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Performance standards and certification of heat pump installations

In this issue:

Improving heat pump system quality in the Netherlands

Guidelines for evaluating heat pump installations for proper performance

IEA OECD heat pump centre



Front cover: Heat pump test bench, TNO, the Netherlands

COLOPHON

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In this issue

Performance standards and certification of heat pump installations

This issue covers heat pump performance and test standards, as well as certification of heat pump systems and installers. The goal of standards and certification is to ensure high-quality heat pump installations that create consumer confidence. The topical articles in this Newsletter focus on the participation in standards committees, heat pump system quality, evaluation of performance and noise reduction. Also an international overview is given on performance standards and certification. Furthermore, there is a report on the strategy of the European Heat Pump Association and on the 2001 ASHRAE winter meeting.

TOPICAL ARTICLES

Performance standards and certification of heat pump installations 10
an international overview
W. Keith Snelson, IEA Heat Pump Centre
Relevant performance standards and certification activities concerning heat pumps, prevailing in countries representative of major markets located in Asia, Europe, and North America: this overview gives an update. In doing so it identifies a continuing trend towards further international harmonisation of standards for heat pump performance as well as a steady increase of energy efficiency requirements over time.

Improving heat pump system quality in the Netherlands 13
Peter Oostendorp and Roberto Traversari, the Netherlands
Heat pumps for space heating and for domestic hot water face strong competition from gas-fired boilers in the Netherlands. Testing and monitoring are crucial in efforts to improve heat pump system efficiency and quality. But monitoring is expensive and the results are not always unambiguous. Now, a standard monitoring system has been developed that claims to overcome these obstacles and is in line with the most recent government guidelines.

Guidelines for evaluating heat pump installations for proper performance 16
John F. Parker, USA
This article discusses the evaluation of heat pump installations for proper performance. Manufacturers' expanded performance data is useful for this analysis. In focus will be air-to-air equipment, which accounts for a large percentage of all heat pumps installed in the United States. Following is an analysis of a method used by Alabama Power Company to apply guidelines for evaluating heat pump installations for proper performance.

Swiss participation in international standards committees 19
Thomas Afjei, Switzerland
The Swiss Federal Office for Energy and the Swiss Association for the Promotion of Heat Pumps (FWS) strive to promote renewable energy sources such as heat pumps. Therefore they not only take part in many international standards committees but also stimulate manufacturers and other market parties to join in. Find out about the working groups these Swiss organisations play an active role in.

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Noise reduction in heat pumps 20
Markus Studer, Kurt Eggenschwiler, Switzerland
If not designed and installed properly in a suitable location, heat pumps can produce noise at nuisance levels for adjacent residents. Various systems and guidelines used for measuring, predicting and regulating noise levels produced by heat pumps are discussed. Practical measures are presented for preventing noise nuisance. Working with a heat pump that produces little noise to begin with is a good starting point.

NON-TOPICAL ARTICLES

The European Heat Pump Association (EHPA) strategy 22
Roar Rose, Norway, Cathérine Ducruet, France
The European Heat Pump Association (EHPA) is the interface between the EU and the national heat pump networks and markets. The EHPA strategy, finalised March 2001, aims at almost doubling the currently projected residential heat pump installations by 2010, which will have considerable effects on CO_2 emission reduction and energy savings. To reach this target, it is essential that heat pumps are accepted as a complement to other renewable energy sources and that the European Commission promotes and supports heat pump technologies.

2001 ASHRAE Winter meeting 24
Jos Bouma, IEA Heat Pump Centre
The 2001 ASHRAE Winter meeting was held in Atlanta, Georgia, home of ASHRAE Headquarters. A wide range of heat pump-related topics, academic as well as specialist were discussed at this past winter's meeting, which focussed on ground-coupled heat pumps and water source heat pumps.

Growing reliance on certification



When a manufacturer advertises its products' performance using a recognised standard, it makes for a more efficient marketplace. When a manufacturer also makes use of a third-party certification programme to verify these claims, it provides the market with added assurance, which is good for both business and consumers.

Third-party certification programmes verify a manufacturer's claim about product performance via continuous independent testing, thereby helping build consumer confidence. These programmes speak well for the industry and for the companies that participate in them. They level the playing field for manufacturers and assure the consumer that he/she is receiving the performance paid for. Such programmes are gaining acceptance for increasing numbers of products.

In our industry, where less-than-qualified assemblers can purchase components and then 'manufacture' less-than-satisfactory heat pump equipment, such programmes are vital. The twenty-three performance certification programs of the Air-Conditioning and Refrigeration Institute (ARI) specifically address performance by verifying cooling capacity and efficiency. They lead to rational purchase decisions that save energy and help promote market stability, not just in North America, but also to an increasing extent around the world. Engineers who work with specifications for refrigeration, air conditioning, and heat pump equipment can rely on third-party certified information. Consumers are also coming to rely more heavily on third-party certifiers to provide the assurance that products will perform as advertised.

There is growing world-wide reliance on certification programs to assure compliance with national and international standards. ARI, in cooperation with EUROVENT, now certifies large water-chilling packages around the world. An increasing number of countries and regional manufacturing associations are developing their own programmes, many based on the ARI model. In the future, they will hopefully all be linked through mutual recognition agreements, so that products certified in any country can obtain global certification. Users world-wide will then be assured that they are getting the performance they pay for.

More information on the ARI certification programs, including extensive listings of all models that are certified, can be found at http://www.ariprimenet.org.

Mark Menzer
Vice President, Engineering and Research
Air-Conditioning and Refrigeration Institute

Heat pump news

The Norwegian Heat Pump Certification Scheme

Norway - The Norwegian Heat Pump Certification Scheme was established last year. The Scheme includes training courses for personnel involved in heat pump design and installation, and the first course was held in Oslo in February, 2000.

The overall objective of the Scheme is to ensure high quality of heat pump installations and to provide advice on correct application of heat pump systems. Another important issue is to define clear rules for responsibility when several sub suppliers are involved. The Norwegian Certification Scheme is not primarily focused on the heat pump as a technical device, but on the complete heating system.

Beyond this, the Certification Scheme aims at:

- ensuring that actual and calculated energy savings are more or less identical. This also includes the calculation basis that leads to choosing such heating systems;
- contributing to correct design and installation of the integrated heat pump system, including the heat exchangers and distribution systems;
- ensuring high technical quality and efficiency for the total heat pump system.

The course lasts for three days, including a written examination. There have been courses organised in several Norwegian cities and by the end of 2000, a total of 120 people had been certified. During the first year of operation, the interest in the Scheme has been significant and is assumed to keep growing.

OFE (an information office on energy and environmental issues) administers the Certification Scheme and is also responsible for the courses, often in close co-operation with regional energy efficiency offices. Additional guidance is provided by a steering committee that includes representatives from all relevant marketing groups, installers, energy advice centres, etc.

The Norwegian Heat Pump Association is involved in establishing an "Insurance of Confidence" for end users purchasing a heat pump installation from a certified company. When the Scheme is completely established, membership in the Norwegian Heat Pump Association will be open for certified companies only.

Roar Rose/Marit Brånås
Contact via Norwegian National Team
Address: see back cover.

Standard on storage for renewable energy

Canada - Canada is moving toward adoption of a national standard that will encourage the use of storage for renewable energy technologies.

Underground thermal energy storage (UTES) is a process of storing free or cheaply available energy within the subsurface of the earth. The practice is used in several European countries, particularly the Netherlands and Sweden, and at least ten major projects are already operating in Canada and the United States.

There are a number of applications that can use UTES, but the renewable energy industry in Canada agreed that earth energy systems have the most immediate need for a national standard to ensure quality systems. The country's national standards organization, CSA International, has agreed to include a UTES standard as an integral part of a new installation standard that addresses ground source heat pumps.

The new CSA standard is expected to be finalized this year, and will then be approved as a national guideline.

Source: Solar Energy and Renewable Energy News - SolarAccess.com
More information: Bill Eggertson
Fax: +1 613 728 2505

Gas engine heat pump provides cold comfort in the UK

UK - Advantica Technologies Ltd has recently built a test house with a small gas engine-driven heat pump on its Loughborough site to demonstrate a range of state-of-the-art energy and home automation products. It is a two bedroom detached, brick-built house of standard construction with insulated cavity walls and double-glazing.

The small gas engine-driven heat pump imported from Japan provides heating and cooling. The reversible outdoor unit is capable of providing 8 kW cooling and 11 kW heating via a maximum of four indoor fan coil units. In the house, just two fan coils (one in the lounge and one in the bedroom) were sufficient to provide comfort during July and August.

Several manufacturers in Japan have produced small gas engine heat pumps and these have overcome all of the main barriers to their acceptability - noise levels, servicing and engine life, and exhaust emissions. The outdoor unit tested by Advantica is very quiet (49 dBA) and requires only one routine service per year. The engine is expected to operate for 40,000 hours before major overhaul or replacement. Emissions of NO_x are very low due to lean burn operation.

Tests by Advantica confirmed the manufacturer's claims for efficiency, with $PER_{heating}$ = 1.2 (at -10°C ambient temperature), $PER_{cooling}$ = 1.0 (at 35°C). At partial load operation, a $PER_{heating}$ as high as 1.7 was measured.

Source: UK Heat Pump Network Newsletter, Issue 4, November 2000
More information: Bob Tucker
E-mail: bob.tucker@advanticatech.com

New IIR Web site

France - The IIR's new Web site *http://www.iifiir.org.* provides a portal that gives access to a broad range of services and information on refrigeration, air conditioning and heat pumps. It is a valuable tool for Associate Members of the IIR who will benefit from the "member-only space" comprising exclusive on-line services, and for users looking for a broad range of information and high-performance services.

Among **services** now available thanks to the site are:
- the Fridoc database containing over 60,000 references: natural-language and multicriteria searches can be performed;
- the IIR Publications Catalogue enabling searches on a book-category or keyword basis;
- IIR information resources such as: questions and answers, searches and information monitoring, and document ordering;
- the IIR-conference agenda that can be consulted or downloaded.

Among **sources of information**:
- the "News" section providing information on the refrigeration sector, technology, regulations and standards, and key IIR events;
- summary or full files presenting state-of-the-art refrigeration issues (being set up);
- a "Regulations-Standardization" section containing summaries, glossaries, full texts on key issues (global warming, food safety etc.) at global and regional levels;
- "Useful Web sites" forming links with many international and national organisations.

Each of the ten IIR Commissions now has its own Web site. These sites have the same architecture and sections are made available to all users: presentation of Commission activities and conferences organised by each Commission, information and links to other sites; they also have several Commission- or associate-member-only sections containing exclusive information. An "Expertise Directory" enabling networking of members within the scope of each Commission will be phased in. It will be a valuable communication-facilitation tool.

Source: IIR
Fax: +33-1-47631798
E-mail: iifiir@iifiir.org

Promotion of heat pumps continues

Switzerland - The 'Fördergemeinschaft Wärmepumpen Schweiz' (FWS) wants to have at least 100,000 heat pumps installed and running by 2010.

The *Energie 2000* programme has a successor called *EnergieSchweiz* to continue the promotion of heat pumps. The FWS takes over a part of the responsibilities. Its main goal is to realise the target set in the field of renewable energy as efficiently as possible: by 2010, another 3% of heat production should be generated using renewable energies. In numbers, the FWS goal is to have at least 100,000 heat pump systems installed by 2010. For comparison, at the end of 2000, almost 60,000 systems were installed. This target implies a market share of almost 50% in the new housing market and a share of 10% in the market for replacement of oil heating systems.

To realise its goals, FWS is planning to educate more regional groups who can offer their services locally. Another tool is the FWS homepage, in which a better integration with the members' homepages will be established. Also, a commission for quality control of earth probes will be installed. Drilling companies can voluntarily get a quality seal and offer more security for end-users.

Source: Wärmepumpe News Winter 2000/01
More information: FWS
E-mail: fwsmail@fws.ch

Heat pump soon in the white house?

USA - Scientists at the US national laboratories have projected enormous energy savings if the government takes aggressive steps to encourage energy conservation in homes, factories, offices, appliances, cars and power plants.

A lengthy and detailed report based on three years of work by five national laboratories said that a government-led efficiency programme emphasising research and incentives to adopt new technologies could reduce the growth in electricity demand by 20-47%.

The report quoted proven benefits of various technologies in field tests. At Fort Polk, an Army base in Louisiana, electricity use during peak hours fell by 43 percent after base managers installed fluorescent lights, low-flow shower heads, new attic insulation and new home heating and cooling systems. Most of the savings however came from installing ground-source heat pumps.

The ground-source heat pumps, though still something of a novelty, are completely proven and save so much money that President Bush installed a system at his new ranch home in Crawford, Texas. Vice President Cheney's official residence, the Naval Observatory in Washington, also uses ground-source heat pumps to cut down on its energy bill.

Source: Joseph Kahn

Annual meeting ÖKKV

Austria - On 14/15 March 2001 the annual meeting of the Austrian Association of Refrigeration and Air Conditioning (ÖKKV) took place in Vienna, and more than 100 people attended this meeting. The first day was a heat pump day. Members of the Austrian Association of Heat Pump Manufacturers and Installers presented interesting developments. One of them was an absorption unit for retrofitting existing buildings. Furthermore, a borehole heat exchanger for ground-coupled heat pumps with CO_2 as heat carrier was presented as well as installations covering the entire range of single-family houses to large industrial heat recovery systems.

