade-off impacts associated with specific design, installation, and maintenance practices.

By evaluating heat pump faults commonly found in operating equipment, and assessing the relative capacity and efficiency degradations, stakeholders will be better positioned to understand how installation and maintenance practices affect heat pump performance.

3. Objectives and scope

The desired end-product objectives are:

- Develop information for use by key stakeholders in industry (HVACR and construction trades), government (policy makers), and building sector (owners/operators).
- Produce reliable data to position each participating Annex country to evaluate its pertinent industry standards and practices for the heat pump system types of primary interest to ensure optimum heat pump performance.
- Reduce usage of energy and emissions of greenhouse gases by encouraging use of quality heat pump installation and maintenance practices.

These objectives have parallel interest under the IEA Framework of Implementing Agreements as the intent is to identify, quantify, and deliver information to key industry stakeholders and policy makers and to provide pertinent resources to building owners and operators. The objectives will be achieved by independent studies and investigations performed by the country-specific participants. The main output of this Annex is information sharing on heat pump installation and maintenance aspects so that better cross-country understanding is achieved to reduce energy consumption (and the related CO₂-emissions) while satisfying the needs of building owners and operators.

4. Means

Each participating Annex partner will focus on ***those heat pump types and applications that are in general usage within their residential and commercial building sectors***. It is anticipated that each country's recognized standards, industry practices, and measurement instrumentation approaches will serve as the basis for the individual Annex partner efforts.

In undertaking the sensitivity analyses, each individual Annex partner will be seeking to quantify impacts on system performance (e.g., capacity, energy utilization, etc.) related to varying QI and QM practices /attributes for their varied equipment applications of interest.

Tasks to characterize the impacts and tradeoffs associated with varying levels of QI and QM that each country is to observe are:

Task 1: Critical literature survey

Undertake literature review and critical analysis of the results from prior related research to identify QI & QM metrics and to secure quantitative and qualitative impacts of various deviations from the specified levels recommended in industry's relevant QI & QM standards. This may include benchmarking of current QI/QM standards and practices in place in each participating country.

Task 2: Identify sensitivity parameters

Building on the literature search, and working with pertinent country experts, develop a consensus of the QI & QM elements to be included in the participant's sensitivity investigation. The table below provides examples of possible elements, metric ranges, and increments, based on current plans for the US QI/QM investigation (focused on the prevailing central air distribution approach used in US systems). Other participants may modify this listing of parameters based upon the heat pump and distribution systems of most interest to their industry and end users.

Possible Example for the QI and QM Sensitivity Analysis		
Attribute	Possible Reporting Metric range	Possible Reporting Increments
Equipment-related		
<i>Equipment sizing</i>	Nominal heating or cooling capacity (kW or Btu/hr) for building: 90 – 200% of load calcs	10 – 25% intervals
<i>Airflow across the coil</i>	CFM: 50 – 125% of design	10 – 25% intervals
<i>Refrigerant charge</i>	TXV: -6 to 6°C of subcooling Orifice: -6 to 6°C of superheat	1-2 °C intervals
<i>Electrical</i>	Voltage: 80 – 120% of rated voltage	10% intervals
<i>Equipment matching</i>	Mismatched indoor heat exchanger with mismatched refrigerant metering device.	Two scenarios: ~30% too large and ~30% too small
Air distribution system		
<i>Duct leakage (unconditioned space)</i>	Leakage %: 0 – 50% of supply air flow	10% intervals
<i>Airflow balance</i>	Flow imbalance to room (based on design)	Two scenarios: ~30% too low and ~30% too large
Additional examples or heat pump operating faults could include:		
<ul style="list-style-type: none"> – compressor and/or reversing valve leakage – condenser air blockage – evaporator air blockage – liquid line restriction – refrigerant undercharge/overcharge – non-condensable gas in system – failure to clean coils, – dirty ducts, – filter loading/changeout – viability and impact of varied measurement approaches (instrumentation, procedures, etc.) 		

Task 3: Modeling and/or laboratory-controlled measurements

Computer modeling and/or laboratory-controlled experiments to be undertaken to verify the results provided by earlier researchers, to fill-in ‘holes’ in regard to quantifying the impacts of QI & QM vs. non-QI & QM applications, and to better understand the singular and additive impacts on equipment effectiveness.

Task 4: Simulations on seasonality impacts

Simulations are to be undertaken to determine the role that seasonal temperature differences have on the varied QI & QM elements and the resultant impact on heat pump performance. This modeling of different geographic temperatures impacts within a country or region (i.e., different outdoor temperature and humidity conditions) help to identify regional effects if any.

Task 5: Report and information dissipation

Each participant’s final report will address the results of the tasks above. As appropriate, the report(s) should also address the viability and impact of varied measurement methods (instrumentation, procedures, etc.) to cost-effectively undertake various QI & QM measurements (e.g., refrigerant charge, airflow, duct leakage, etc.) in the field.

5. Target audience and Benefits

The sectors targeted for this Annex include:

- HVAC practitioners responsible for designing, selecting, installing, and maintaining heat pump systems in varied applications.
- Building owner/operators interested in achieving improved comfort conditioning and efficiency performance from their HVACR equipment.
- Entities charged with minimizing energy utilization (i.e., utilities, utility commissions, energy agencies, legislative bodies, etc.) in varied heat pump applications and geographic conditions.

