



# EUROPEAN HEAT PUMP NEWS

## The Newsletter of the European Heat Pump Concerted Action

Issue 2, August 1999.

### EDITORIAL

This is the second Newsletter within the project: 'Concerted Actions for the Promotion of Heat Pumps in Europe', partially funded by the European Commission as a THERMIE B activity and co-ordinated by FIZ Karlsruhe, (Germany). Other participants in the project include SINTEF (Norway), NOVEM (The Netherlands), ADPM (France), Leistungsgemeinschaft Wärmepumpe (Austria) and David Reay & Associates, assisted by BR Technology, (UK).

As detailed in the 1<sup>st</sup> Issue, there are four main objectives of the Concerted Action:

- To implement the promotion of heat pumping technologies on a Europe-wide basis
- To improve the awareness concerning heat pumps of a number of specific groups who are crucial to increased heat pump market penetration
- To make recommendations for a European training programme, for example for installers
- To support the application of environmentally sound working fluids.

Planning of two Workshops, which will take place in conjunction with INTERCLIMA in Paris in November 1999, is now at an advanced stage. The venues for the two workshops, and of course INTERCLIMA, will be the Congress Halls close to CdG airport.

The Workshop on Heat Pump Training Programmes will take place on 8 November and is being organised by ADPM, the French group representing heat pump manufacturers and users. The content of the presentations, based upon training programmes which use high quality course material and present experiences or comprehensive studies of methodologies and heat pump installation results in various countries, will in particular be targeted at installers of equipment. It is intended that the content of future training packages, possibly on a Europe-wide basis, will be influenced by the discussion at this workshop.

As reported elsewhere in this issue of *European Heat Pump News*, SINTEF has been closely associated with projects on alternative heat pump working fluids. The second of the two workshops will be on the subject of natural working fluids, and will be based in part on the work carried out by SINTEF. This workshop, scheduled for the 9<sup>th</sup> of November, is being organised by the Dutch organisations, TNO and NOVEM. The focus will be on the application of hydrocarbons, ammonia and carbon

dioxide in buildings. It is intended to involve representatives setting standards for the use of such fluids, as well as potential users, equipment suppliers etc.

The fee for attending these workshops is being set to cover the administrative costs, room hire and lunch, etc., and is thus being kept to a minimum. Further information can be obtained either by contacting FIZ (see below) or one of the organisers, (see Forthcoming Events).

Axel Lehmann,  
FIZ, August 1999.

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### **INNOVATION IN HOME HEATING - An Update**

The use of ground source heat pumps in the home in the UK under an installation initiative taken by a major UK utility company, Scottish Hydro-Electric, was reported in the first issue of *European Heat Pump News*. New data have now become available for the second year of operation of a monitored unit in a test house and the next-door 'control' house.

In the period 21 April 1998 to 21 April 1999, the electricity consumption for space and water heating in the heat pump house was 4733 kWh, while in the control house it was 8621 kWh, a saving of 45% using the heat pump. Consumption for non-heating purposes was very similar between the two houses at around 2200 kWh.

Since first installing the unit in February 1997, 54 further Markus Energi units have been sold by the electricity company.

*Information supplied by Maurice Millar, (now with NIFES, Glasgow). Scottish Hydro-Electric's energy efficiency web address is:*

[www.hydro.co.uk/serve/energy/index.htm](http://www.hydro.co.uk/serve/energy/index.htm)

Markus Energi has a web site: [www.markusenergi.com](http://www.markusenergi.com)

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### **UK NETWORK ON HEAT PUMPS LAUNCHED**

A network for information exchange and collaboration on heat pumps was launched on 7 July 1999, at a seminar at South Bank University in London.

The keynote speaker, David Strong, the Managing Director of the Energy and Communications Division at the Building Research Establishment, highlighted the potential environmental benefits of today's heat pumps and stressed the need for potential users to have up-to-date, reliable performance information. Over 100 delegates; designers, suppliers, architects and potential users, then heard how the Network will generate and deliver this information along with independent guidance on heat pumps. A discussion followed on how best to provide the reassurance that customers need if they are to take up heat pumps in increasing numbers. The new Network will need to tackle issues such as certification schemes and can benefit from the experience already gained in other countries.

The network is a partnership between government and industry. Through support and funding from the Department of the Environment, Transport and the Regions (DETR), the Department of Trade and Industry (DTI), the Heat Pump Association (HPA) and the wider

industry, the Network will help the UK heat pump market to develop by encouraging appropriate application of heat pump technologies and the transfer of best practice. The Network will provide a focus for the work on heat pumps in the UK and encourage international collaboration.