People working in the field of refrigeration, air conditioning and heat pumps work closely together to overcome problems caused by new EU regulations being applied in Austria.

More information: Hermann Halozan
Address: see back cover

Large project with active piles planned

Germany - In Hannover a new bank building is planned featuring piles that extract energy from the ground.

For over 20 years, concrete components have been used for the extraction of energy from the ground. The basic principle is to equip concrete elements needed for construction with plastic pipes. In these pipes, a brine is circulated to transfer the heat or cold and use it respectively for heating or cooling. The high conductivity and storage capacity of these elements provide good energy absorbtion and rejection. These techniques have already been demonstrated in a large number of projects. The architectural office has planned a building with a base of 14,000 m^2 and a volume of 298,000 m^3 for the Norddeutsche Landesbank in Hanover. A total of 122 piles will be drilled into the ground.

All these piles, each with a diameter of 90 cm and a length of 20 m, will supply the building with heating and cooling energy, which will be brought to the required temperature level with heat pumps. To utilise the cold / warm energy, a system of pipes is laid down in the concrete floors. The heat or cold is then distributed though the pipes in all 8 floors of the building. Planning and construction of the enercret®-energy pile system is in the hands of Nägele Energietechnik, Sulz-Roethis, Vorarlberg, Austria.

Source: Geothermische Energie, März / September 2000, Nr. 28/29

Zeolite heat pump developed

Germany - A gas-fired adsorption heat pump using zeolite for the phase-change matrix, and developed in Germany, has an output of 14 kW and a COP of 135% when working under domestic heating conditions. The initial costs are said to be 30% less than those for an equivalent electrically driven unit.

Zeolite has a very high interstitial surface area, typically 800 to 1200 m^2/g, and a bulk density of around 750 kg/m^3. It is a naturally-occurring material, non-flammable and environmentally safe. Its composition and performance stay unchanged after several thousand charge/discharge cycles.

Source: JARN, January 25, 2001.

Zürich airport builds giant heat pump

Switzerland - One of the world's largest heat pump systems is being built in Zürich-Kloten. As already reported in the IEA HPC Newsletter volume 17 no. 1, Zürich airport wants to become the ecological leader of Europe.

In the middle of the airport's course base, the Midfield Dock is presently being constructed. This building, 500 m long, 34 m wide and 21 m high, will be a colossus and consume huge amounts of energy. From the start, it was clear that renewable energy was going to be used and that the building was to be illuminated with natural daylight. To create comfortable conditions for passengers, staff and computers, heat will have to be removed in summer. To do this in an environmentally as well as economically sound manner, a heat pump will be used. As the airport is built over a ground water lake, the heat drawn off will be stored in the earth during summer and used to heat the buildings in the winter. More than 400 foundation piles with a diameter of over a meter were drilled over 20 m into the ground. Their main purpose is to support the building. But they are also equipped with a system of pipes through which a water-glycol mixture is circulated. The piles yield 790 MWh heat in the winter and 610 MWh cold in the summer.

The investment for the piles was about USD 650,000. The yearly energy bill will be reduced by about USD 55,000, and the maintenance costs will increase by USD 6,600. With an amortization period of 30 years at an interest of 5.5 percent, the financial gains of the piles will be USD 9,400 yearly.

Source: Wärmepumpe News Winter 2000/01

Ventilation heat recovery heat pump system

UK - A novel low maintenance, energy efficient and compact domestic ventilation heat recovery heat pump system was discussed during the 21st Air Infiltration and Ventilation Centre (AIVC) conference, September 2000. This heat pump system uses revolving heat exchangers instead of a fan impeller. The prototype system has a COP of up to 5 and an average of 2.5 over a range of conditions. A typical system provides 2 kW of heating for air supplied at 250 m^3/h. The system can also be used for cooling by switching the air flows over the evaporator and condenser.

Source: Air infiltration review, Vol. 22, No. 1, December 2000

Preliminary programme "R-conference" available

Croatia – The preliminary programme of the "R-conference" *Refrigerant management and destruction technologies of CFCs*, a joint conference of IIR Commissions B1, B2, E1 and E2 is now available, in print and on http://www.fsb.hr/r-conference. The programme features an HPC co-sponsored workshop on refrigerant management programmes.

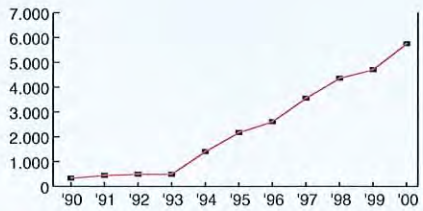
Source: IEA Heat Pump Centre

German sales up 22%

Germany – Since 1990, 53,516 new heat pumps for space heating and hot water have been installed in Germany.

In comparison to modern oil and gas heating devices, heat pumps save up to 44% of primary energy and reduce the emission of CO_2 into the environment by almost 55%. Applied in a single-family house, a heat pump prevents about 3 tons of CO_2 emissions each year.

Over the past year, almost 6,000 heat pumps for space heating have been installed in Germany. If the heat pump systems for hot water are also counted, then a total of 10,000 new heat pump systems have been installed in 2000 in Germany. Since the foundation of the 'Initiativkreis WärmePumpe' in June 1993, the number of newly installed heat pumps for space heating has increased at a rate of between 8% and 179%.



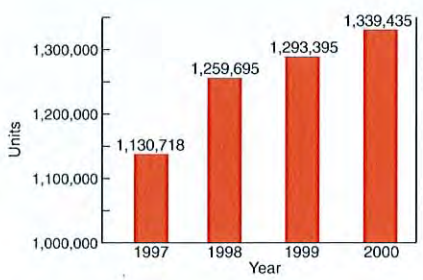
▲ *Figure 1: Number of newly installed heat pumps per year for space heating in Germany. (Source: Initiativkreis WärmePumpe (IWP) e.V., München.)*

Source: Wärmepumpe News

USA Heat pump shipments hit record in 2000

USA - Air-to-air heat pump shipments of 1,339,435 units set a new single year record with a four percent increase over 1999 (**Figure 2**).
Shipments of air-source heat pumps and central air conditioners reached a record 6,685,481 units in 2000 compared to 6,647,071 units a year earlier, a rise of 0.6%, according to ARI statistics.

Source: Koldfax, February 2001



▲ *Figure 2: Air-to-air heat pump shipments*

AC sales rising in Europe

Belgium - There were some 7.5 million room air conditioners in the European Union in 1996, and sales are growing at an average of 12% a year.

These statistics are part of a report published by Eurovent. The report says that Italy and Spain, which account for 47% of all sales, dominated sales in 1996. Germany, France, Greece and the UK accounted for 41%.

According to the Eurovent report, there is a 35% difference in efficiency between the most and the least efficient product types that provide the same cooling. This range, the report says, is typical of differences that can exist in an unregulated market. It also shows the potential to save energy through policy intervention.

Source: ASHRAE Journal, February 2001

Stiebel Eltron bonus

Germany - Heat pump manufacturer Stiebel Eltron from Germany, wants to stimulate the sale of residential heat pumps. Stiebel is offering a USD 115 bonus for those heat pump system owners who make their system available as a reference object, e.g. for visits by press or interested building owners.

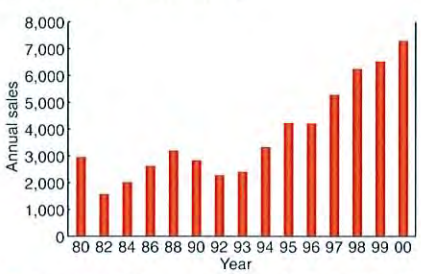
Source: KI Luft- und Kältetechnik 1/2001

New Swiss record

Switzerland - The century of renewable energy has started off very promising. With a total of 7,264 heat pumps sold in Switzerland in the year 2000, an all time high was achieved. This is an increase of 11.8% compared to the preceding year. The Swiss Association for heat pump promotion, FWS, received the sales numbers from 55 companies in this field, which comprise almost 100% of the Swiss market. The result is judged as outstanding, because the market of the oil-fired heating boilers decreased by 4% in the same period.

The main market for heat pumps is still the single-family house market. Here, four out of ten newly built houses have a heat pump installed for space heating and hot water.
No improvement is visible in the retrofitting market, where around 1000 heat pumps were sold in the years 1991-1999. This is a market share of about 2-3 %. The potential of this market is very attractive, because every year more than 40,000 units (mainly oil-boilers) have to be replaced.
No big changes can be reported concerning the market shares of the different types of heat pump. Air-to-water units are still leading with a share of 52%, followed by the brine-to-water types with 40%. Of minor importance are water-to-water and the so-called radiator heat pumps, which have a share of around 4%. The "radiator" heat pump is an air-to-air heat pump that can be ideally used to replace a direct electric storage heater for a single room.

The future for heat pumps in Switzerland looks promising. With heating oil prices around 30 USD per litre instead of 20 USD per litre, as in the years before 2000, it is quite possible that the retrofitting market will also grow. More Swiss house owners will replace their oil-boilers by a heating system that uses renewable energy. This is a win-win solution, because the investor and the environment are benefiting.



▲ *Figure 3: Heat pump sales in Switzerland*

More information: FWS
E-mail: fwsmail@fws.ch

CO_2 as heat transfer fluid

Austria - Karl Mittermayr has developed a revolutionary loop concept for ground- coupled heat pumps. Instead of a conventional brine, Mittermayr, for the first time, utilises CO_2 as the heat transfer fluid. After three years of research and development in scientific partnership with the Technical University of Graz, it has now been proven that the new system works excellently. The measured coefficient of performance (COP) of a heat pump system with the new type of ground loop is 5.4.

For years Mittermayr's house served as a test facility for loop concepts with different heat transfer media. After several initial tests with prototype loops to a depth of 50 m, a second demonstration installation was installed in November 2000 with two probes to a depth of 65 m. With this system a COP of 5.4 was obtained.

One of the advantages of the new system is that the heat transfer fluid CO_2 circulates without the aid of a pump. Therefore, no auxiliary power is used and because the loop has no moving parts it is free of maintenance.

The use of copper tubes with a synthetic coating makes it possible to introduce them in deep drill holes quite easily. The working pressure of 30-40 bar at temperatures of 0-12°C ensures a perfect heat transfer and enables the loop to combine with any kind of heat pump system, independent of the working fluid that is used in the heat pump system.

In 2001, the final field tests of the new loop will be carried out and mass production will start. Market introduction is scheduled for 2002.

Source: LGW Aktuell, Ausgabe 1/2001

CO_2 for refrigeration

The Netherlands - TNO-MEP (The Netherlands Organisation for Applied Scientific Research) and GTI Koudetechniek have started using the first prototype of a new industrial cooling installation with CO_2 as the working fluid in December 2000. The applied industrial cooling capacity is about 40 kW at -30°C.

This is a breakthrough in industrial cooling technology, which offers energy-efficient, environmentally friendly and relatively safe refrigeration. The installation has been built using existing components. More extensive research and monitoring will be carried out on the performance of the system.

There is great interest from the market for industrial refrigeration using CO_2. Over the next years, more and more ammonia will probably be replaced by CO_2 as working fluid.

Source: Koude & Luchtbehandeling, January 2001
More information: TNO-MEP, H.F.M. Bothe
E-mail: H.Bothe@mep.tno.nl

High COP for air-source heat pump

Germany - Using propane as the refrigerant and floor coils as the condenser, a residential heat pump system developed by Acalor is said to achieve a COP of over 5.0.

The air-source evaporator is kept free of ice by using an intermittent hot-gas defrost reverse-cycle technique causing a loss of only 5% in efficiency. The refrigerant condenses directly within the copper floor coils (diameters 10 to 18 mm) at a temperature of 30°C and nearly 10-bar pressure. A standard system contains about 5 kg of propane and is considered to be a low safety risk.

Source: JARN, February 25, 2001.

Workshop "Hands-on experience with heat pumps in buildings"

The Netherlands – The preliminary programme of the workshop *Hands-on experience with heat pumps in buildings* that will be held 10-11 October 2001 in Arnhem, the Netherlands, is available on the HPC Internet site (http://www.heatpumpcentre.org). The workshop is co-organised by the HPC and Dutch utility NUON for the IPUHPC, the International Power Utility Heat Pump Committee. Sponsors are NUON and EdF, France.

Speakers from the USA, Canada, Europe and Japan will share their international heat pump experience with the participants. The workshop provides an excellent forum to meet other heat pump practitioners from utilities and industry. Technical tours (optional) will update you on the technology development and real projects in residences in the Netherlands.

You may register for this workshop by downloading the workshop invitation from the internet, or contact the HPC secretariat.

Source: IEA Heat Pump Centre,
Address: see back cover.

Topics for international collaboration welcome!

If you have a suggestion for an international collaborative project in the framework of the IEA Heat Pump Programme, please contact the Heat Pump Centre. The Programme aims to increase the number of collaborative projects (Annexes) and your suggestions are welcome.

Ongoing projects at the IEA Heat Pump Centre

The Netherlands – The Heat Pump Centre (HPC) is currently carrying out a number of projects on key issues for the heat pump community. These projects have been initiated by the National Teams from our member countries (see back cover). The projects are listed here by strategy area of the IEA Heat Pump Programme (HPP).