Improved heat pump installation and maintenance will result from increased awareness of HVAC contractors/installers, building owners/operators, and consumers about the benefits provided by following recognized quality installation and maintenance practices.

6. Time schedule

The Annex commenced 1 November 2010, and will remain in force until 30 November 2013. Within the limits of the terms of the Agreement, this Annex may be extended by two or more of the participating countries (Participants), acting in the Executive Committee and taking into account any recommendation of the IEA's Committee on Energy Research and Technology concerning the terms of this Annex 36. Extensions shall thereafter apply only to those Participants.

The following is a tentative work schedule for the different tasks – exact timing will depend upon the actual start date of the Annex.

Start Date	End Date	Activity
November 2010	April 2011	Task 1 – Critical literature survey
May 2011	October 2011	Task 2 – Identify sensitivity parameters
November 2011	July 2012	Task 3 – Modelling and/or lab-controlled measurements
August 2012	April 2013	Task 4 – Simulations on seasonal impacts
May 2013	November 2013	Task 5 – Report and information dissemination

7. Deliverables

The deliverables of the Annex are:

- a) An Internet website (linked to the HPC-site), that will serve as the participants' portal for sharing their country efforts and viewing the work done by other countries.
- b) Progress reports to the HPC four times annually for publication in the Newsletter, and semi-annually to the HPP Executive Committee (May and November).
- c) An annual summary report for inclusion in the HPP Annual report describing the work carried out under the Annex.
- d) Final report consolidating the salient findings of the individual country inputs. This report will re-state the objectives of the Annex, its key findings, a description of the results sensitivity analysis undertaken by the Annex Participants, and recommendations for further study. **NOTE** – The Annex Final Report will remain confidential (embargoed) among the Participants for a period of eighteen (18) months after submission to the HPP Executive Committee. However, the Executive Summary of the final report shall be made available for general distribution to all IEA HPP countries immediately after approval of the final report by the Executive Committee.

8. Funding

- a) Participant’s Financial Obligations: Each Participant (country) will bear the costs of its own participation in the Annex, including any necessary reporting, travel costs to undertake their portion of the effort, and costs to organize and hold working meetings hosted by the country. Approximately one face-to-face working meeting per year is anticipated during the course of the Annex (schedule to be determined by the Participants). It is envisioned that many of the Annex activities can be undertaken via web-conferencing and e-mail communications.
- b) Publications: The cost/effort to prepare the draft Final Report and summary assessments described in paragraph 7 above (‘Deliverables’) shall be equally shared by all the Participants.
- c) Each Participant shall make a direct financial contribution to the Operating Agent to cover coordination, report submission/review/consolidation, and other Annex-related costs.

The table below shows the fees per Participant, based upon varying numbers of Participants. Each Participant’s fee shall be paid in 3 annual instalments.

Number of participants	Participants’ fees		
	2010	2011	2012
2	\$ 10000	\$ 10000	\$ 10000
3	\$ 8500	\$ 8500	\$ 8500
4	\$ 7500	\$ 7500	\$ 7500
5	\$ 6000	\$ 6000	\$ 6000
>5	\$ 5000	\$ 5000	\$ 5000

Each Participating country’s fee shall be paid in US\$, as shown in the above Table.

9. Specific obligations and responsibilities of the participants

- a) Each Participant shall nominate a lead representative to participate in the work under this Annex and act as the point of contact (POC) with the Operating Agent. At his/her discretion the POC may appoint other individuals to lead the Participant’s work in each of the Annex Tasks as defined in Section 4.
- b) Each Participant shall carry out the equivalent of at least 6-12 person months of task-sharing work during the Annex period unless otherwise agreed by the Participants.
- c) Each Participant shall contribute to the working meetings and workshop(s) on the results achieved through the activities conducted under this Annex, including the identification of speakers and participants.
- d) Each Participant shall make a direct financial contribution to the Operating Agent to cover co-ordination and report preparation expenses and other Annex related costs.
- e) Each Participant shall provide a Country Report as identified in Section 4 (Task 5) and shall contribute to the deliverables identified in Section 7.

10. Specific obligations and responsibilities of the Operating Agent

The Operating Agent shall:

- a) Develop, in co-operation with the Participants, a detailed work schedule, a framework for the Country Reports, and a budget for all the activities carried out under this Annex, including methodology and time schedule
- b) Provide the Executive Committee with periodic reports describing the progress of the work being accomplished under the Annex
- c) Deliver the results as described in Section 7 (‘Deliverables’)
- d) Provide to the Executive Committee, within six months after completion of all the Annex work, a draft of the Final Report for its approval and transmittal to IEA headquarters.

- e) In co-ordination with the Participants, use its best efforts to avoid duplication with activities of other related programs and projects implemented by or under the auspices of the Agency or by other competent bodies
- f) Provide the Participants with necessary guidelines for the work they carry out, assuring minimum duplication of effort
- g) Co-ordinate the efforts of all Participants and ensure the flow of information within the Annex
- h) Provide general administration

The IEA Heat Pump Centre will assist in the establishment of the Annex, in the organisation of the workshop(s) and the publication of the proceedings, and publication of the Final Report.

