8th International Energy Agency

HEAT PUMP CONFERENCE 2005

FINAL PROGRAM

CAESARS PALACE

May 30
to June 2
2005

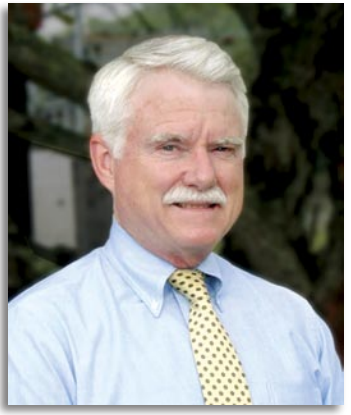
Las Vegas,
Nevada, USA

Global Advances in Heat Pump Technology, Applications, and Markets

IEA HP 2005

Table of Contents

Welcome



John Tomlinson
Oak Ridge National Laboratory

Dear Colleagues:

As Chairman of the U.S. National Organizing Committee for the 8th IEA International Heat Pump Conference, I am very pleased you could join us for this exciting and informative conference.

The National Organizing Committee has worked diligently to prepare a conference plan that includes a comprehensive technical program providing a global perspective of the current status of markets, applications, and technology development for heat pumping technologies. We are pleased to have the participation of a number of well-known experts in this field, together with a broad range of international papers on various aspects of the technologies.

In addition, an interesting program of technical tours and workshops has been planned to enable conference attendees to see, first-hand, examples of technology development, application, and marketing efforts. Workshops are being conducted by researchers working on specific topics of the IEA Heat Pumping Technology international collaboration effort.

Las Vegas is the fastest growing U.S. city and provides an excellent venue for the conference, with a climate conducive for effective heat pump usage, and as an exciting location with numerous entertainment and sight-seeing opportunities for attendees and their families. We hope you enjoy your stay in Las Vegas.

I look forward to personally meeting you during the next few days.

Acknowledgements

The success of this conference would not be possible without the financial support of our sponsors. The International Organizing Committee (IOC) and the National Organizing Committee (NOC) would like to thank the following for their generous contributions.

Country Sponsors

Austria	
Canada	Natural Resources Canada
Germany	Federal Ministry of Economy and Labour (BMWA)
Japan	New Energy and Industrial Technology Development Organization
	Heat Pump and Thermal Storage Technology Center of Japan
Norway	Enova SF (Norwegian Energy Agency)
Sweden	Swedish Energy Agency
Switzerland	Swiss Federal Office of Energy
USA	United States Department of Energy

Corporate Sponsors

ACCA Air-Conditioning Contractors of America

ARI Air Conditioning and Refrigeration Institute

Carrier Carrier Air Conditioning, Heating, and Refrigeration Systems

ClimateMaster ClimateMaster, Inc.

Acknowledgements

DOE U. S. Department of Energy

IVT IVT Industrier

Lennox Lennox International, Inc.

Organizational Sponsors

ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers

GHPC Geothermal Heat Pump Consortium

IIR International Institute of Refrigeration

IGSHPA International Ground Source Heat Pump Association

ORNL Oak Ridge National Laboratory

Featured Speakers

JAMES B. GIBSON
Mayor
Henderson, Nevada

Opening Plenary,
Tuesday, May 31, 09:00

James B. Gibson was elected Mayor of the City of Henderson in May 1997 and re-elected to his third term in 2005. As the second largest city in Nevada and one of the fastest growing cities in America, Henderson has experienced a staggering 335% growth rate over the past fifteen years. By 2010, Henderson's population is projected to exceed 306,000. He formerly served as General Counsel for the operating subsidiaries of American Pacific Corporation. Mayor Gibson has been a practicing attorney for 29 years. He is currently employed as the Chairman & CEO of Transit Systems Management, the management company for the Las Vegas Monorail.

Mayor Gibson is active in civic affairs and currently serves on the Southern Nevada Regional Planning Commission's Air Quality Committee. He is a member and current secretary-treasurer of the Las Vegas Convention and Visitors Authority Board of Directors, member of the Nevada Development Authority Board of Directors, member of Board of Directors of the Las Vegas Events, member of the City of Henderson Redevelopment Agency, and has served as Chairman of the Henderson Chamber of Commerce Legislative Committee for eleven legislative sessions, and as a member of the Regional Transportation Commission. In addition, he represents the City on the Federal Lands Sub-Committee and has been active on various committee assignments for the Clark County Bar Association.