Environmental

The project *Refrigerant recovery and recycling: an international assessment* will document refrigerant recovery, reclamation, and recycling policies, practices, and national plans in major markets in Asia, Europe, and North America. Quantifying the emission reduction impact, and comparing and contrasting the effectiveness of different policy approaches is also part of the project. Results of the project will be discussed during a workshop at the IIR conference *Refrigerant management and destruction technologies* in Dubrovnik, Croatia, 29-31 August 2001 (see page 27).

A follow-up project will extend the scope of this project to include refrigerant disposal, and expand the geographical scope of the results. This project will commence in the second half of 2001.

Another project is a pilot study for the UK to *Quantify what heat pump technology can contribute to CO_2 emissions reduction.* The goal of the study is to contribute to the UK's Kyoto Commitment programme. Similar studies in other HPP countries may follow.

Market and deployment

The market for *Retrofit heat pumps for buildings* is potentially much larger than for application in new buildings. However, this potential is not being realised. At the end of 1999, a project was started to investigate the current market for heat pumps for retrofit, and identify market barriers and potential solutions. Information on the project's progress was given in Newsletter 18/4. The final report will be available July 2001. For ordering information, see page 27.

Software tools and handbooks assist the marketing of heat pumps in various ways. System design is an essential step between equipment and application. This project is intended to assist users to select a suitable design tool for their needs. On the HPC Internet site users are invited to give their opinion on the tools they use. Completion of the project and publication of an overview of user opinions is scheduled for the end of 2001.

Technology

In recent years, improvements of *Single-room heat pumps for cold climates* have been claimed by industry. An upcoming project will provide an overview of high-efficiency residential single-room heat pump designs for cold climates and their practical Seasonal Performance Factor.

Information dissemination

Case studies are extremely useful in demonstrating the maturity of heat pump technology and illustrating the benefits. The project *Successful heat pump installations; dissemination of example projects* will result in a data base of heat pump installation examples covering a wide range of applications gathered from a great variety of countries and climates. A format for the description of the example projects will be available from the IEA Heat Pump Centre in June 2001. The case studies will be published on the Internet site in September 2001.

With regard to example projects, a frequently asked question is: "How can the results of a case study in one country be translated to another country or climate and give a reliable prediction of the performance of the system?" Comparing systems in different countries is in particular difficult without knowledge of the climatic conditions and the design values for heating and air-conditioning systems. The project *Translating case studies* will help users to get an insight into heat pump performance under different climatic conditions in various countries or regions and runs parallel to the project mentioned above.

Providing factual independent information about existing knowledge and best practices of heat pump technology and their application is the goal of 'Informative fact sheets', a new product of the HPC. The first two topics are *Closed loop ground-coupled heat pump systems* and *Hydrocarbons as refrigerant in residential heat pumps.*

Your reaction

If you want more information about one of these projects or if you want to contribute with your experience, please contact the IEA Heat Pump Centre.

Source: IEA Heat Pump Centre

Ongoing Annexes

Red text indicates Operating Agent.

Annex 16 IEA Heat Pump Centre	AT, JP, NL, NO, UK, US
Annex 25 Year-round Residential Space Conditioning and Comfort Control Using Heat Pumps	FR, NL, SE, US
Annex 26 Advanced Supermarket Refrigeration/Heat Recovery Systems	CA, DK, SE, UK, US
Annex 27 Selected Issues on CO_2 as a Working Fluid in Compression Systems	CH, JP, NO, SE, UK, US

IEA Heat Pump Programme participating countries: Austria (AT), Canada (CA), Denmark (DK), France (FR), Germany (DE), Italy (IT), Japan (JP), Mexico (MX), The Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), United Kingdom (UK), United States (US).

Performance standards and certification of heat pump installations - an international overview

W. Keith Snelson, IEA Heat Pump Centre

Performance regulations are typically used to establish minimum efficiency criteria which equipment must meet or exceed in order to be in compliance. In the case of heat pumps, performance standards that regulate energy efficiency levels have been in existence in some countries since the 1980s. Since then the increased need for regulation of energy consuming appliances and equipment has led governments in some other countries and groups of nations to adopt their own energy efficiency standards for heat pumps and air-conditioners. Certification of equipment performance in accordance with such standards and corresponding product labelling is mandatory in some countries. Development of certification programs and control of independent testing procedures is generally seen as a national responsibility of appropriate industry associations.

This article contains an update of relevant performance standards and certification activities prevailing in countries representative of major markets located in Asia, Europe, and North America. The overview identifies a continuing trend towards further international harmonisation of standards for heat pump performance and acknowledges a steady increase of energy efficiency requirements over time.

Performance measurement

In general performance testing and rating standards refer to the measurement of capacity and energy demand of heat pumps and air-conditioning equipment, but can also include other performance criteria such as sound levels and operation under temperature extreme conditions. Depending on the application, measurements are necessary to determine the equipment's capability to provide heating, cooling and dehumidification, and its rate of energy consumption. These data are required by system designers to match the size of the heat pump or air-conditioning unit to the building thermal load.

USA

Based on ASHRAE test methods the US Department of Energy (DOE) introduced mandatory energy conservation standards for testing, rating and energy efficiency performance for room air conditioners in 1990, for residential unitary split system air-conditioners and heat pumps in 1992, and for unitary single package systems in 1993. The DOE issued energy conservation standards for larger equipment for use in commercial applications in 1994 and 1995 based on the ASHRAE Standard 90 building energy code. Minimum efficiency requirements for water-source and groundwater-source heat pumps up to 40 kW cooling capacity have also been covered by these standards since 1994.

The DOE is charged with periodic review of these appliance related energy conservation standards with a view to increasing energy efficiency levels where appropriate. Accordingly, following some very active input from the industry, new legislation has recently been proposed to take effect in 2006 that will raise the minimum Seasonal Energy Efficiency Ratio (SEER) cooling performance ratings of residential split system air conditioners and heat pumps by 20% to 12 SEER (COP=3.52), with a corresponding 9% increase in Heating Seasonal Performance Factor (HSPF) to 7.4 HSPF (COP=2.17). These changes are expected to have far reaching long term benefits in terms of lowering energy costs to the consumer and contributing to reductions in electricity generation by power plants.

Japan

In Japan minimum energy efficiency levels for heat pumps and air-conditioners have been regulated by the Japanese Industrial Standard since 1997 as part of the Energy Conservation Law that was implemented in 1979. As part of its current plan to curb greenhouse gas emissions the Japanese Ministry of International Trade and Industry (MITI) has established a comprehensive plan to raise energy efficiency levels in all sectors of the economy including equipment such as air-conditioning and heat pumps. The new targets announced in April 1999 under the Top Runner programme (see box page 12) will raise the average COP (for heating and cooling) for reversible room air-conditioners (heat pumps) by as much as 75% depending on cooling capacity of the units. For cooling-only air conditioners the corresponding increase in Energy Efficiency Ratio is up to 18%. These changes are scheduled to take effect in 2004 and 2007 respectively. Although the energy efficiency targets that fall under the legislation of the Energy Conservation Law are officially voluntary, any adverse publicity regarding product

performance strongly influences the application of commercial pressure to persuade manufacturers to comply.

Europe

Some countries in Europe such as France, Germany and Austria have had minimum efficiency standards applicable to heat pumps for many years, but in recent times the tendency has been for national standards to be superceded by regulation at the regional level largely through actions of the European Committee for Standardisation (CEN). In partnership with the European Committee for Electrotechnical Standardization (CENELEC) the CEN works to establish technical specifications necessary for products manufactured according to sets of voluntary standards and consistent with the harmonised trading policies within the EU and EFTA. These standards are arrived at by consensus and when adopted they are considered to be binding on all CEN National Members. In the case of heat pumps and air-conditioning units for residential and commercial applications the technical committee CEN/TC 113 has responsibility for performance standardisation, and in 1997 the standards EN 255-2 and EN 814-2 were issued covering testing and labelling requirements for heating and cooling mode operation respectively.

International

The increasing trend towards globalisation of manufacturing organisations and the expansion of worldwide trading opportunities has created a growing need for international standardization of many technologies including refrigeration and air-conditioning. The International Organization for Standardization (ISO) facilitates the international coordination and unification of industrial standards through a worldwide federation of national standards bodies representing 130 countries. The testing and rating of air-conditioners and heat pumps is the responsibility of technical committee ISO TC 86, working through its subcommittee SC6 and various working sub-groups. Up to now ISO TC 86/SC6 has published four ISO standards related to thermal performance. ISO 5151 covering non-ducted air-conditioners and heat pumps was issued in 1994 and ISO 13253 covering ducted equipment was issued in 1995, and both of these standards are currently being revised. Water source heat pumps are covered under ISO 13256-1 and 13256-2 which were both published in 1998.

Performance certification

Certification programmes usually mean the establishment of a permanent organised programme (typically operated by a manufacturers' trade association) which provides for the rating of equipment covered and a mechanism for verification of that rating by an independent testing agency. All certification programmes rely on testing procedures and methods, usually developed by technical organisations and incorporated by reference in the certification procedure or standard. In countries where energy efficiency testing of air-conditioning and heat pump equipment is a legal requirement, the certification procedure becomes an integral part of the mandatory regulations. As regards subsequent field performance of heat pump installations this is also heavily dependent on the technical skills and knowledge of the technicians involved, and accordingly some countries have established programmes that provide comprehensive testing and certification for HVAC technicians (see example page 4).

USA

The testing and certification of room air-conditioners (cooling only) falls under the jurisdiction of the Association of Home Appliance Manufacturers (AHAM), and performance testing is required to establish cooling capacities and corresponding Energy Efficiency Ratios. Almost all other air-conditioning and heat pump equipment is covered under the rating and certification programmes of the Air-Conditioning and Refrigeration Institute (ARI). The ARI programme uses the relevant ASHRAE standards as the test method, and appropriate DOE energy efficiency regulations are applied within the corresponding ARI certification programme standards. If test results are satisfactory, the equipment capacities, power consumption and efficiencies can be certified and the products can be listed in the ARI product directories. This information is also available in an online database that provides up to date product performance data to equipment specifiers, contractors, building owners, architects, and others. ARI is also moving to adopt more international standards to enable its member companies to compete more effectively in the global market. For example ISO Standard 13256-1 has now been adopted as the basis for ARI's water-source heat pump certification programme, and other ISO standards are under review.

Europe

The European Association of Air Handling and Refrigerating Equipment Manufacturers (EUROVENT/CECOMAF) includes 15 national associations from 11 countries. EUROVENT operates a certification programme similar to ARI, with performance testing being conducted by independent laboratories and leading to product ranges being published in the Eurovent Directory. The Eurovent programme covers air-conditioners (including reverse cycle air-conditioners) up to 100 kW cooling capacity, and uses ISO 5151 for rating non-ducted units, but ducted units are tested according to a EUROVENT 6/6 standard. Some countries especially in northern and central Europe are more interested in heating-only heat pumps, and this was one of the driving forces leading to establishment of the D-A-CH quality label, a collaboration between heat pump associations in Germany, Austria, and Switzerland. In addition to meeting minimum energy efficiency requirements of standard EN 255 the D-A-CH label also requires the provision of installation and operating manuals, a two-year complete warranty, a 10-year parts guarantee, and prompt

response to any service calls. As a next step in this collaboration it is planned to broaden the scope of the D-A-CH label to cover the complete heat pump system. Some countries such as Sweden and Switzerland also require installers of heat pump equipment to be certified.

Elsewhere in Europe the heat pump industry has been somewhat fragmented, creating the impetus for establishment in February 2000 of a European Heat Pump Association (EHPA), where 18 organisations have so far joined together to coordinate heat pump related activities at the EU level. One of the highest priorities of the EHPA is to develop a product endorsement mark for residential heat pumps that would provide consistent labelling throughout Europe in terms of energy consumption and seasonal energy efficiency. The EHPA label is intended to cover the entire heat pump heating system. It would be based on the D-A-CH scheme and use the same minimum energy efficiency standards for performance certification purposes. The EHPA labelling subcommittee is currently seeking EU financial support for this proposal.

Japan

In Japan the industry association Japan Refrigeration and Air-Conditioning Industry Association (JRAIA) has the responsibility for performance certification of equipment. JRAIA operates its own testing laboratory which is equipped with standard performance testing facilities for heat pumps and air-conditioners. Test measurements are conducted in accordance with the procedures and minimum efficiency requirements of standards JIS-B-8616 and JIS-C-9612, and an authorised certification label is applied to all products certified through this procedure.

Towards increased energy efficiency and greater standards harmonisation

Two clear trends emerge from this overview. The minimum energy efficiency levels for air-conditioning and heat pump equipment, which were first established over two decades ago in some cases, have increased substantially in recent years and this trend is likely to continue in the future. One example of the impact attributable to such standards strengthening activities was evident from data recently published in the *Appliance Efficiency* newsletter, Issue 3, Vol. 4, 2000. Forecasts were presented indicating the potential impact on energy cost savings and carbon emission reductions resulting from the adoption of new US energy efficiency standards for various appliances. Extrapolating from this data it is estimated that in the case of air-conditioners and heat pumps the cumulative contribution to the reduction of carbon emissions between 1990 and 2010 is in the region of 50 million metric tonnes.