All those active and interested in heat pumping technologies for industrial and buildings-related applications are being invited to participate in the Network and over 300 have already expressed interest in joining.

The Network is being managed by the Building Services Research and Information Association (BSRIA) on behalf of DTI, DETR and HPA and they will be running six-monthly workshops, producing a UK newsletter, and co-ordinating the collaborative project work.

The objectives and scope of the Network were listed and discussed fully in the previous issue of *European Heat Pump News*.

*For more information contact: Heat Pump Network Secretariat, BSRIA, Old Bracknell Lane West, Bracknell, Berks RG12 7AH, UK Tel: +44 (0)1344 426511 Fax: +44 (0)134 4487575*

*e-mail: Sandra.Gomez@bsria.co.uk (general co-ordinator), Rosemary.Rawlings@bsria.co.uk (technical co-ordinator)*

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### **Heat pumps get Exemption from Investment Taxes**

The Norwegian Finance Ministry has worked out a regulation for exemption from investment taxes for all renewable energy sources. The regulation was released in April 99, and was made valid from January 1999.

The regulation includes commercial and industrial heat pumps, wind power, bio fuel plants, district heating, and of course hydropower plants. The purpose of the regulation is to make it more economic beneficial to use renewable energy sources.

For heat pumps, the investment tax exemption includes the heat pump itself, as well as the heat source system, valves, heat exchangers, and other technical equipment connected to the heat pump. Both expenses for investment, operation and maintenance of the equipment are included in the regulation. Heat distribution systems in buildings are not covered by the regulation.

22.July 1999,  
Norwegian National Team  
Trude Tokle

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## Comparison of practical performance between CO<sub>2</sub> and R-22 reversible heat pumps for residential use

Recent research on the practical performance of CO<sub>2</sub> and R-22 in reversible heat pumps for residential use shows that the COP for systems using CO<sub>2</sub> as refrigerant is competitive with systems using R-22.

Using CO<sub>2</sub> as a refrigerant offers a series of benefits like low price, excellent availability, non-toxicity, non-flammability, compatibility with construction materials, and no need for recycling. But very often it is argued that systems using CO<sub>2</sub> are only 50-70% as efficient as HCFC and HFC systems. However, such assertions are based on theoretical calculations which, according to researchers Rune Aarli and Per-E. Frivik, fails to take account of the practical characteristics of the transcritical CO<sub>2</sub> process.

At SINTEF Energy Research AS the two researchers have carried out laboratory experiments comparing the practical performance of CO<sub>2</sub> and R-22 in reversible heat pumps for residential use. They found that the overall system efficiency of the CO<sub>2</sub> system, in terms of COP, was competitive to the conventional system using R-22.

Results from experiments in AC mode gave COP numbers between 0.5% and 14% lower than that of the R-22 reference unit, while the experiments carried out in heating mode resulted in COP numbers between 3% and 14% higher than the R-22 system.

The results were achieved with a less than optimal design for the heat exchangers used in the CO<sub>2</sub> system, also leading to water retention which caused fluctuating system pressures. The CO<sub>2</sub> compressor performed sub-optimally in some of the experiments, owing to worn out bearings and leakage through the stuffing box. Based on these facts the researchers conclude that there should be room for further improvements in the performance of the CO<sub>2</sub> system.

Rune Aarli is expecting to finish his Ph.D. "On the design, efficiency, and market potential of residential air condition and heat pump units with CO<sub>2</sub> as working fluid" later this autumn.

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## European Funded Consortium Project Reaches Half-way Stage

A European Consortium led by Weir Entropie (Paris) is developing a high efficiency, low cost LiBr absorption chiller of cooling capacity range 350kW to 2.5MW for the European commercial cooling market. Partners in the consortium are BG Technology (Loughborough, UK),

ZAE (Munich) and GasNatural (Barcelona). The 30 month project is supported under the EC JOULE programme and is due to complete in 2000. Project reference is JOE3-CT97-0059.

Weir Entropie is already a well established supplier of heat pumps, desalination and other thermodynamic plant for the process industries. There is a potentially large market for gas-fired and cogeneration driven absorption cooling applications throughout Europa. The establishment of a European product should help to stimulate a more competitive market for large absorption chillers which has traditionally been reliant on imports from the US or Far East. Gas utilities such as BG see the commercial cooling market as valuable for growing summer gas demand.