Featured Speakers

ANTONIO PFLÜGER
Head
IEA Energy Technology Collaboration Division

Opening Plenary,
Tuesday, May 31, 09:00

Dr. Antonio Pflüger is Head of the Energy Technology Collaboration Division, Office of Energy Efficiency, Technology and R&D, at the International Energy Agency (IEA).

Antonio Pflüger, a German national, was Head of the Energy and Environment Division in Germany's Federal Ministry of Economics and Labour from 1999 until taking up his current post at the IEA in September 2003. He had been with the Ministry since 1990, holding various positions, including two years in the division for nuclear energy, three years as deputy head of division for aerospace affairs, and a seven-month secondment to work on energy efficiency at the IEA in 1992. He was also co-spokesperson for the Ministry in 1992-1993.

Prior to that, he managed RD&D projects for energy conservation and renewable energies in the German Federal Ministry for Research and Technology. He has written a number of publications and articles on issues such as sustainable energy supply, renewable energies and energy efficiency.

Dr. Pflüger holds a Doctorate in Physics from the University of Freiburg, Germany.

(continued on next page)

Featured Speakers

JEFF H. LITTLETON

Executive Vice-President & Secretary
American Society of Heating, Refrigerating, and Air-Conditioning Engineers

Opening Plenary, Tuesday, May 31, 09:00

Jeff H. Littleton has served as executive vice president of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) since March 2004. ASHRAE's 106 person staff, headed by Mr. Littleton, supports chapter and member services, publishing and communications programs, and technological and professional development. The Society has headquarters in Atlanta, Georgia, and maintains an office in Washington, D.C. As ASHRAE's chief staff officer, Mr. Littleton is a member of the ASHRAE Board of Directors, Executive Committee, the Board Planning Committee and the Standards Advisory Committee. He is also a member of the ASHRAE Foundation Board of Trustees and Executive Committee.

Mr. Littleton earned a bachelor of business administration degree from Baylor University in Waco, Texas, in 1983. He is a member of the Council of Engineering and Scientific Society Executives, the Georgia Society of Association Executives, and the American Society of Association Executives.

Featured Speakers

WILLIAM G. SUTTON
President
Air-Conditioning and Refrigeration Institute

Conference Banquet, Wednesday, June 1, 19:00

William G. (Woody) Sutton has served since December, 2001 as president of the Air-Conditioning and Refrigeration Institute (ARI) in Arlington, Virginia, the national trade association representing manufacturers of more than 90 percent of North American-produced central air conditioning and commercial refrigeration equipment. Established in 1953, ARI's certification symbol has appeared on more than 120 million pieces of equipment as ARI expanded to 22 product-specific certification programs covering a wide array of products that improve the quality of life for people around the world. Sutton has extensive expertise in leadership, change management, and government affairs, having completed a diverse and highly successful thirty-year career with the United States Navy, retiring at the rank of rear admiral. He holds a Master of Science Degree in Naval Architecture and Marine Engineering from the Massachusetts Institute of Technology and a Bachelor of Science Degree in Naval Engineering from the United States Naval Academy.

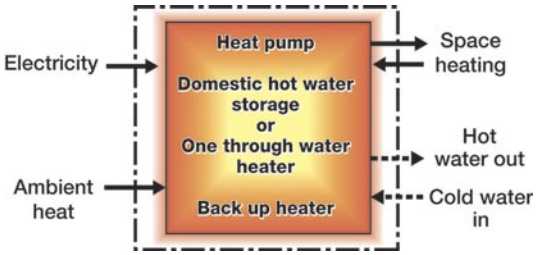
As director of programs in legislative affairs, Sutton's responsibilities included advocacy to the defense authorization committees in both Houses of Congress; and in an earlier role as Naval Aide to President Reagan, he coordinated the complex aspects of military support to the President, both domestically and internationally. Sutton serves on the Board of Directors of the American National Standards Institute (ANSI) which accredits ARI's certification programs. He is active in the US Chamber of Commerce Committee of 100, the National Association of Manufacturers Council of Manufacturing Associations, and the United Way National Capital Area.