Secondly it is evident that there is a continuing shift towards greater harmonisation of energy efficiency standards for air-conditioning and heat pump equipment. At the regional level this is largely being driven by the need for reduction of market barriers amongst blocs of countries where free trading agreements are in place. In North America for example the energy efficiency performance standards in Canada and Mexico are very similar to those in the US, where most of the manufacturing capacity is located. Activities in EU countries such as establishment of the D-A-CH quality mark and the more recent EHPA labelling initiatives are clear signals towards adoption of corresponding CEN standards for these products throughout Europe. From an international perspective the HVAC&R industry has seen the benefits of developing and supporting international standards, and the growing adoption of ISO standards is expected to continue.

W. Keith Snelson,
IEA Heat Pump Centre

Japan's Top Runner Programme

In April 1999, the Japanese Top Runner Programme was introduced as part of the revision of the "Law Concerning the Rational Use of Energy". The new energy efficiency regulation is in force for nine categories of machinery and appliances such as the automobile, air-conditioner, TV, video, and copy machine. HPC Newsletter Vol. 18, No. 1 also covered the Top Runner Programme.

Table 1 shows the efficiency targets for each type and capacity of heat pumps. The tougher efficiency targets for small equipment have been chosen because smaller units, which have already attained a relatively high efficiency, dominate the Japanese market.

In 2000, an energy efficiency labelling programme was started for five categories of equipment designated in the Law Concerning the Rational Use of Energy. This made it possible to mark products with an energy-saving label and the achievement percentage relative to the defined target efficiency.

▼ Table 1: Target efficiency of heat pumps and air-conditioners

Unit types	Cooling capacity (kW)	Heat pumps *Target mean COP for cooling and heating*	Air-conditioners *Target cooling COP*
1. Window type (ductless or through-the-wall)		2.85	2.67
2. Ductless wall mounted split type *2	<2.5	5.27*1	3.64
	2.5-3.2	4.90*1	3.64
	3.2-4.0	3.65*1	3.08
	4.0-7.1	3.17	2.91
	>7.1	3.10	2.81
3. Other ductless split type *2	<2.5	3.96	
	2.5-3.2	3.96	
	3.2-4.0	3.20	2.88
	4.0-7.1	3.12	2.85
	>7.1	3.06	2.85
4. Ducted split type*2	<4.0	3.02	2.72
	4.0-7.1	3.02	2.71
	>7.1	3.02	2.71
5. Multi split type with independently controlled indoor units	<4.0	4.12	3.23
	4.0-7.1	3.23	3.23
	>7.1	3.07	2.47

**1: Target year is 2007 except for ductless split type < 2.5 kW for which target year is 2004.*
**2: Excluding multi-split type with independently controlled indoor units.*

Improving heat pump system quality in the Netherlands

Peter Oostendorp and Roberto Traversari, the Netherlands

In the Netherlands, heat pumps for space heating and for residential hot water face strong competition from gas-fired boilers. In efforts to improve heat pump system efficiency and quality, testing and monitoring play a crucial role, but monitoring is not cheap and the results are not always unambiguous. The Netherlands organisation for applied scientific research (TNO) has developed a standard monitoring system (SOM-WP) that is unambiguous and affordable and in line with the most recent Dutch and European government guidelines.

Heat pump system quality

A high standard of quality for heat pump systems is an important requirement for successful implementation. Quality should be seen in terms of energy efficiency, cost, reliability, comfort, and need for maintenance. As heat pump systems must compete with conventional systems, the focus is shifting from energy efficiency, which was the original motivation for using heat pumps, to other aspects. Especially in the Netherlands, heat pumps face stiff competition from gas-fired boilers, which are cheap, reliable, light in weight, simple to install, noiseless, etc. It should come as no surprise then that heat pump system quality is a very important issue in the Covenant on Residential Heat Pumps (see Newsletter 18/2).

Heat pump testing

Since 1997, TNO has had facilities available for testing all types of heat pumps relevant to the Dutch residential market (see front cover).

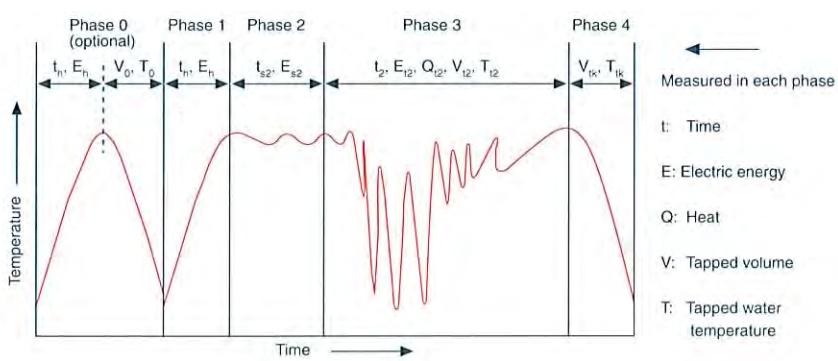
To reduce cost and time, we have developed protocols that can be run fully automatically, especially for standard applications, e.g. tests in accordance with the well-known European Standard EN255, which applies to heat pumps for space heating. To comply with the needs of the Dutch market, we also developed a test protocol for domestic hot water heat pumps in line with the existing Dutch test standard for domestic hot water boilers. The latter is based on standard daily tapping patterns (classes). The test results directly reflect heat pump performance under realistic operating conditions. **Table 1** gives the standard daily hot water use per class. In practice, heat pump water heaters are tested for classes 3 and 4 only.

▼ *Table 1: Tapped volume and energy for different comfort classes.*

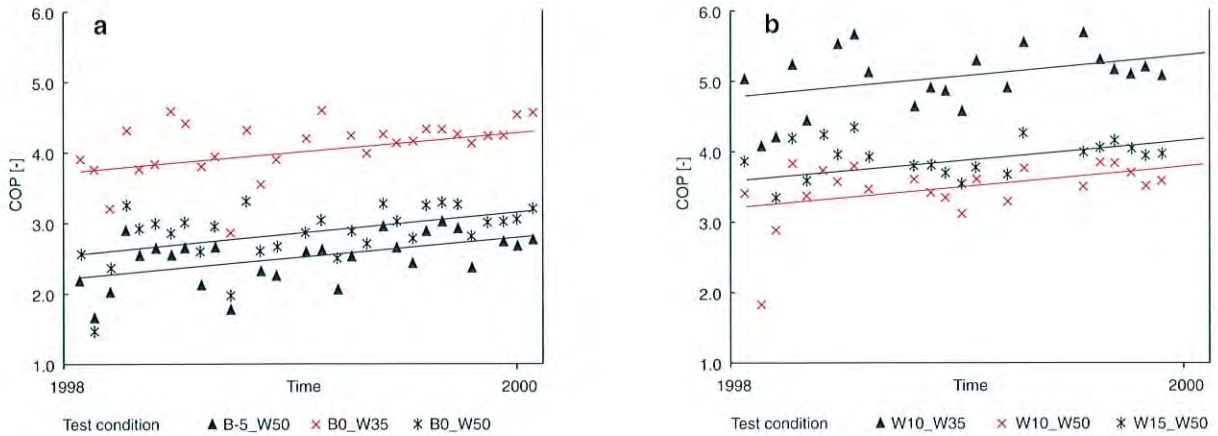
Comfort class	Tapped volume [litres at 60°C]	Tapped energy [kJ/day]
Class 1	90	19,000
Class 2	120	25,000
Class 3	150	31,000
Class 4	180	38,000

Test protocol for heat pump water heaters

Figure 1 illustrates the protocol that TNO developed for testing hot water heat pumps. Phase 0 is an option to determine the maximum amount of hot water that can be tapped at the maximum temperature level; it consists of heating up the boiler and subsequently emptying it in a single "tapping". During phase 1, the boiler is heated to the operating temperature (at least 55°C). Phase 2 is used to determine the stand-by losses of the boiler at operating temperature during at least 24 hours. In phase 3, a series of "tappings" is executed, realistically divided over a 24-hour period and in number and total volume characteristic for the specified class (Table 1). Phase 4



▲ *Figure 1: Test protocol for residential hot water heat pumps.*



▲ *Figure 2: Performance of heat pumps tested at TNO 1998-2000, tests according to EN255*
a. brine-to-water heat pumps (test condition 'B-5_W50': brine temperature -5°C to water temperature 50°C)
b. water-to-water heat pumps (test condition 'W10_W35': water temperature 10°C to water temperature 35°C)

is used to determine the amount of hot water that can be tapped from the boiler at operating temperature.

Increase of efficiency

The heat pump tests carried out at TNO Environment, Energy and Process Innovation (TNO-MEP) can play a useful role in realising the very ambitious targets for heat pump implementation in the Netherlands: 16 PJ energy saving by means of residential heat pumps in the year 2020. First of all, testing as such during a period of 3 years *coincides* with a significant increase in performance, as shown in **Figure 2**.

As a test station, we feel the temptation to claim, at least partially, a *causal* connection. The test report of each heat pump submitted for testing always presents the test results against a background of other (anonymous) tests, giving each manufacturer or supplier a direct insight in the quality of his product relative to the top-10 of the heat pump market (**Figure 3**).

Energy Performance Standard

In the Netherlands, heat pumps are included in the EPN (Energy Performance Standard). This standard describes how the value of the EPC (Energy Performance Coefficient) is calculated for new houses and buildings. The EPC is a measure of the yearly primary energy consumption. Local authorities are entitled to set a maximum permissible value for the EPC, and the designer is essentially free to choose a mix of measures (related to the building and the installation) to meet that requirement. TNO has developed a standard method for introducing the results of an EN255 test into the EPC-calculation: the better the heat pump, the lower the resulting EPC. The mandatory character of the EPN/EPC guideline strongly improves the perspective for residential heat pumps in the Netherlands.

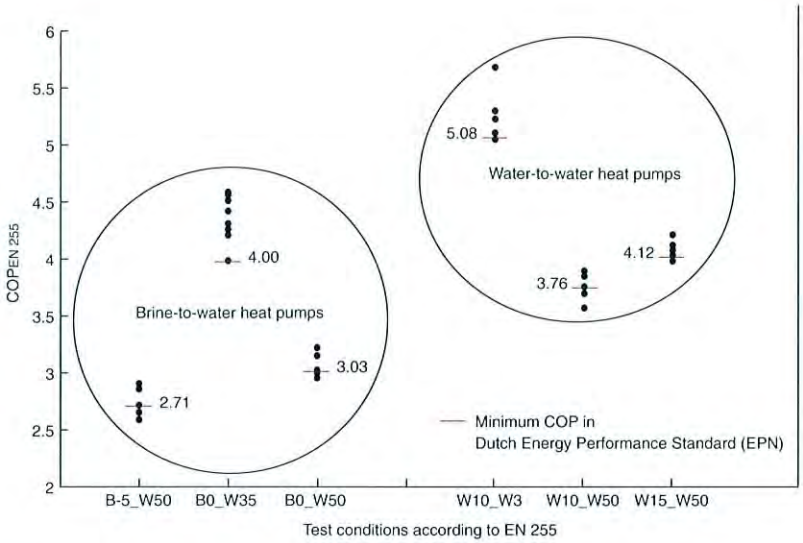
Energy Premium Regulation

Since the start of 2001, heat pump water heaters using ventilation air as a heat source have been included in the EPR (Energy Premium Regulation). Buyers of heat pumps with a COP above 2.2, when tested according to the protocol described above (Figure 1), receive a premium of about USD 615. As soon as system quality in the field is satisfactory, similar incentives can be expected for heat pumps for space heating.

International cooperation

The Heat Pump Development and Test Centre of TNO is one of the initiators and acts as secretariat for a partnership between test stations for heat pumps and air conditioners. Other participants are SP (Sweden, chair), Töss (Switzerland), DTI (Denmark), Cetiat (France), TÜV (Germany) and CEIS (Spain). To increase its impact, the partnership has been formalised as a Working Party under Commissions E1 "Air conditioning" and E2 "Heat pumps and energy recovery" of the International Institute of Refrigeration (IIR/IIF). We encourage any heat pump/air conditioner test laboratory interested in joining this partnership to apply to the secretariat at TNO (Roberto Traversari, address see below).

The aim of this partnership is:
- to study methods and results of measuring the operational perfor-



▲ *Figure 3: Test results of top-10 heat pumps tested at TNO.*

mance of residential heat pumps;
- to increase knowledge of unitary equipment performance among IIR members, manufacturers, suppliers and users;
- to provide advice, through the IIR, to parties involved in implementing heat pump systems;
- to encourage the harmonisation of testing procedures and standards;
- to encourage the publication of information through the IIR.

Hot issues concerning the testing of residential heat pumps are currently:
- the way that EN255 deals with the circulation pump. Heat pumps are marketed with and without a built-in circulation pump. Obviously, a test standard should enable a sound comparison of all heat pumps. Without going into details, the effect of the current standard is that a significant advantage is obtained when a supplier offers a heat pump to be tested *without* the circulation pump;
- the test conditions given in EN 255. When using alternative refrigerants, test conditions with a condenser outlet temperature of 50°C can cause problems;
- the difference between the inlet and outlet temperature of the external media at condenser and evaporator (or the mass flow though evaporator and condenser) is not well defined while it certainly influences the test results.