BG Technology is contributing to this project through the development of a new high efficiency first-stage generator. The main features of this generator are its compact size and high thermal efficiency. It has been designed with a very low solution volume to reduce the inventory of LiBr in the chiller. This will help to increase the thermal response of the chiller and should lead to more effective control. The combustion system is based on the Acotech flat flame metal fibre burner technology from Belgium. This burner offers a wide

turn down range and low emissions of NO<sub>x</sub>. The first prototype of this generator has been built and delivered to ZAE for testing. Careful and detailed thermal engineering by BG Technology has led to a design which should be cheap to manufacture and which should offer a long lifetime of operation.

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## CERTIFICATION OF HEAT PUMPING TECHNOLOGIES AND INSTALLERS -

*Prepared by Michel Guittard and Jacques Bernier*

### SUMMARY

Further to the "Marketing Survey on Heat Pumping in Europe" in the frame of the JOULE 2 R&D. Programme, it appeared necessary to many Heat Pump

Concerted Action Group (H.P.C.A.G.) members to propose a Certification procedure that would guarantee not only performances of products but also the competence of specialists which install them. So, the overall quality of the HP System will be achieved.

Heat pumps are a different way to perform the same functions obtained by conventional systems. But Heat Pumps give more energy efficiency with more environment protection; it represents an innovation not only for end users but also for designers and installers. The approach to H.P.s is different for each country due to different techniques, regulations, applications and experiences. People involved in the HP "quality assurance chain" must be aware of these problems and it is necessary to take great care over them by information and training to assure the end users of both quality and safety.

A consortium was established around ADPM and EUROVENT Certification in order to present this project in the frame of SAVE 2. It is in accordance with the Heat Pump Concerted Action Group, a position requesting continuity from the research to the satisfaction of end user requirements: comfort and economy. It will be a pilot programme with the participation of the principal European manufacturers associations. It gives a large realistic industrial

dimension to the project and guarantees the quality of results by its past experience in certification.

The consortium is constituted by:

- UCF represents the companies responsible for the design, installation, maintenance and repair of equipment for applications. It ensures the continuation of quality, adhere to the obligations relating to the environment and give absolute priority to the education and training of technicians as well as to the distribution of information to companies that are end users.
- TWK is engaged in specific training courses on testing and certification of materials for manufacturers and installers.
- SINTEF foundation for scientific and industrial research at the Norwegian Institute of Technology

for refrigeration and Air Conditioning SINTEF has experience in technology dissemination of H.P.

ADEME (Agence de l'Environnement et de la Maitrise de l'Energie) and EDF (Electricite de France) also contribute and support this operation.

All other European members of H.P. networks will be involved in dissemination of the certification procedure and training courses when they are established.

This certification in heating and cooling systems for building is a labelling action in the area of energy saving

equipment with dissemination of information, reinforced existing actions in national use energy in buildings. Furthermore, a concept of Performance Warranty applied to heat pumping system installation can ensure a good working order of the installation.

Finally, this operation helps the promotion and the use of H.P. which, in this application field, are contributing up to 50% of energy saving in comparison with other type of installation H.P.s working with new fluids contribute also to environment protection.

### TECHNICAL RULES

In France, the HP Commission has enacted technical rules for calculation, minimal performances and implementation of various types of installations. Four such technical guide books of 60 to 80 pages are published [an English version will be available soon].

These booklets aim to remind us of, and to specify as practical advice, useful instructions during the various phases of installation, from the design stage to the servicing and maintenance of the following systems;

- heat pump outside air/water associated with a heating or cooling floor
- heat pump glycol-water/water associated with a heating floor or a heating/cooling floor. Glycol-water/water system refers only to underground sensors for direct evaporation of cooling fluid.
- heat pumps floor/floor associated with a heated floor

### GUIDELINES, DTU, STANDARDS AND REGULATIONS

These documents are the results of the work of the AFF heat pumps commission which groups together various specialists of the thermodynamic heating techniques [installers, a/c and cooling technicians, manufacturers, design and research departments, EDF, etc.].

Ademe (1), ADPM (2), AFF (3), APAVE-IFE Formation, Avenir Energie, Climasol, Clime1, le Costic,

CTA, Deleage, EDF, Erset-France, Geothermie, Multibeton, Promotelec, SIMT, Snefcca, Sofath, Solterm, Systherm-30, UCF (4), Uniclina, have taken part in the creation of these guide books within the HP Commission. These books relate mainly to the systems of heating/cooling by heat pumps with a duty of less than 50 kW, intended for the new residential buildings.