Workshops

Workshop 1

IEA HPP Annex 28 — Test Procedures and Seasonal Performance Calculation Methods

08:30 – 12:30, May 30, Messina 3rd Floor



8:30 – 8:45 **Welcoming**
- Introduction to the IEA HPP Annex 28
- Background, Motivation
- Overview national projects

8:45 – 9:30 **Results for the calculation method**
- ***Europe***
  - Presentation of calculation approach for combined systems
  - Special requirements for compact units
- ***North America***
  - Experiences with ASHRAE standards in the U.S.

9:30 – 10:15 **Evaluation of the system performance by field test results**
- High temperature A/W-heat pumps in France
- Compacts units in Germany and Switzerland
- Ground-coupled systems in Austria

10:15 – 10:45 **Coffee break**

10:45 – 12:00 **Results for the test procedure**
- ***North America***
  - Extension of ASHRAE standard for testing B/W heat pumps
- ***Europe***
  - Presentation of testing procedure
    - Experiences with existing standards
    - Evaluation and proposed procedures
  - Testing of compact units
  - Special testing requirements for CO_2 heat pumps

Workshops

- *Japan*
  - Japanese testing and calculation for CO_2 heat pumps

12:00 – 12:30 **Discussion and Conclusion**
- Synthesis of the results
- Implications for the standardisation
- Implementation of the results
- Further research topics not covered in IEA HPP Annex 28

Workshop 2

IEA HPP Annex 29 — Ground Source Heat Pumps – Overcoming Market and Technical Barriers

13:30 – 17:30, May 30, Messina 3rd Floor

13:30 – 13:45 **Welcoming**
- Introduction to the IEA HPP Annex 29
- Background, Motivation
- Introduction to State of the Art, Market Analysis
- Overview country projects

State of the Art, Market Analysis (Task 1)
Reports from participating countries

13:45 – 14:15 ***Austria***

14:15 – 14:45 ***Canada***

14:45 – 15:15 ***Japan***

15:15 – 15:30 ***Norway***

15:30 – 16:00 **Coffee break**

16:00 – 16:15 ***Spain***

16:15 – 16:30 ***Sweden***

16:30 – 16:45 ***United States***

16:45 – 17:00 **Discussion**

17:00 – 17:15 **Concluding Remarks**

17:15 – 17:30 **Networking**

Conference Program

Monday, 30 May, 2005

08:30 – 12:30 **Workshop 1** – "Test Procedures and Seasonal Performance Calculations for Residential Heat Pumps with Combined Space and Domestic Water Heating (IEA HPP Annex 28)" – Messina – 3rd Floor

13:30 – 17:30 **Workshop 2** – "Ground Source Heat Pumps – Overcoming Market and Technical Barriers (IEA HPP Annex 29)" – Messina – 3rd Floor

13:30 – 17:30 **Registration** – 4th Floor Conference Desk

18:00 – 20:00 **Welcome Reception** - Emperors Ballroom

Welcome: Mr. John Tomlinson, Oak Ridge National Laboratory and Chairman, National Organizing Committee

Mr. Ted Fox, Director, Engineering Science and Technology Division, Oak Ridge National Laboratory

Tuesday, 31 May, 2005

08:00 – 09:00 **Registration** – 4th Floor Conference Desk

Note: All Technical Sessions in Emperors Ballroom – 4th Floor

09:00 – 12:15 **Session 1: Opening Plenary Session**

Chairperson: Mr. John Ryan, U.S. Department of Energy

Co-chairperson: Dr. Peter Rohlin, Swedish Energy Agency

09:00 – 09:05 Introduction of Mayor Gibson – Mr. John Tomlinson, National Organizing Committee

09:05 – 09:15 Welcome to Attendees – Mr. James Gibson, Mayor, Henderson, Nevada

09:15 – 09:45 Opening Address on Behalf of the International Energy Agency, Dr. Antonio Pflüger, Head, Energy Technology Collaboration Division, IEA

09:45 – 10:30 Welcoming remarks – Mr. Jeff Littleton, Executive Vice President, ASHRAE