11. Information and intellectual property

- a) *Executive Committee's Powers.* The publication, distribution, handling, protection and ownership of information and intellectual property arising from this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Annex.
- b) *Right to Publish.* The Participants shall have the right to publish information provided to or arising from their contribution to the Annex under Section 9b, except for proprietary information, as defined in paragraph (c) below.
- c) *Proprietary Information.* For the purposes of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical compositions of materials, or manufacturing methods, processes or treatments) which is appropriately marked provided that such information:

- 1) Is not generally known or publicly available from other sources
- 2) Has not previously been made available by its owner(s) to others without obligation concerning its confidentiality; and
- 3) Is not already in the possession of the recipient Participant(s) without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information, and of the Operating Agent, to identify such information as proprietary and to ensure that it is appropriately marked. The Participants and the Operating Agent shall take all necessary measures in accordance with this paragraph, the laws of their respective countries and international law to protect the proprietary information provided to or arising from this Annex.

- d) *Production of Relevant Information by Governments.* The Operating Agent should encourage the governments of all Agency Participating Countries to make available or identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Annex.
- e) *Production of Relevant Information by Participants.* Each participant agrees to provide to the Operating Agent all previously existing information, and information developed independently of the Annex, which can assist or is needed by the Operating Agent to carry out its functions in this Annex, which is freely at the disposal of the Participants, and the transmission of which is not subject to any contractual and/or legal limitations, under the following conditions:
 - 1) The Participant will make such information available, at its own costs, provided that such costs are not substantial
 - 2) If substantial costs are necessary for the Participant to make such information available, the Operating Agent and all Participants will determine the charge of the costs for each participant, upon approval of the Executive Committee.
- f) *Use of Confidential Information.* If a Participant has access to confidential information which would be useful to the Operating Agent in carrying out the studies, assessments, analysis or evaluations described in this Annex, such information may be communicated to the Operating

- Agent but shall not become part of any report or other form of documentation issued as part of this Annex, nor shall it be communicated to the other Participants, except as may be agreed between the Operating Agent and the Participant who supplies such information. This information has to be marked clearly as “confidential”.
- g) *Acquisition of Information for the Annex.* Each Participant shall inform the Operating Agent of the existence of information that can be of value to the Annex, but which is not freely available, and each Participant shall endeavour to make such information available to the Annex under reasonable conditions, in which event the Executive Committee may, acting unanimously, decide to acquire each information.
 - h) *Reports on Work Performed under the Annex.* The Operating Agent shall, in collaboration with the other Participants, prepare reports on all work performed under the Annex and the result thereof, including studies, assessments, analysis, evaluations and other documentation, but excluding proprietary information, in accordance with paragraph 11(c) above. **NOTE** – The Annex Final Report will remain confidential (embargoed) among the Participants for a period of eighteen (18) months after submission to the HPP Executive Committee. However, the Executive Summary of the final report shall be made available for general distribution to all IEA HPP countries immediately after approval of the final report by the Executive Committee.
 - i) *Copyright.* The Operating Agent, or each Participant for its own results, may take appropriate measures necessary to protect copyrightable material generated under this Annex. Copyright obtained shall be the property of the Operating Agent, for the benefit of the Participants provided, however, that Participants may reproduce and distribute such material, but shall not publish it with a view to profit, except as otherwise provided by the Executive Committee. The Contracting Parties understand and agree that the name, acronym and emblem of the IEA has been notified to the World Intellectual Property Organisation (WIPO) Secretariat according to Article 6 of the Paris Convention for the Protection of Industrial Property, as amended on 28 September 1979. The Contracting Parties further understand and agree that the OECD/IEA shall retain the copyright to all IEA deliverables, materials or publications published or to be published by the IEA or jointly by the IEA and a third party to this Annex. Should the Contracting Parties use any such deliverables, materials or publications they shall give full acknowledgement to the OECD/IEA as being the source of the material with a copyright notice in the following form: © OECD/IEA, (year of publication).
 - j) *Authors.* Each Participant shall, without prejudice to any rights of authors under its national laws, take necessary steps to provide the co-operation from its authors required to carry out the provisions in this paragraph. Each Participant shall assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

13. Operating Agent

The Air Conditioning Contractors of America (ACCA), and the National Institute of Standards and Technology (NIST), in collaboration with Oak Ridge National Laboratory (ORNL) and the U.S. Department of Energy (DOE), are designated as Co Operating Agents.

Contact information for the Co Operating Agents:

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14. Participants in this Annex

The Contracting Parties which are Participants in this Annex are the following:

Organization	Country
Ademe	France
The Swedish National Energy Administration	Sweden
Department of Energy and Climate Change	UK
Department of Energy	USA

15. Research organizations participating in this Annex

The contracting parties are the ones signing the contract, but others may carry out the research work, states those parties in the table below.

Organization	Contact person	Country	Address	Phone	Email	Website	Annex NT leader (Y/N)
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