Other guide books are being drafted, particularly for the outside air/water heat pumps associated with fan-heaters, and for outside air/air heat pumps.

These documents do not, of course, replace the standards, DTU and other regulations currently in effect in France and in Europe at the date of their publishing, for all or part of the system under description. However, they come as a supplement to the existing regulations and will be updated whenever new statutory texts are published.

Every guide book is written to the same pattern to facilitate easy comprehension.

For clarity, we shall summarise the content of one of these guide books dealing with outside air/water heat pumps associated with a heating floor or a heating/cooling floor.

After a reminder of the standards of implementation and an update on Eurovent certification, the basic testing features are defined. The sizing of the heat pump and of the extra heater are calculated according to the loss in winter "Deper" and in accordance with the Th-G rules, to ensure a 19oC heat at the basic outside temperature Tb.

In heating mode, the thresholds of minimum performance coefficient [PC] of the machine should, at the least, be equal to:

- PC >3.3 at test point T dry air = 7°C, T humid = 6°C, T condenser exit = 35°C
- PC >2 at test point T dry air = -7°C, T humid = -8°C, T condenser exit + 35°C, or as a substitute for this point:
- PC . 1.5 at test point T dry air = -7°C, T humid + -8°C, T condenser exit + 50°C

It is essential to select a machine which has a de-icing system capable to run at outside air temperatures of at least -10°C. In cooling mode, the refrigerating efficiency should be at least equal to 2.3 for an outside air temperature of 35°C, and an ice water/evaporator rate of 12°C/7°C.

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### ***Twin Bed Adsorption Heat Pump at Warwick University***

Warwick University have recently been awarded funding from the UK Government DETR to further develop its Convective Thermal Wave Air Conditioner/Heat Pump.

Under the direction of Dr Bob Critoph, Warwick University have successfully built a prototype chiller

based on the adsorption of ammonia on a pair of active carbon beds. The system is an adsorption cycle which operates by successively adsorbing ammonia vapour in a cold carbon bed and desorbing ammonia from a warm carbon bed. The pressure swings achieved create the compression necessary to drive the ammonia refrigeration cycle. Under an early programme sponsored in part by BG, a cooling COP of 0.95 was predicted under ARI work a 10kW laboratory prototype chiller was built to validate the performance of the carbon beds. The project is now moving forward to the next stage to build a pre-commercial prototype with financial and technical support from BG Technology, Thermomax (a supplier of Solar Heating equipment), and local heat exchanger fabricators (Britannia Heat Transfer and Hymatic Engineering Ltd). This prototype will demonstrate the cooling and heating COP's in an integrated system that could be packaged commercially. If successful, the product would be targeted for use in small to medium commercial buildings.

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### **Heat Pump Replication at a Major UK Chemicals Site - British Chrome & Chemicals**

British Chrome & Chemicals (BC&C), a member of the Harcros Chemical Group, has been producing chromium compounds and other chemicals at its Cleveland site since 1928. One product, sodium sulphate, is an ingredient in washing powders for automatic washing machines. The production of pure sodium sulphate requires a concentration process, and in 1987 the first

1.1 MW MVR plant was installed to enable evaporation to be carried out efficiently. Operating for 7750 h/year, the cost of the unit (£500,000) was about 30% of that of a multiple-effect thermal vapour recompression evaporator system, with its additional boiler capacity requirements.

Currently (1999), the unit has benefited from modifications to the Borsig compressor in 1995, which led to a 10% reduction in the cost of the steam produced by the unit at 1.75 bar. The current cost of steam using

the MVR unit is of the order of £8.00/t, based on an electricity price of 4 p/kWh. In the early years of



operation, savings were about £200,000 per annum.

*The First MVR Unit at BC&C*

The experience over recent years with the unit has convinced the Company that a planned capacity increase brought about by construction of a new product line will also incorporate this type of MVR unit. An interesting aspect of this installation is that early problems were solve by the plant engineers, and then incorporated in the compressor by Borsig, the OEM.

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## Large-scale Heat Pumps for Swedish Municipal Incineration Plant

A new thermal power plant is being built 15 km north of Umea in northern Sweden. It is to run on municipal waste and biomass (175,000 tons per annum). The incineration plant is equipped with the latest technology in fuel engineering and flue gas cleaning and has an optimised heat utilisation ratio. It will have a heat production of 350 GWh/a. 20% of this will be provided by two heat pumps, thereby increasing the plant's efficiency substantially.

