Annex 36

IEA Heat Pump Programme

Quality Installation / Quality Maintenance Sensitivity Studies

Avoiding Heat Pump Efficiency Degradation Due to Poor Installations and Maintenance

	Type of Heat Pump (HP)			
	Air-to-Air HP	Air-to-Water HP	Brine-to-Water HP	Exhaust Air HP
The most common faults	Fan (26%)	Pressure switch (44%)	Control and Electronics (31%)	Control and Electronics (32%)
	Control and Electronics (25%)	Control and Electronics (25%)	Shuttle valve (19%)	Shunt valve/motor (19%)
	Temperature Sensors (16%)	Temperature sensors (10%)	Liquid pumps (17%)	Temperature sensors (11%)
The costliest faults	Control and Electronics (23%)	Pressure switch (25%)	Control and Electronics (28%)	Control and Electronics (24%)
	Refrigerant Leakage (17%)	Control and Electronics (21%)	Liquid pumps (18%)	Refrigerant leakage (17%)
	Fan (15%)	Compressor (19%)	Shuttle valve (12%)	Domestic Hot Water tank (13%)

Summary of the Most Common & Costliest Faults in Different Types of Heat Pump Systems (According to the reports to Heat Pump Manufacturers during 2010 – 2012).

The outcome from this Annex activity clearly identifies that poorly designed, installed, and/or maintained heat pumps operate inefficiently and waste considerable energy compared to their "as-designed" potential. Additionally, it is clear that small faults for a given field-observed practice are significant, that some attribute deviations (in various equipment applications and geographical locations) have a larger impact than others, and that multiple faults or deviations have a cumulative impact on heat pump performance.

Methodology

It is widely recognized that residential and commercial heat pump equipment experience significant "in-field" performance loss (i.e., capacity and efficiency) depending on how the components are sized, matched, installed, and subsequently field-maintained. However, the extent and degree to which design, installation, and maintenance faults impact system performance was unquantified.

IEA Annex 36 evaluated how deficiencies in these areas cause heat pumps to perform inefficiently and hence waste considerable energy.

Some investigations (France and UK) included field tests and assessments. Other efforts included laboratory tests (France, UK, US) and/or modelling work (France, UK, US), and statistical analyses of large failure databases (Sweden).

Objectives

The final report provides reliable information for use by key stakeholders in industry (HVACR and construction trades), government (policy makers), and the building sector (owners/operators), so that each stakeholder can take actions to ensure optimum heat pump performance. This serves to lower energy consumption – and the resultant emissions of greenhouse gases – by encouraging the observance of quality heat pump design, installation, and maintenance practices.

The Annex results position stakeholders to better understand how quality installation (QI) and quality maintenance (QM) practices beneficially impact heat pump performance.

- HVAC practitioners will be able to provide their customers with a higher quality product, delivering "as designed" efficiency throughout its service life.

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- Homeowners and building owner/operators will realize enhanced comfort, reduced energy usage, improved occupant productivity, and enhanced occupant safety.
- Program managers for entities charged with minimizing energy utilization (i.e., utilities, utility commissions, energy agencies, legislative bodies, etc.) will be better able to focus attention, resources, and effort, on the important heat pump system design, installation, and maintenance parameters for different types of heat pump applications in varied geographic conditions.

Significant Achievement

FRANCE – Focused projects on heat pump space heating and water heating

... led to the development of a CO_2 HPWH tailored to the needs of the French market. The resulting system was of modular design, requiring an installation time of ½ day, and delivering an annual COP (SPF) of ~3.0.

SWEDEN – Comprehensive analysis of faults in Swedish heat pump systems

... building on the faults database analyses, a 'smart fault detection & diagnostic (SFDD) system' is currently under development.

SWEDEN – Operation and maintenance of heat pumps in apartment buildings owned by smaller property companies

... an information manual – aimed at owners of small multi-family buildings – was developed, that provides guidance on purchasing, commissioning, operation & maintenance, and system monitoring for various heat pump systems.

UK – Improvements to design and installation standards of domestic heat pump systems

... the investigation resulted in revisions to the heat pump system design/installation standard (with improved guidance to designers, installers, and maintenance personnel. The standard provides updated sizing requirements, new guidance on heat emitter design (e.g., appropriate spacing of pipes in underfloor systems and the appropriate sizing of radiators), new information on designing ground loops and boreholes, and updated guidance on the sizing of domestic hot water tanks.

US – Sensivity anaysis of installation faults on heat pump performance

... the laboratory investigations and modeling analyses quantified the amount of degradation experienced by air source heat pumps typically-installed in the US. This information is serving as the basis for which U.S. Federal, State, and local entities are assessing their energy efficiency programs and effecting changes.

Further information

Contact person: 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), were designated as Co Operating Agents. Represented by Glenn Hourahan, glenn.hourahan@acca.org

Participating countries: France, Sweden, United Kingdom, and the United States (Operating Agent)

Publications: Final report of Annex 36, available at www.heatpumpcentre.org

Internet: http://web.ornl.gov/sci/ees/etsd/btric/usnt/QiQmAnnex/ and information regarding Annex 36 at www.heatpumpcentre.org

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