System performance

Until now, attention has mostly been paid to the quality of the heat pump as a component. Obviously, a sub-optimal system design is disastrous for even a heat pump of the best quality. For that reason, TNO has over the years emphasised the importance of system design. In the Netherlands, we have frequently been asked to provide so-called *second opinions*, especially when initiators of heat pump projects present their plans to funding organisations. In a phase where system design has not yet been realised and can still be altered, evaluation of heat pump system designs appears to be quite worthwhile. This is true for the designer, who is generally quite willing to discuss improvements to the design, as well as for TNO, where a useful accumulation of knowledge takes place. For Novem, the Netherlands agency for energy and the environment, the main motivation for second opinions is in the resulting adequate transfer of knowledge from TNO to market parties.

Within the Covenant on Residential Heat Pumps, TNO-MEP participates in the working group on system quality. One of the main targets is setting up a quality-assurance system to guide the *process* of realising a heat pump system, from the initial idea up to and including implementation of the system.

Monitoring heat pump systems

Monitoring heat pump systems involves two main issues: the costs and the usefulness of the results. TNO has developed a standard monitoring system (SOM-WP), applicable to both the markets for residential and for commercial and institutional buildings, which meets the following criteria:
- simple and cheap;
- clear definition of variables, parameters and procedures;
- *different* objects, when monitored by *different* actors, provide *comparable* results. In a next issue of this Newsletter we will report more extensively on this topic.

Acknowledgements

Novem supported the activities by TNO on the test standard for residential hot water heat pumps, the Energy Performance Standard (EPN), the second opinions and the Standard monitoring system for heat pumps (SOM-WP).

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Guidelines for evaluating heat pump installations for proper performance

John F. Parker, USA

This article discusses the evaluation of heat pump installations for proper performance. Manufacturers' expanded performance data is useful for this analysis. Since air-to-air equipment accounts for a large percentage of all heat pumps installed in the United States, this article will concentrate on this equipment type. While performance at standard rating conditions is appropriate for comparing equipment, actual performance could depend upon different operating conditions. Following is an analysis of a method used by Alabama Power Company – a Southern Company, to apply guidelines for evaluating heat pump installations for proper performance.

Backgrounds

Alabama Power Company has monitored heat pump installation quality to enhance customer satisfaction for many years. Customer satisfaction to some degree depends on a properly installed system that provides:

1) maximum reliability,
2) maximum energy efficiency,
3) repair cost containment, and
4) overall satisfaction.

The form shown in **Figure 1** is used for monitoring installations for proper performance and for compliance with application and installation guidelines for quality installations. The use of the form for monitoring quality is discussed in the following.

Proper performance analysis

Area 1: GENERAL INFORMATION

This area is used to record customer, location, and optional information.

Area 2: NAME PLATE DATA

Model and serial numbers of installed components are used to verify that the proper equipment has been installed. The equipment must be listed in Air-Conditioning and Refrigeration Institute's *Directory for Unified Heat Pump Equipment*. Cooling load calculations are used along with the expanded ratings to verify that the equipment performance is adequate based on the calculated loads. The auxiliary heater output is checked to ensure that it is adequate for comfort at

Heat Pump Quality Check

Check ☑ Items If OK

Analysis By: Dlr ☐ Rep ☐ Spec ☐ | Employee Reporting I.D.

1 GENERAL INFORMATION

☐ New ☐ Conversion ☐ Replacement | Inst. Date

Customer Name	Job No.
Street Address	Phone No.
City	District
Account No.	Meter No.
Dealer Name	Dealer No.

2 NAME PLATE DATA Manufacturer / No. _____ / _____

	Model No.	Serial No.	
ODU			☐
IDU			☐
Coil			☐
Aux. Heater			☐
Equipment Specs	Compressor Volts / Amps; ODF Amps; IDF Amps; AUX HTR Volts / Amps / kW		☐

Comments

3 CAPACITY CHECK: ODT = _____ °C (°F) Select ☐ Heating 18 °C (65 °F) or below; or ☐ Cooling above 18 °C (65 °F)

Check \ Mode	Emergency Heat	Heating	Dry Bulb Temp	Cooling Wet Bulb Temp	Enthalpy kJ/kg (Btu/lb)	DLWH MFR
☐ Return	°C (°F)	°C (°F)	°C (°F)	°C (°F)		MOD #
☐ Supply	°C (°F)	°C (°F)	°C (°F)	°C (°F)		RI = °C (°F) WO = °C (°F)
☐ Temperature Difference °C (°F)	°C (°F)	°C (°F)	°C (°F)	°C (°F)		RO = °C (°F) WI = °C (°F)
☐ Airflow Volume L/s (CFM)						Diff = °C (°F) Diff = °C (°F)
☐ Calculated Performance at ODT						# Tanks / Tot L (Gal)
	Htg. = 0.0012 x (L/s) x (± °K) Sens. = 0.0012 x (L/s) x (± °K) (Htg. = 1.08 x CFM x ± °F) (Sens. = 1.08 x CFM x ± °F)			(Latent = Tot - Sens) (Latent = Tot - Sens)	Tot = 0.0012 x (L/s) x (± kJ/kg) (Tot = 4.5 x CFM x ± Btu/lb)	☐ No DLWH Installed

Comments

4 CYCLE CHECK (Summer): Winter check sequence is e-d-b-c-a-f (Check if OK) System must be checked in all cycles

A Cooling ☐ b Off ☐ c Emergency Heat ☐ d Heating 2 ☐ e Heating 1 ☐ f Fan On ☐

Comments

5 FILTER / DUCT (Check each item if OK) (Check only one Filter Type: d., e., f., or g.)

Filter / R.A.G. Size Velocity

a. #1 [x] ☐ b [ ] ☐ c Location Access ☐

#2 [x] [ ]

Type d Hi Velocity ☐ e Lo Velocity ☐ f Elec ☐ g Hi Density ☐

Duct a Size ☐ b Support ☐ c Insulation ☐ d Sealed ☐ e Air Distribution ☐

Comments

6 SYSTEM APPLICATION / INSTALLATION (Circle Items that are Not OK and Check Blocks only if All Items on a Line are OK)

ID Equipment Mounting:	a. Support	b. Access / Clearance	c. Attachments	d. Noise	☐
OD Equipment Mounting:	a. Support	b. Access / Clearance	c. Attachments	d. Noise	☐
Refrigerant Lines:	a. Support	b. Insulated	c. Diameter	d. Lift / e. Length / f. Slope / g. Ell's	☐
Drains / Plumbing:	a. Diameter	b. Slope	c. Trapped	d. Aux Pans / e. Condensate Pump	☐
Thermostat / Controls:	a. Location	b. Level	c. Connections	d. Low Voltage / e. Cable Kcmil (AWG) / Length	☐

Comments

WHITE / APCO HPTC YELLOW / APCO Division Office
PINK / APCO District Office GOLD / Certified Dealer

Signed _____ Date ____/____/____

Figure 1. Heat Pump Quality Check Form

▲ *Figure 1: Heat Pump Quality Check Form, developed and used by the Alabama Power Company*

▼ *Table 1: Temperature / enthalpy ranges for cooling (standard air).*

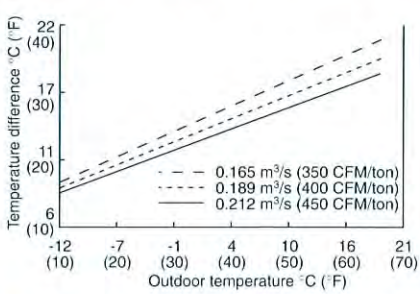
	Dry bulb temp	Wet bulb temp	Enthalpy
Return	26.7°C (80°F)	19.44°C (67.0°F)	55.50 kJ/kg (31.51 Btu/lb)
Supply	14.2°C (58°F)	13.89°C (57.0°F)	39.09 kJ/kg (24.47 Btu/lb)
Difference	12.5°C (22°F)	5.55°C (10.0°F)	16.41 kJ/kg (7.04 Btu/lb)

design conditions. The proper voltage must be supplied to the equipment. If appropriate, notation is made that the correct "short-orifice" type-metering device is installed based on the manufacturer's instructions.

Area 3: CAPACITY CHECK

The refrigerant system is evaluated for proper performance. The form is designed to evaluate heating and/or cooling performance for proper functioning based on expected operating parameters. Airflow is normally determined prior to this check to ensure proper airflow volumes for the application. If needed, the blower speed is adjusted before proceeding with the analysis.

The criterion for selecting heating or cooling is based on the outdoor temperature (ODT). At temperatures *below* 18°C (65°F), heating performance is evaluated with only the compressor providing heat to the structure. The supply and return dry bulb temperatures are measured at the nearest supply outlet and the nearest return inlet to the indoor unit. If these readings indicate low performance, measurements are then taken at the supply and return duct connections to the unit. The difference between the room temperature and the temperature at the equipment should not vary by more than 2°C (3°F) for the supply duct and 2°C (3°F) for the return duct. Greater differences require an analysis of the air distribution system for thermal insulation or for return leaks.



▲ *Figure 2: Approximate temperature rise, 1st stage heat.*

At temperatures *above* 18°C (65°F), cooling performance is evaluated. The outdoor ambient temperature at the equipment should be above 29°C (85°F). At lower temperatures, the observed performance may not be reliable for classifying the system performance as being acceptable. Although only wet bulb temperatures are required to determine cooling performance, dry bulb measurements are often useful for evaluating the actual sensible and latent capacities to the calculated loads. The latent capacity may be increased or decreased by adjusting the airflow to more closely match the calculated latent load. Calculations may be recorded on the form. Comments may be written in the "Comments" section.

Evaluation of cooling performance is more critical than for heating. The cooling load on the equipment varies with the following:

- the dry and wet bulb temperatures of the air inflow to the coil;
- airflow volume;
- ambient outdoor temperature.

Table 1 shows the expected temperature differences for cooling. **Figure 2** shows the expected temperature rise, in heating, with compressor heat only.

The wet bulb temperature difference between the return and supply is used to evaluate the total cooling performance. A wet-bulb difference of approximately 5.5°C (10°F) across the evaporator is expected at design airflow and rated conditions. The dry-bulb difference varies with the latent heat load being removed.

Area 4: CYCLE CHECK

This area is used to verify proper performance of the electrical system. This is to ensure that the system is functioning correctly in all thermostat, i.e. "system switch," operating modes. The sequence shown (Figure 1, Area 4) is based on the use of temperature differences to classify each operating mode as normal or abnormal. This involves verifying the following:

- operation of the compressor and outdoor and indoor blower motors;
- auxiliary heater cycling;
- reversing valve operation.

The compressor, outdoor and indoor blower motors should be observed to operate when cooling. The reversing valve is working properly if the vapor line from the evaporator is cool, and the temperature drop is 8 to 11°C (15 to 20°F). Similar observations should be verified for the remaining operating modes, see **Figure 3**. The electrical system is classified as normal if all expected load combinations are verified. Comments or corrections are made as appropriate.

Area 5: FILTER/DUCT

The air distribution system is the most important system to be evaluated. Corrections may be difficult to make after the structure has been completed. Proper performance considerations are airflow volume, sizing of return grilles, and supply outlet selection.
The nominal airflow volume expected per 3,514 watts (12,000 Btuh) is 0.189 m^3/s (400 CFM). However, the selected airflow volume may range from 0.165 m^3/s (350 CFM) to 0.212 m^3/s (450 CFM) to obtain the proper sensible and latent heat capacities. Proper air filtration is necessary to ensure acceptable indoor air quality.

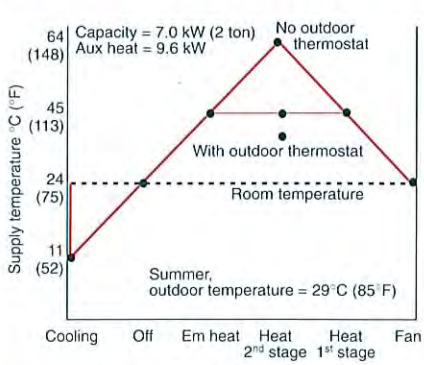
Return air filter locations should be readily accessible to the customer for ease of maintenance or replacement. The filter or grille area must be adequately sized to increase the filtration efficiency of the filter media and to control noise generation.
A maximum face velocity of 1.5 m/s (300 fpm) is recommended for a filter

grille assembly; for a return grille with a remotely located filter, this value becomes 2.0 to 2.5 m/s (400 to 500 fpm). Local code requirements are used to verify proper filter size or grille areas. For high-density filter applications, the return duct must be reasonably airtight to control duct leakage caused by a greater pressure drop across the filter.

Guidelines for proper duct system performance are:

- proper sizing to control noise generation;
- proper airflow volume;
- proper support in accordance with codes pertaining to the duct materials;
- proper duct insulation with minimum compression of blanket type insulation materials applied to the exterior of the ducts;
  all joints and connections sealed;
- a temperature differential between conditioned spaces within 1 to 2°C (2 to 3°F) of the thermostat set-point temperature.

Proper performance of the supply outlet is a key consideration in evaluating the air distribution system. The throw, spread, and drop characteristics of the outlet are very important for proper distribution and air mixing within the occupied space. In climates where the cooling function predominates, a high location (ceiling or top of wall) is preferred. For a location where the heating function is predominant, a low location (perimeter or floor) is recommended. Proper air mixing for comfort is indicated by a temperature



▲ *Figure 3: Temperature change relationships for electrical cycle check.*

difference of not more than 3°C (5°F) from the floor level to the top of the typical occupied zone 1.8 meters (six feet) above the floor.