Von Roll Ltd., Zurich will supply the incineration plant to Umea Energi AB. Commissioning is scheduled for the end of 1999. Consortium partner Götaverken, based in Göteborg, is producing the flue gas cleaning system, the condensing steam turbine which will generate 15 MW of electric current, and the heat recovery system which condenses the flue gas using a heat pump.

The first stage of flue gas cleaning employs a bag filter, followed by an acid scrubber and a SO<sub>2</sub> scrubber. The flue gas is then condensed with the moisture content being reduced from 12 to 4.3 vol.-%. It is also necessary to treat water, pulverised fuel ash and the slurry produced during flue gas cleaning.

The heat utilisation ratio has been increased from 88 to 107% by the recovery of heat from the flue gases.

Conventional thermal power plants do not usually take condensing heat into account in the calorific value of a fuel and consequently this potentially recoverable energy is lost to the environment. This is to change in this plant. The plant will be equipped with the latest technology in fuel management and flue gas cleaning and will have an optimised heat utilisation ratio. The technical specifications are as follows:

incineration capacity	61 MWth
boiler capacity	55 MWth
turbine generator	+15 MWel
turbine condenser	+40 MWth
heat pump heating capacity	+13.8MWth
heat pump+utilities	-3.4MWel
plant efficiency	65.4/61 = 107%.

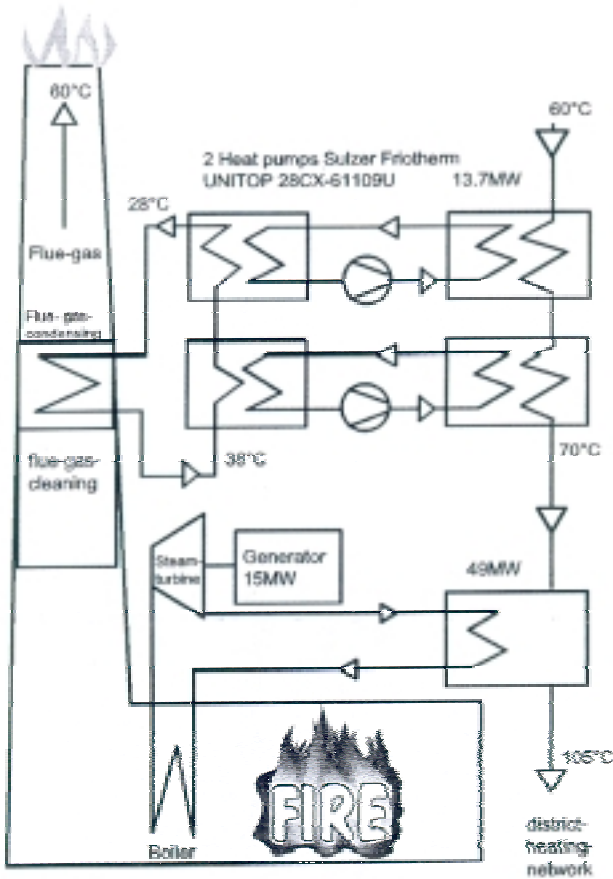
Following negotiations with Götaverken, a contract was signed in summer 1998 for the supply of two "UNITOP" heat pumps (type 28C-61109U). The technical specifications are as follows:

heating capacity:	approx. 13, 700 kW
heat source temperature in/out	38/28 °C
heat sink temperature return/supply	60/70 °C
power at terminal	3, 360 kW
COP	13, 700/ 3, 360 = 4.08.

The two heat pumps are connected in series on both the heat source and heat sink sides, considerably improving the coefficient of performance. Furthermore, there are operating conditions with lower district heating temperatures where a COP of up to 5.0 can be achieved.

As far as the manufacturer of the heat pumps is aware, this is the first heat recovery system of its kind in the world. Sweden's Sulzer Friootherm is currently working on further, related projects. This example might also be accepted in Germany where there has been until now a lack of opportunities and technical capacity to increase the efficiency of modern power stations by using large-scale heat pumps.

*Sulzer Friootherm AG, Winterthur (Switzerland)  
Sulzer-Escher Wyss GmbH, Lindau (Germany)*



**Municipal Incineration Plant UMEA Sweden**

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**BRING YOUR HEAT PUMP PROJECT TO THE ATTENTION OF THE EU - AND WIDER! SEND COPY BY POST, FAX OR EMAIL TO THE EDITOR FOR POSSIBLE PUBLICATION ON THE WEB VERSION OF 'European Heat Pump News'.**

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**Heat Pump Projects within FP4**

Access to the Cordis database operated by the European Commission allows you to view information on projects currently being funded in the 4<sup>th</sup> Framework Programme (and eventually the 5<sup>th</sup> Programme, once the results of the call for proposals are announced). Of course, a number

of these projects, both R&D and Demonstration, concern heat pumps.