10:30 – 10:45 Conference remarks – Mr. John Ryan

10:45 – 11:15 Coffee Break – Promenade outside Emperors Ballroom

Conference Program

11:15 – 12:30	**Regional Reports:** " Heat Pumps – Status and Trends"
11:15 – 11:35	a) RR-1 North America – Mr. Mark Menzer, Air Conditioning and Refrigeration Institute
11:35 – 11:55	b) RR-2 Europe – Dr. Monica Axell, Mr. Fredrik Karlsson, IEA Heat Pump Centre
11:55 – 12:15	c) RR-3 Asia/Pacific – Mr. T. Yoshii (Heat Pump Technology Center of Japan) and Mr. Wei Xu (China Academy of Building Research)
12:15 – 13:30	Lunch – Florentine Ballroom – 3rd Floor
13:30 – 18:00	**Session 2: Energy and Environment**
	Chairperson: Dr. Sophie Hosatte, Natural Resources Canada
	Co-chairperson: Mr. David Lewis, Lennox International, Inc.
13:30 – 14:00	Keynote: KN-2 Heat Pumps and the Environment – Prof. Hermann Halozan, Pres. IIR Comm. E2, Heat Pumps
14:00 – 14:25	O2-1 Reduction of CO_2 emissions by heating residential buildings with low-cost heat pumps – E. Wobst
14:25 – 14:50	O2-2 CO_2 Emission Reductions for Geothermal Heat Pump Systems in Northeast and Mid-Atlantic United States – Alice Gitchell, Lynn Stiles
14:50 – 15:15	O2-3 The present status and the future view of the CO_2 refrigerant heat pump water heater for residential use – M. Kusakari
15:15 – 15:45	Coffee Break
15:55 – 16:20	O2-4 TEWI analysis of high-temperature residential heat pumps – Denis Clodic, Charbel Rahhal
16:20 – 16:45	O2-5 Climate-change impact of supermarket refrigeration systems – D. Bivens, P. Lundqvist
16:45 – 17:00	Summary of Poster Session 2

(continued on next page)

Conference Program

17:00 – 18:00 **Poster Session 2**

P2-1 Co-z-ing up to the customer: how to break through the first cost barrier – Paul Bony, Ed Thomas, Katherine Johnson

P2-2 Demonstration of advanced integrated hvac&r systems in a Loblaws supermarket in Canada – Daniel Giguère, Georgi Pajani, Sophie Hosatte

P2-3 Methods and potential for on-site performance validation of air conditioning, refrigeration, and heat pump systems – Klas Berglöf

P2-4 Energy-saving performance of distributed air-conditioning system for laboratory buildings – N. Endo, T. Maeda, Y. Hasegawa, M. Sugai, H. Tsuboi, T. Endo, A. Morimitsu, A. Yabe

P2-5 Investigation on operational reliability of heat pump system – Takehiro Tanaka

P2-6 Technological and scientific challenges in heat pumps – R. J. Romero, J. Siqueiros, R. Best, C. Cuevas, G. González, J. Uruchurtu, F. Sierra , G. Urquiza, M. Basurto-Pensado, A. Álvarez, S. Silva

P2-7 Practical study on desiccant air conditioning systems in supermarkets – Mashimo Katsuyuki, Tanaka Takao

13:30 – 18:00 **Session 3: Heat Pump Applications**

Chairperson: Dr. Peter Rohlin, Swedish Energy Agency

Co-chairperson: Mr. Wayne Reedy, Carrier

13:30 – 14:00 Keynote: KN-3 Heat pumps – who uses them and why? – G. C. Groff, V.P. IIR Science and Technology Council, Head, Section E, Heat Pumps and Air Conditioning

14:00 – 14:25 O3-1 Increasing consumer confidence in heat pumps – Nance C. Lovvorn

14:25 – 14:50 O3-2 Unprecedented heat pump market development in Norway: What happened, and will it last? – Rune Aårlien, Trude Tokle, Bård Baardsen

Conference Program

14:50 – 15:15 O3-3 Successful application of heat pumps to a dhc system in the Tokyo Bay area – Akira Okagaki

15:15 – 15:45 Coffee Break

15:55 – 16:20 O3-4 Performance audits of heat pumps - procedures and uncertainties – P. Fahlén