Area 6: SYSTEM APPLICATION / INSTALLATION

While the guidelines evaluated in this section may have little impact on electrical, refrigerant, or air distribution system performance, they are important to ensure reliable and energy efficient operation. Five equipment components are evaluated for proper performance.

Indoor equipment is evaluated for service accessibility and clearance to remove key components for service and for proper support. Proper equipment mounting is necessary to control noise and to ensure proper condensate removal when in the cooling mode. A visual check ensures that component failure due to vibration or contact between components is reduced.

Outdoor equipment is evaluated as discussed above for the indoor equipment. Space must be provided for proper service and for removal of key components. Proper clearance is essential for proper airflow circulation across the outdoor coil. Equipment is supported as required by manufacturer installation instructions.

Route refrigerant lines by the most direct and practical path. Refrigerant lines should be replaced when replacing equipment as the existing lines may be contaminated. The manufacturer's recommendations for refrigerant lines, such as size, length, lift are to be followed. Incorrect sizing could result in reliability or performance related problems. Suction lines should have a natural slope for oil return to the compressor. Sharp changes in refrigerant flow direction lengthen the total effective length of the line set. Care must be taken to protect exposed lines against physical damage and to ensure that they cannot cause personal injury.

Condensate piping must be installed according to code. Care is required to ensure that a single trap is installed in the condensate line from the indoor coil to an approved discharge location. Where equipment is installed above finished areas, an auxiliary drain pan with a separate secondary drain line is installed as required by code. The secondary drain line should terminate at a different location from the primary drain location so that the customer can recognize when a problem exists with the primary drain. A condensate pump is required when provision is not made for the condensate line to terminate into a floor drain or other appropriate below grade location.

The thermostat and controls must be compatible with the equipment electrical system. The thermostat must be located away from cold walls and heat producing sources. Where necessary for proper performance of electronic controls, 0.8226 mm^2 (18 kcmil) low voltage conductors are recommended and often necessary for reliable electrical system performance.

Concluding remarks

The benefit of applying the above guidelines to evaluate installed heat pump installations for proper performance is a satisfied customer. If properly installed and monitored, the equipment should provide years of service at low costs of ownership and operation – not to mention increased comfort.

Although the discussion here focused on air-to-air heat pump systems, a similar approach may be applied for closed-loop ground-coupled heat pump installations.

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Swiss participation in International standards committees

Dr Thomas Afjei, Switzerland

The Swiss Federal Office of Energy (SFOE) and the Swiss Association for the Promotion of Heat Pumps (FWS) strive to promote renewable energy sources such as heat pumps. Therefore they support manufacturers, equipment suppliers and researchers to take part in international standards committees. This article sums up the working groups these Swiss parties play an active role in.

SwissEnergy and standards

This year, international co-operation in standards committees comes under the "indirect promotion" section of the new "SwissEnergy" policy programme. It is the declared objective of the Swiss Federal Office for Energy and, on its behalf, the FWS to encourage the more intensive use of ambient heat as renewable energy source through the promotion of heat pumps. Also market parties participate in public efforts to bring the market share and quality of heat pumps to a higher level.
Manufacturers, branch federations and federal agencies can, by actively participating in standards committees, make their needs more widely known and obtain access to new knowledge, thereby strengthening the position of the Swiss heat pump and refrigeration industry.
The INB/TK 181 technical committee of the Swiss Standards Association (SNV), which is responsible for heat pump and refrigeration technology, participates actively in four European Standards Association (CEN) working groups and in a mutual IEC/ISO working group. A complete list follows in which these activities and the various groups are briefly introduced.

International working groups

CEN TC182 WG5
This working group's goal lies in establishing the scientific fundamentals underlying refrigeration plants, in order to determine the maximum allowable content of flammable refrigerant (type L3). This necessitates carrying out risk analyses (i.e. risk assessments using flammable working fluids). The results of these analyses are to be incorporated in the European Standard EN378.

Joint IEC/ISO working group

Two international groups work together on the preparation of the IEC 60335-2-40 standard: the joint working group of the International Electrotechnical Committee (IEC) and the International Organization for Standardization (ISO). This new standard is also relevant to the pending revision of EN378.

CEN TC113 WG7
Working group on the establishment of suitable test conditions for capacity controlled heat pumps under full load and partial load. A practicable and reliable test method is essential to the test stations and for introduction of the "Heat Pump Quality Label" in Europe. The Swiss test station is located at the Heat Pump Test Centre in Töss, near Winterthur.

CEN TC113 WG8
Working group on the revision of the requirements for stationary tests according to EN255. Here, the existing EN255, EN814 and EN12055 standards will be brought together under a new EN standard.

CEN TC113 WG9
For several years now, the acoustics and noise control department of the Swiss Federal Laboratories for Materials Testing and Research (EMPA), under contract to the Federal Office of Energy, has been engaged at the Swiss test station in Töss in measurements of the acoustic power emitted by heat pumps. In test stations of this type, it is usually not possible to use conventional measurement methods for acoustic power due to the demanding conditions under which such tests must be carried out (for example internal reflection, noise interference, airflow and temperature). The EMPA has successfully demonstrated that acoustic power can be determined via the intensity measurement method.
The work at EMPA contributes substantially to our knowledge on noise abatement, see article on page 20 of this Newsletter.

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Noise reduction in heat pumps

Markus Studer, Kurt Eggenschwiler, Switzerland

If not designed and installed properly in a suitable location, heat pumps can produce noise at nuisance levels for adjacent residents. Various (national and international) systems and guidelines used for measuring, predicting and regulating noise levels produced by heat pumps are discussed. Some measures are presented that can be effective in preventing noise nuisance from heat pumps. Of course, working with a heat pump that, according to a test report, produces little noise to begin with is a good starting point.

Two kinds of noise

Heat pumps produce noise as well as heat and cold. The noise, if not dealt with properly, can become a major problem. The main sources of noise are compressors, fans and circulation pumps. Heat pumps installed in the open generally produce *airborne noise;* for heat pumps inside buildings, *mechanical vibration* must also be considered.

The transmission of mechanical vibration is very difficult to quantify. This has two reasons. First, no obligatory standards exist on this subject. Second, calculations are extremely difficult since it is necessary to consider the complex situation of the entire building. Airborne sound transmission, however, can be determined relatively easily.

Test Centre in Töss measures noise levels

The airborne noise production of machines and devices is described using the sound power measured in Watts and the sound power level measured in decibels. A series of general international basic standards is available that describe the procedures for the determination of sound power levels. These are the standards laid down in the ISO 3740 series, which are based on effective sound pressure measurements, and the ISO 9614 standard, which is based on intensity measurements. A standard that is presently only available in draft form applies especially to heat pumps. This is the CEN prEN 255-7:1992 standard: *Heat pumps – ready-to-connect heat pumps with electrically driven compressors - part 7: Ready-to-connect heat pumps and heat pumps for the heating up of drinking and process water - measurement of airborne sound emissions - determination of sound power level.* This standard defines the operating conditions under which the sound power level measurement must be made (**Table 1**).



▲ *Figure 1: This situation can lead to noise problems: air-to-water heat pump mounted in the open near a bedroom window (photo: WPZ).*

▼ *Table 1: Operating conditions for the measurement of the sound power of heat pumps in accordance with CEN prEN 255-7:1992.*

Heat pump	Measurement point	
Outside air-to-water	A15	W50
Water-to-water	W10	W50
Brine-to-water	B0	W50

A = ambient air; B = brine; W = water

0, 10, 15, 50: temperature (°C)

In the heat pump test centre (WPZ) in Töss, the sound power level is measured as part of the normal test programme for heat pumps. The results are presented in the form of a logarithmic representation of sound power in decibels. These measurements are carried out by the EMPA, the Swiss Federal Laboratories for Materials Testing and Research, on behalf of WPZ. In addition to the sound power level measurements, the report also contains information on measurement accuracy and a representation of the sound power level in bands of thirds. **Figure 2** shows an example of a sound power measurement.

Calculating emissions

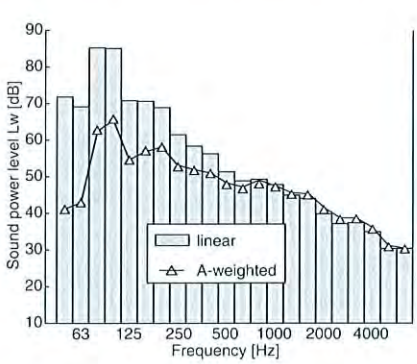
• ***In the open:***

Airborne sound emissions produced by a heat pump at a particular "receiver" location, e.g. in the open bedroom window of a neighbouring house, can be calculated i.e. predicted, from the sound power values determined in Töss. The predicted values can then be evaluated using the appropriate noise protection limits, as specified for example in the LSV, or Swiss noise protection regulations. To avoid unpleasant surprises – such as complaints from neighbours – it is recommended that acoustics specialists become involved in the planning at an early phase in order to make an estimate of the noise emissions to be expected. In Switzerland, for situations in which a neighbouring building is exposed to noise emissions from a planned heat pump installation, noise protection regulations apply independently of whether building approval is necessary for the heat pump or not. Chapter 3, article 7 of the LSV stipulates: 'The noise emission of a new stationary installation must, by order of the executive authorities, be limited to an

extent that: a) it is acceptable from a technical and operational point of view and economically viable; and b) the noise emissions caused by the installation alone do not exceed the planned values.'

• ***Inside buildings:***
With regard to noise production by heat pumps inside buildings, the LSV refers to Swiss SIA-Standard 181, which regulates sound insulation in building construction. As heat pumps are usually installed in separate rooms (e.g. in the basement), the transmission of the airborne sound is usually not a problem as long as the doors and windows of bedrooms, living rooms etc. are kept closed. We refer to specialist literature for cases where heat pumps produce a high level of airborne sound emissions or for unusual sound source locations. In such cases it is worth obtaining the opinion of specialists. As it is usually very difficult to calculate or predict the mechanical vibration emissions of a heat pump, great attention should be paid during the installation phase to uncompromising insulation against mechanical vibration. A collection of important basic principles, illustrated by examples, is to be found in the guidelines of the German Association of Engineers (VDI) specialised literature and various publications (see literature list).

The application of SIA Standard 181 must also be examined. The standard is only applicable (except by special agreement) if the heat pump is installed outside a "usage unit". "Usage units" are rooms or groups of rooms that form an independent, legal or organisational unit with respect to their use. For a single-family house, the owner must contractually define his requirements regarding sound insulation. In terraced housing, the normal sound protection requirements of SIA-Norm 181 (minimum standards) apply to the emissions of the heat pump in the basement of the neighbouring house. Any extra requirements must be arranged by contract. The same applies to multi-family houses.



▲ *Figure 2: Thirds-band spectrum of the sound power level of an air-to-water heat pump.*

Low-noise strategy

It is always best if noise control is applied from the start, meaning a choice for a low-noise design heat pump as well as proper placing and installation. Sound-absorbing measures taken to remedy an existing situation are much more expensive and often no longer technically feasible. Of course, a low level of noise production – as quoted in a heat pump's test report – is also without doubt a good marketing and sales argument. There are also many more possibilities for employing quiet devices in noise-sensitive environments. If the basic principles of low-noise construction and installation are respected right from the start in planning the work to be done, a quieter device should not be significantly more expensive. It will almost always be cheaper if measures against noise radiation are taken using specialist know-how.

Proven rules exist with regard to noise control and the low-noise design of heat pumps, e.g. in the German VDI guidelines and various specialist publications. In the following, a short introduction is provided on how to approach the problem. The designer can obtain help not only from specialised books but also from manufacturers' documentation or directly from a qualified acoustics expert.

Air-to-water heat pump in the open:
Most noise problems occur with air-to-water heat pumps installed in the open. Measures taken after-the-fact to remedy the noise source itself can be very expensive, as the main source of noise is usually the fan. The best solution is to start by designing the fresh-air and exhaust air ducts to also work as mufflers. The heat exchanger and the fan are mounted in a sound-absorbing duct and the remaining parts are encapsulated. This optimum solution is, of course, not always necessary.

Two additional aspects have to be considered, especially for heat pumps mounted in the open:

- *location*: the heat pump must if possible be shielded and not be installed near living rooms or bedrooms. In the worst case, one may have to get around the problem by using an indoor-mounted heat pump with suitable fresh-air and exhaust (sound-absorbing) ducts. Noise protection walls round around the heat pump are – for airflow reasons – not the best solution.
- *the fan*: the model and the dimensioning of the fan are crucial as far as noise performance is concerned. Moreover, fans should never be mounted on light structures (such as thin steel sheeting), as these will radiate the mechanical vibration of the fans as airborne sound.

Air-to-water heat pump indoors:
The fresh-air and exhaust ducting of indoor-mounted air-to-water heat pumps are crucial with regard to the noise situation. Possible emission locations in the vicinity and in one's own house must be considered when choosing where the heat pump is to be installed. Often, low-frequency emissions in particular are a nuisance. When planning a project, sufficient space must be reserved in the ducting for any mufflers that may become necessary. In addition to the points mentioned below with regard to the mechanical vibration emissions of brine-to-water and water-to-water heat pumps, the de-coupling of mechanical

vibration in particular should also be considered. The air ducts should be mounted in such a way that they are isolated from any sources of mechanical vibration.