One project, 'A new high efficiency reversible air-to-water heat pump working with propane for commercial applications in Southern Europe' is led by Asociacion

para la Investigacion y Diagnostico de la Energia, based in Madrid (contact Juan de Blas, Email: [gangel@diies.es](mailto:gangel@diies.es) ). The project number is JOE3970077.

Due for completion next year, the 'HEAHP' project is directed in part at developing equipment which will be a less obtrusive alternative to the very large number of single room window units which are currently being installed in homes, small offices and shops. This of course means a unit sized to serve several rooms or apartments. Additionally, by using propane, there will be an opportunity to introduce to the region a working fluid well-recognised in central and northern Europe.

Only European manufacturers of components are involved, and the project should result in tests on a prototype heat pump unit.

A second project, reference JOE3980091, managed by Prof. Mostofizadeh of TTZ-IEV Bremerhaven in Germany, is directed at using combined absorption/compression cycles for heating and air conditioning of buildings. Directed at the larger end of the size range - for hotels, shopping centres and hospitals, for example - the principal characteristic of the process is absorption at low pressure. For cooling purposes, triple point conditions are set, resulting in an ice suspension which can be used for air conditioning. In the case of heating, the pressure in the absorber is raised slightly and the absorption heat produced is used for heating.

An experimental scale plant (40 kW cooling, 50 kW heating) will be used for evaluation of the concept. A

COP of 6.5 in refrigerating mode (cooling water temperature 25°C) will be achieved, it is claimed. One of the other collaborators, Colibri bv in the Netherlands, will be bringing to the project its expertise in compact freezers, desorbers etc. and enhanced heat & mass transfer.

Further information on EU projects can be obtained by visiting the EU web site on: <http://dbs.cordis.lu/cordis-cgi/>

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**LITERATURE**

**IEA Final Report on Annex 22.**

Now available to those living in countries which participated in Annex 22 of the IEA Heat Pump

Implementing Agreement, the Final Report on this Annex: Guidelines for Design and Operation of Compression Heat Pump, Air Conditioning and Refrigerating Systems with Natural Working Fluids is now available, priced NLG 100. Order number is HPP-AN22-4.

**UNEP Ozone Secretariate 1998 Report of Refrigeration, Air Conditioning & Heat Pumps TOC.**

The 1998 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (TOC) was recently published. This 285 page document includes full data on uses of refrigeration, air conditioning and heat pump working fluids, allowing one to follow trends in phase-out of ODP substances. A chapter is devoted to heat pumps for heating only and heat recovery, and includes commentary on new working fluids, and alternative cycles, as well as consumption data for working fluids world-wide in 1998.

Library requests should quote ref: ISBN 92-807-1731-6.

**FORTHCOMING EVENTS**

**20<sup>th</sup> International Congress of Refrigeration of the IIR, 1999.**

To be held in September 1999 in Sydney, Australia. Theme: Refrigeration into the 21<sup>st</sup> Century, (but there are always many heat pump papers/posters). Contact:

Congress Secretariate, GPO Box 128, Sydney, NSW 2001, Australia. Fax: +61 2 2622323. Email: [tourhosts@tourhosts.com.au](mailto:tourhosts@tourhosts.com.au)

**6<sup>th</sup> National UK Conference on Heat Transfer, 1999.**

To be held at Heriot-Watt University, Edinburgh on 15-16 September 1999, organised by the IMechE. There are a number of industrial sessions, and several papers are relevant to heat pump technologists. There will be a parallel exhibition. Contact: IMechE Conference & Events Dept., on tel. +44 171 973 1291.

**Workshops on Heat Pump Training Programmes and Natural Working Fluids, INTERCLIMA, Paris, 8 & 9 November, 1999.**

(See Editorial). For information on the Training Workshop, contact Michel Guittard of ADPM on [flexisvc@club-internet.fr](mailto:flexisvc@club-internet.fr)

For information on the workshop on natural working fluids, contact NOVEM: [G.Breembroeck@novem.nl](mailto:G.Breembroeck@novem.nl)

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**PLEASE SUBMIT ALL ARTICLES/NEWS ITEMS FOR PUBLICATION IN THE NEXT ISSUE OF EUROPEAN HEAT PUMP NEWS BY 31 OCTOBER 1999.**