16:20 – 16:45 O3-5 Heat pumps in Switzerland - a success story – S. Peterhans, F. Rognon

16:45 – 17:00 Summary of Poster Session 3

17:00 – 18:00 **Poster Session 3**

P3-1 Review of air-source heat pumps for low temperature climates – Stefan S. Bertsch, Eckhard A. Groll, David B. Bouffard, William J. Hutzel

P3-2 High-temperature heat pump for resinous timber drying – V. Minea

P3-3 Possibilities of applying heat pumps in Slovakia – Dusan Petras, Peter Matej

P3-4 Heat pump for district cooling and heating at Oslo Airport, Gardermoen – Geir Eggen, Geir Vangsnes

P3-5 An analysis of the current situation of sewage-source heat pumps in northeast China – Zesheng Yan, Jixiang Liao, Qingyan Ma

P3-6 Energy saving and economic analysis of surface-water heat pumps in heating season in Hunan, Cina – Tingting Liu, Jianguo Peng, Guoqiang Zhang, Xuanjun Lin

P3-7 Application of lake-water heat pump system for district heating and cooling in South China – Xiao Chen, Guoqiang Zhang, Jianguo Peng, Xuanjun Lin

P3-8 Analysis of a surface-water heat pump system applications – He Tao, Wang Qingqin

P3-9 Some aspects of the application of water-loop heat pump systems in China – Lizhong, Wang Qingqin, Lubin

(continued on next page)

Conference Program

P3-10 Strategies for large-scale application of water-loop heat-pump air-conditioning system in China – Yang Yao, Yiqiang Jiang, Zuiliang Ma, Shiming Deng

P3-11 Influence of different drying methods on the quality of fruit – M.N.A. Hawlader, Conrad O. Perera, Min Tian

18:00 Close of first day Sessions – Attendees have free evening (optional Blue Man Group show at 19:00)

Wednesday, June 1, 2005

08:00 – 12:20 **Session 4: Ground- and Water-Source Heat Pump Systems (Design and Application Tools)**

Chairperson: Prof. Hermann Halozan, Tech. Univ. Graz

Co-chairperson: Mr. Steve Szymurski, ARI

08:00 – 08:30 Keynote: KN-4 Ground-source heat pumps: meeting global challenges through load networking – James E. Bose, Marvin D. Smith, Oklahoma State Univ.

08:30 – 08:55 O4-1 Simulation and optimization of ground-source heat pump systems – J. D. Spitler, X. Liu, S. J. Rees, C. Yavuzturk

08:55 – 09: 20 O4-2 A joint Western and Eastern culture procedure for cost-estimating geothermal heat pump systems – William S. Fleming, Professor Li Xiuguo, Mr. Li Yuanpu

09:20 – 09:45 O4-3 Status of Design Tools for Ground-Source Heat Pump Systems – Göran Hellström

09:45 – 10:15 Coffee Break

10:15 – 10:40 O4-4 Development of a design and performance prediction tool for ground-source heat pump system – K. Nagano, T. Katsura, T. Nogawa, A. Okamoto, Y. Namamura

10:40 – 11:05 O4-5 A novel design tool for heat pump systems – Martin Forsén, Per Lundqvist

11:05 – 11:20 Summary of Poster Session 4

Conference Program

11:20 – 12:20 **Poster Session 4**

P4-1 Integrated geothermal ice storage system – Ed Lohrenz

P4-2 Thermal and cost-benefit analysis of a geothermal pilot project at a Northwest Tennessee correctional facility – Jason E. Gentry, Robert A. LeMaster, J. Douglas Sterrett

P4-3 Comparing new control concepts for heat-pump heating systems on a test bench with the capability of house and earth probe emulation – M. Bianchi, E. Shafai, H. P. Geering

P4-4 Design and optimum control of a Swedish dual-source (air and ground) heat pump system – T. Lindholm, R. Hoflund, Y. Zhou

P4-5 Ground source heat pumps – overcoming market and technical barriers (IEA Heat Pump Programme Annex 29) – Hermann Halozan, René Rieberer

P4-6 Performance of ground-source residential heat pumps – Eric Dumont, Marc Frère