Brine-to-water and water-to-water heat pumps:
Brine-to-water and water-to-water heat pumps are usually installed indoors. Although attention sometimes has to be paid to the radiation of airborne sound as well, the emphasis with regard to sound-absorbing measures should be placed on mechanical vibration. Basically, all plant components are to be mounted, if possible, on a single plate that rests on professionally designed elastic supports. Insulation against airborne sound is guaranteed by the encapsulation of all components. Supply and venting of cooling air should take place via mufflers. Feed-through for piping must be soundproofed, and no mechanical vibration should be transferred to the capsule.

Checklist

- **Place of installation:** The building's foundation slab (floor in the basement) is considerably more suitable for the mounting of a heat pump than a floor higher up in the building. Close proximity to offices, living rooms and bedrooms is to be avoided.
- **Piping:** Piping is to be isolated from the heat pump using compensators and is to be de-coupled from the building using elastic pipe clips. Special attention is to be paid to refrigerant piping.
- **Splitting point:** For split installations, one should make sure that no refrigerant piping is required – or at least only over short distances.
- **Auxiliary equipment:** If necessary, auxiliary equipment such as heat exchangers, pumps, fans, control valves, electric controls etc must also be sound-insulated using suitable measures, unless they are elastically de-coupled from the building together with the heat pump.
- **Dimensioning:** In order to achieve optimum sound insulation at the lowest possible cost, all sound-absorbing measures must be correctly dimensioned and optimised.

Literature
Eggenschwiler, Kurt: *Noise from heat pumps* (in German)
Baschnagel, Karl: *On the low-noise construction of heat pump installations* (in German)
Available at: www.empa.ch/deutsch/fachber/abt177/laerm/laerm-pu.htm

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The European Heat Pump Association (EHPA) strategy

Roar Rose, Norway, Cathérine Ducruet, France

The European Heat Pump Association (EHPA) is the interface between the European Union (EU) and the national heat pump networks and markets. The EHPA strategy, finalised March 2001, aims to double the number of heat pump installations currently projected for 2010 (7.3 million) to 15 million. This would have a considerable effect on CO_2 emission reduction and energy savings: 40 million tons and 100 TWh respectively per year. To realise this goal, it is essential that heat pumps receive widespread acceptance as a complement to other renewable energy sources. The European Commission can do its part by promoting and supporting heat pump technologies through funding activities that provide information on the advantages of heat pumps and that help ensure the quality of the heat pumps.

EHPA
EUROPEAN HEAT PUMP ASSOCIATION

The EHPA was established in February 2000 with the goal of promoting awareness and proper deployment of heat pump technology in the market place for residential, commercial/institutional and industrial applications. EHPA activities will in the first place focus on the residential market, as this market has the potential of providing major energy savings. Some important activities are conducting strategic studies and co-ordinating activities with regard to labelling and supplier certification. An article on the establishment and aims of the EHPA was published in Heat Pump Centre Newsletter Volume 18/2, 2000.

This article reflects the insights gained and the strategies proposed by the EHPA strategy committee, presented in its strategy document in March 2001.

EU global warming policy

The European Commission is drawing up policies to be implemented within the EU with regard to environment protection and energy utilisation. These policies include:

- development of renewable sources;
- energy efficiency;
- air pollution abatement;
- sustainable development.

One of the aims that is common to all policies is combating climate change.

Heat pumps can play a decisive role in enabling the Commission to achieve or even exceed its policy targets with regard to the above. The quantities of renewable energy that are potentially recoverable by heat pumps are considerable. For example, if only 3% of French dwellings were equipped with heat pumps by 2010, it would be possible to realise more than double the target set by the White Paper on Renewable Energy for the entire EU in terms of thermal capacity installed.

National efforts and attitudes

In comparison to other renewable sources of energy, the present contribution of heat pumps to energy conservation and in particular the decrease of fossil fuel consumption is considerable in some countries. In Sweden and Austria for example, heat pumps account for 75 to 80% of the reduction in fossil fuel consumption and the other renewable sources (wind, solar, small hydro and biomass) for the rest, i.e. 20 to 25%. However, in spite of the efforts in various European countries to promote the use of heat pumps in residential dwellings, the total number of installations in the EU and in Europe as a whole is still quite modest. The extent to which heat pumps have so far been included in national energy and environment planning programmes varies considerably from country to country; see **Table 1**.

Towards a European heat pump policy

A European policy on heat pumps similar to the policies set up in the USA, Canada, Switzerland and elsewhere is essential for the following reasons:

- the technology is available and operational, and its commercial development is taking place in a variety of forms in the different countries of the EU;
- it is a cause for concern that several countries in the EU have launched uncoordinated, individual actions to develop and promote heat pumps;
- heat pumps are competitive when comparisons are made over the lifetime of the equipment but, in order for the market to develop, incentives and support measures are needed.

In view of the potential offered by heat pumps for realising Community policies on energy and environment, a heat pump promotion policy would make it possible to achieve EU targets more quickly.

Heat pumps can also increase the energy independence of the EU, help develop its industries, and stimulate employment and export possibilities, in particular in the field of renewable energy technologies.

Residential heat pumps in Europe

Based on the data available from EHPA members and the IEA Heat Pump Centre, it is estimated that there are some 3.7 million heat pumps currently installed in Europe. Based on the same sources, the number of residential heat pumps that will be installed in 2010 has been projected at 7.3 million units; see **Figure 1**. In the majority of countries included in this study, the heat pump market is expected to increase annually by 10% or more during the next decade. In a few countries, the increase is expected to be less.

Strategy

In an effort to contribute substantially to the increased use of renewable energies, to energy conservation and to CO_2 emission reduction in Europe, the EHPA intends to double the number of heat pumps expected to be installed by the year 2010 from roughly 7.3 million to 15 million. These 15 million units would increase the annual energy and CO_2 emission savings to 100 TWh and 40 million tons respectively. The EHPA is convinced that a common EU strategy and framework for national planning and action is essential to achieve this ambitious target and to overcome market barriers. The following strategic actions are therefore suggested.

The European Commission should:

- value heat pumps as a source of renewable energy and environmentally friendly technology;
- integrate heat pumps into European policies and member state policies;
- communicate with target groups and inform them about the potential of heat pumps;

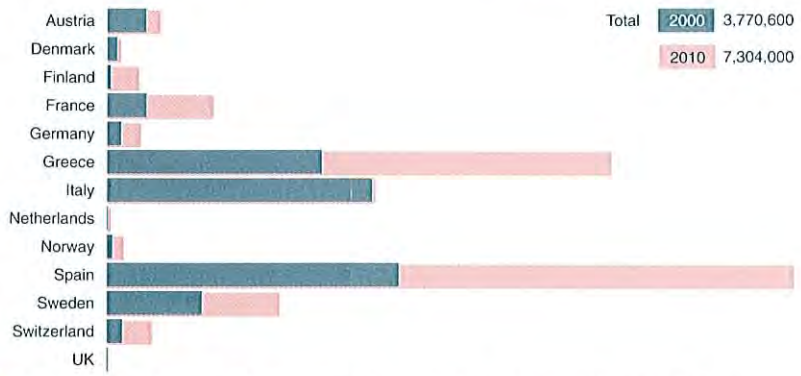
▼ *Table 1: National heat pump-related activities (P = in preparation, cross-hatched = partly)*

National heat pump status	Austria	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Spain	Switzerland	United Kingdom
A national programme on the heat pump exists:											
Lead by a public/governmental organisation											
Financially supported by a public/governmental organisation											
Lead by another actor											
Activities:											
R&D programmes											
Field tests											
Quality assurance activities:											
Requirements on products							P				
Label on products											
Requirements on heat pump heating system							P			P	
Certification of heat pump heating system							P				
Education and training of installers (specific to heat pump)							P				
Qualification of installers											
Certification of installers										P	
Education and training of other organisations											
Customers dissatisfaction treatment procedure											
Marketing activities:											
Information											
Communication											
Financial supports:											
Lower VAT											
Subsidies/incentives											
Benefit from energy or CO_2 tax											
Lower electricity tarif											

- formulate goals for the number of heat pumps installed in 2010;
- encourage heat pump deployment through a specific incentive policy.

The EHPA should:

- maintain and improve the gathering of relevant statistics and conduct market surveys with regard to heat pump developments in relation to the goals formulated by the European Commission;
- initiate a programme to increase awareness and knowledge of heat pump technologies:
  - formulate specific communication plans targeting priority groups, in particular the authorities;
  - inform potential customers by providing dedicated material;
- encourage education, training and certification of sellers, installers, etc., as well as heat pump system quality standardisation and labelling by:
  - promoting and disseminating best heat pump system practices;
  - promoting a common labelling scheme for heat pump products, installation compliance and installer qualification on an EU-wide basis;
  - maximising the energy and environmental benefits by ensuring at all levels that high-quality products and installations are promoted and realised.



▲ *Figure 1: Heat pumps in Europe installed in 2000 and projected in 2010.*

Conclusion

Once the strategy presented above is accepted by the European Commission, a detailed 3 to 5-year action plan for the EHPA activities will be drawn up, including a budget. Funding from the EC is essential to support the work and actions suggested in this action plan and to carry out this work in different EHPA technical committees.

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2001 ASHRAE Winter meeting

Jos Bouma, The Netherlands

The 2001 ASHRAE Winter meeting was held in Atlanta, Georgia, home of ASHRAE Headquarters. A wide range of heat pump-related topics, academic as well as specialist, were discussed at this winter's meeting, which focussed on ground-coupled heat pumps and water source heat pumps (see Newsletter's last issue). Experiments with new refrigerants were described and a heat pump system was highlighted that has been in operation since 1978.

(Ab)sorption heat pumps and refrigeration systems

Absorption heat pumps are attracting renewed attention due to the phase-out of CFC's and HCFC's. Three papers (USA and Israel) discussed detailed simulation of the processes within absorption systems, the characterisation of the overall cycle design, and thermophysical properties of the working fluids in the presence of process-enhancing additives. Specific topics covered included:

- absorption in a laminar falling film of ammonia-water;
- surface tension of aqueous lithium bromide with controlled vapour concentration of z-ethyl-hexanol; and
- effective-lift characterisation of GAX cycles.

Ground-coupled heat pumps

Pumping design and performance modelling of vertical bore and open loop systems were the main topics in the area of ground-coupled heat pump systems at this meeting. One paper analysed the energy use of different pumping options. Simulation of ground-coupled systems is an ever-growing area of research. A Canadian paper presented the results of a simulation exercise, while a US paper discussed field-validated results of a short time step model for vertical ground loop heat exchangers.

In another Canadian paper, a simplified tool was presented for assessing the feasibility of ground-source heat pump systems. The model consists of a simplified building load and ground-source heat pump system simulator. It has been developed to perform annual building energy use evaluation in order

to estimate heat pump system and ground loop size and performance. The model is based on recognised calculation methods and has been developed to minimise user-input requirements. It can serve to evaluate vertical closed loop, horizontal closed loop and groundwater systems for residential, commercial/institutional and industrial buildings. The algorithms are put into a spreadsheet program and incorporated into a free software package to evaluate renewable energy projects. A comparison of the modelling results with published data from design software packages showed that the ground loop calculation was in good agreement with the average value predicted by the design software (within 25%). This indicates that the simplified model meets the requirements for carrying out feasibility analyses. In other words it is not a design tool, but rather a screening tool to eliminate projects that are unlikely to be financially viable.

Micro-channel heat exchangers

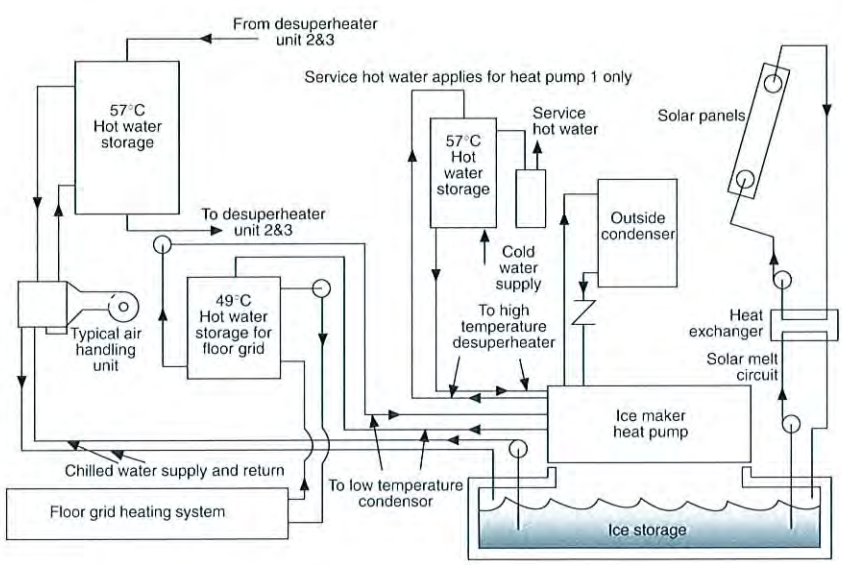
Since 1986, full aluminium microchannel or microtube heat exchangers have found wide acceptance in the automotive industry. While weight reduction was one of the main reasons for their implementation, these heat exchanger types have additional advantages compared to conventional mechanically expanded finned tube heat exchangers that are traditionally used in heat pump, air conditioning and refrigeration equipment. They are of particular interest for use in systems with carbon dioxide as refrigerant. Benefits include improved heat transfer characteristics, improved recycling and lower material costs. They are increasingly used today in condensing units, air conditioners, unitary rooftop units and in boilers. In several papers, the advantages and disadvantages of applying this technology to stationary HVAC systems were discussed.

A presentation by the University of Illinois gave an academic comparison, for practical use, of refrigerant charge, pressure drop and heat transfer effects of flat and round microtubes. Flat tubes are obtained by flattening round tubes. There are two types of flat tubes, those with segregated tube channels and those with interconnected tube channels. Several tube geometries (port shapes) are possible. It was concluded that flattened tubes provide significant charge reductions, reasonable pressure drop, heat transfer as good as in round tubes and that they offer a lot of promise for heat exchangers in heating and cooling equipment.

One presentation focussed on manufacturing heat exchangers with extruded aluminium tubes, as opposed to drawn tubes. Aspects such as joining aluminium to aluminium and copper, filler material for brazing, corrosion performance of aluminium alloys etc. were discussed. A COP improvement of up to 5% was claimed for a 30 kW cooling R-22 unit with extruded aluminium tubes relative to a unit with copper tubes. A drawback of this tube configuration is the relatively poor water shedding.

R-407C heat pump water heater

In the USA, at least 6% of all electricity is used for water heating, which is equivalent to 150 million MWh per year. Literature shows that heat pump water heaters, compared to electric water heaters, can save up to 67% of electric energy consumption. R-407C as a working fluid is a well-known replacement for R-22 in heat pump systems. It can be used in current R-22 systems with minor component modifications and with different oil. A US study investigated the possibility of R-407C replacing R-22 in the existing heat pump water heaters. The aim of the work was to perform baseline and system tests with a new counter-cross-flow evaporator in an R-22 heat pump water heater modified for R-407C operation. The baseline test results indicated that the R-407C heat pump had a much higher water heating capacity than the R-22 unit with the same designed capacity. However, the R-407C unit also consumed more power, which resulted in lower COP's at higher water temperatures. After fitting the unit with a counter-cross-flow evaporator, the COP increased by almost 20% and heating capacity by 4% compared to the baseline system. The improved system COP was slightly higher than that for R-22. The study demonstrated that R-407C can be used to replace R-22 and recommended



▲ *Figure 1: Icemaker heat pump diagram.*

that future R-407C heat pump water heater designs should have counter-cross-flow evaporators.

Record breaking solar-assisted heat pump

In 1978, a new and unique heating concept was selected for the Reedsburg Technical College in Wisconsin, USA. This was the icemaker heat pump system that provided not only winter space heating but also summer cooling capacity using ice-harvesting equipment. The system has now operated for 23 years with only minor repairs and has the lowest annual operating energy use of any facility that provides summer air conditioning in the Wisconsin Technical College system.

System description:

The icemaker heat pump provides all the space heating as well as the domestic hot water needed (see **Figure 1**). In addition, it provides all the summer cooling capacity, a substantial part of which is supplied by ice made and stored in the winter during the production of heating energy. Additional ice is produced in the summer when recharging the domestic hot water storage tank.

Hot water is extracted from a two-stage condenser. The de-superheat condensers supply the domestic hot water storage tank and the two high-temperature hot water heating storage tanks at 49°C.

The second-pass condenser on all three heat pumps stores energy at 40°C in the low-temperature storage tank. The ice from the evaporator plates is removed by a no-penalty defrost cycle and drops by gravity into the concrete storage bins. Circulating the water from the ice bin through unglazed, low-temperature solar collectors melts the ice. Ice is also melted in using the heat reclamation coils when cooling loads exist during the heating season. The original design includes a radiant floor heating system and the water supply temperature is adjusted between 21 and 29°C, depending on outside temperature. The system allows solar energy to be fully utilised for a building in the Wisconsin area without placing any demand on the electric utilities during the winter months. The SPF for the whole system has been conservatively determined to be 2.6 and to average as high as 3.2 for some years. It was claimed that this was the first commercial use of ice harvesting equipment to heat and cool buildings.

Jos Bouma, IEA Heat Pump Centre
Address see back cover

Inexpensive heat pump heating systems for low-energy houses: Technical Handbook - Fundamentals, Planning Procedures and Practical Examples
Final Report Phase 4
Swiss Federal Office of Energy, 2000. Th. Afjei, A. Bühring, M. Dürig, A. Huber, P. Keller, E. Shafai, P. Widmer, G. Zweifel.
Price CHF 40.- obtainable from ENET, Egnacherstrasse 69, CH-9320 Arbon, Switzerland
Fax: +41-71-4400255, E-mail: enet@temas.ch

The Handbook contains the results of an extensive research project on heat pump heating systems with hydronic heat distribution of the Swiss Federal Office of Energy. The project concerned systems for low-energy houses having an annual space heating requirement under 200 MJ/m²a (55 kWh/m²a). The Handbook contains the design fundamentals for heat pump heating of residential buildings conforming to the MINERGY standard, and also a section devoted to passively heated houses with very low annual heating needs.

Advances in refrigeration systems, food technologies and cold chain
Proceedings, 96 papers (91 English, 5 French)
Sofia, September 1998
Price USD 64 (+ Postage: 10% Europe, 20% for the rest of the world)
International Institute of Refrigeration (IIR),
117 Boulevard Malesherbes, 75017 Paris, France.
Fax: +33-1-4763-1798, E-mail: iifiir@iifiir.org

Main topics: CFC alternatives, refrigeration systems and heat pumps; natural working substances, efficiency and optimisation; heat transfer during food refrigeration; new and improved methods for processing and storage; food shelf-life, safety and quality; cold chain: analysis equipment and control.

Regenerative thermal machines (Stirling and Vuilleumier cycles machines) for heating and cooling
Author: Noburu Kagawa
Price USD 50 (+ Postage: 10% Europe, 20% for the rest of the world)
International Institute of Refrigeration (IIR),
117 Boulevard Malesherbes, 75017 Paris, France.
Fax: +33-1-4763-1798, E-mail: iifiir@iifiir.org

Main topics: thermodynamic principles, research and development in various regions, vapour compression systems using Stirling cycles, heat pumps and chillers using Stirling cycles, Vuilleumier machines, thermo-acoustic machines and pulse-tube refrigerators, perspectives.

Publications of the Air-Conditioning and Refrigeration Institute (ARI):

Directory of Certified Direct Geo-exchange Heat Pumps
Information: http://www.ari.org

This directory lists certified ground-coupled heat pumps verified under ARI 870 (updated periodically). Available electronically as a free download from ARI's website.

ARI Standards & Guidelines (on CD-ROM)
Price USD 85 (plus USD 3 shipping costs per publication)
ARI, 4301 N. Fairfax Drive, Suite 425. Arlington, VA 22203, USA
Fax: +1-703-528-3816

A complete set of ARI Standards & Guidelines (in electronic or hard-copy format) can be purchased.

Available from the HPC

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NEW: **Retrofit heat pumps in buildings**
HPC Survey report, July 2001
Order no. HPC-AR9, NLG 80. Only available in AT, JP, NL, NO, UK, US (from 1 July 2003 available without restriction).

Considerations in the design and selection of Domestic heating and cooling distribution and ventilation systems and their use with residential heat pumps
HPC Survey report, December 2000
Order no. HPC-AR8, NLG 80. Only available in AT, JP, NL, NO, UK, US (from 1 June 2003 available without restriction).

Selected issues on CO_2 as working fluid in compression systems
Workshop proceedings, January 2001
Order no. HPP-AN27-1, NLG 180 or NLG 60 in JP, NO, SE, UK and US.

Ab-sorption machines for heating and cooling in future energy systems
Annex 24 final report, November 2000
Order no. HPP-AN24-4, NLG 100. Only available in CA, IT, JP, NL, NO, SE, UK and US (from 1 December 2002 available without restriction).

Ab-sorption machines for heating and cooling in future energy systems – San Francisco and Turin workshops
Workshop reports, March 2001
Order no. HPP-AN24-3, NLG 180 or NLG 60 in CA, IT, JP, NL, NO, SE, UK and US.

Guidelines for Design and Operation of Compression Heat Pump, Air-Conditioning and Refrigerating Systems with Natural Working Fluids
Final Report, December 1998
Order No. HPP-AN22-4, NLG 300 or NLG 100 in CA, CH, DK, JP, NL, NO, UK and US.

For further publications and events, visit the HPC Internet site at http://www.heatpumpcentre.org

2001

CIAR 2001 (Congreso Iberoamericano de Aire Acondicionado y Refrigeración)
15-17 August 2001 / Buenos Aires, Argentina
Co-sponsored by IIR commissions B1, B2, E1, E2
Contact: Comite organizador
Fax: +54-1-4362-2517
E-mail: rhmasche@volta.ing.unlp.edu.ar

Refrigerant management and destruction technologies of CFC
Joint conference of IIR commissions B2, B1, E1 and E2; HPC co-sponsored workshop on refrigerant management programmes
29-31 August 2001 / Dubrovnik, Croatia
Contact: Zdenka Kuhta
Center of Technology Transfer
Fax: +385 1 611 8710
E-mail: r-conference@fsb.hr
Information: http://www.fsb.hr/r-conference

2nd International Heat Powered Cycles Conference – Cooling, Heating and Power Generation Systems
5-7 September 2001 / Paris, France
Contact: Dr Pierre Neveu, CNAM, Paris
E-mail: neveupi@cnam.fr
Information: http://www2.cham.fr/iffi/hpc.htm

Clima 2000
15-18 September 2001 / Naples, Italy
Co-sponsored by IIR commission E1
Contact: M. Costatino, Clima 2000 S.r.l.
Via Fogazzoro, 36-20135 Milano, Italy
Tel.: +39-2-55193446, Fax: +39-2-55416526
E-mail: clima@clima2000.it

4th International Conference on Compressors and Coolants - Compressors 2001
26-28 September 2001 / Smolenice, Slovakia
Co-sponsored by IIR commissions B1, B2, E1 and E2
Contact: Ing Peter Tomlein
Secretary of the Slovak Association for Refrigeration and Air Conditioning Technology
90041 Rovinka, Slovakia
Fax: +421-7-45980420
E-mail: zvazchkt@isternet.sk

Thermophysical Properties and Transfer Processes of New Refrigerants
3-5 October 2001 / Paderborn, Germany
Co-sponsored by IIR, Commission B1
Contact: Dr Ing Andrea Luke
Universität Paderborn, Warburger Straße 100
D-33098 Paderborn, Germany
Tel.: +49-5251-60-2392, Fax: +49-5251-60-3522
E-mail: luke@wkt.uni-paderbron.de

Symposium on the Analysis and Applications of Heat Pump and Refrigeration Systems
(2 Sessions of) ASME Congress
11-16 November 2001 / New York, USA
Contact: B.G. Shiva Prasad
Fax: +1-607-937-2390
E-mail: b_g_shiva_prasad@dresser-rand.com

2002

ASHRAE Winter meeting, Absorption/sorption heat pumps and refrigeration systems
12-16 January 2002 / Atlantic City, USA
Contact: Jesse Killion
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2025 H.M. Black Engineering Building
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Tel.: +1-515-2940856, Fax: +1-515-2943261
E-mail: jkillion@sjtu.edu.ch

IEA Heat Pump Programme events

Hands-on experiences with heat pumps in buildings
10-11 October 2001 / Arnhem, the Netherlands
HPC/IPUHPC (International Power Utility Heat Pump Committee) joint workshop
Contact: Ms Minie Wilpshaar, HPC
Novem, the Netherlands
Fax: +31 46 4510 389
E-mail: hpc@heatpumpcentre.org

7th IEA Heat Pump Conference
19-22 May 2002 / Beijing, China
Host: China Academy of Building Research
Contact: Ms Francien Somers, TSSU
Novem, the Netherlands
Fax: +31 46 4510 389
E-mail: hpp@novem.nl

Next Issue

Mitigating ozone depletion and global warming

Volume 19 - No. 3/2001

International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among its participating countries, to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development.

IEA Heat Pump Programme

International collaboration for energy efficient heating, refrigeration and air-conditioning

Vision

The Programme is the foremost world-wide source of independent information & expertise on heat pump, refrigeration and air-conditioning systems for buildings, commerce and industry. Its international collaborative activities to improve energy efficiency and minimise adverse environmental impact are highly valued by stakeholders.

Mission

The Programme serves the needs of policy makers, national and international energy & environmental agencies, utilities, manufacturers, designers & researchers. It also works through national agencies to influence installers and end-users.

The Programme develops and disseminates factual, balanced information to achieve environmental and energy efficiency benefit through deployment of appropriate high quality heat pump, refrigeration & air-conditioning technologies.

IEA Heat Pump Centre

A central role within the programme is played by the IEA Heat Pump Centre (HPC). The HPC contributes to the general aim of the IEA Heat Pump Programme, through information exchange and promotion. In the member countries (see right), activities are coordinated by National Teams. For further information on HPC products and activities, or for general enquiries on heat pumps and the IEA Heat Pump Programme, contact your National Team or the address below.

The IEA Heat Pump Centre is operated by

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Netherlands agency for energy and the environment

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