P4-7 Ground-source heat pump with a new compact collector – Johnny Wärnelöv, Urban Kronström

P4-8 Analysis of a ground-coupled heat pump heating and cooling system for a multi-storey office building – A. Presetschnik, H. Huber

P4-9 Development of a ground-source heat pump system with ground heat exchanger utilizing the cast-in-place concrete pile foundations of a building – Ryozo Ooka, Kentaro Sekine, Mutsumi Yokoi, Yoshiro Shiba, SuckHo Hwang

P4-10 Development of high-performance water-to-water heat pump for ground-source application – Yoshiro Shiba, Ryozo Ooka, Kentaro Sekine

(continued on next page)

Conference Program

P4-11 Development of an autonomous performance-testing system of a water-source heat pump and actual performances of small Japanese water-source heat pump units – K. Nagano, T. Nogawa, T. Katsura, K. Shimakura, A. Okamoto

P4-12 Optimum running of heat pump under low-load conditions – Li Bing-xi, Wang Yong-biao, Yuan Di

P4-13 Development and application of an innovative shallow groundwater heat pump system – Xu Shengheng, Yang Ziqiang

08:00 – 12:20 **Session 5: Integration of Heat Pumps in Cooling, Heating and Power (CHP) Systems**

Chairperson: Mr. Ron Fiskum, U.S. Department of Energy

Co-chairperson: Mr. John Tomlinson, Oak Ridge National Laboratory

08:00 – 08:30 Keynote: KN-5 Heat pumping using combined heat and power technology – R. C. DeVault, P. Garland, R. J. Fiskum

08:30 – 08:55 O5-1 Performance of a combined power and desiccant cooling demonstration – John Ward, Don Chase, Rob Helstroom, Stephen White

08:55 – 09:20 O5-2 On the future role of heat pumps in Swedish district heating systems – competition with waste incineration and combined heat and power under greenhouse gas emission restrictions – Marcus Eriksson, Lennart Vamling

09:20 – 09:45 O5-3 Research and development of small-capacity absorption chiller using waste heat from distributed power generation – Eiji Hihara, Jianfeng Wang, Hirofumi Daiguji, Fumio Takemura, Chaobin Dang, Yoonhwan Lee, Michihiko Aizawa, Shigehiro Doi

09:45 – 10:15 Coffee Break

10:15 – 10:40 O5-4 Integration of an absorption chiller system in a supermarket heating, cooling, and power system – Timothy C. Wagner, Thomas J. Rosfjord

Conference Program

10:40 – 11:05 O5-5 Development of the world's first small scale two stage absorption chiller/heater/hot water system – Z. Yue, R. J. Fiskum

11:05 – 11:20 Summary of Poster Session 5

11:20 – 12:20 **Poster Session 5**

P5-1 Study on improvement in efficiency of partial-load driving of installing fuel-cell network with geo-thermal heat pump – S. Obara, K. Kudo

P5-2 Development of a hybrid air-conditioning system driven by low-temperature waste heat – Hirofumi Sasaki, Hiroyuki Tsuda

P5-3 Cooling, heating, and power application screening tool – S. Fischer, R. C. DeVault

P5-4 Study of gas-engine-driven air-conditioner for annual cooling operation – T. Yokoyama

P5-5 Low-electric-input gas engine heat pump air-conditioner – Sadayasu Nakano, Toshinari Sakai

P5-6 Development of hybrid-type adsorption heat pump adding electrically operated pump – Mitsuhiro Kubota, Y. Hirota, Y. Sugiyama, F. Watanabe, N. Kobayashi, M. Hasatani, M. Kanamori, M. Hiramatsu

P5-7 Development of triple-effect absorption chiller-heater – Kiyoyuki Mori, Masahiro Oka

P5-8 Heat recovery in multi-GHP (gas-driven heat pump) system – Seong-ryong Park, Young-jin Baik, Ki-chang Chang

P5-9 Combined district cooling and district heating production with large centrifugal heat pumps – Peter Bailer

12:30 – 13:30 Lunch

13:30 Departure for **Technical Tours** – Caesars Palace Events Center Entrance

18:00 Return from Technical Tours

(continued on next page)

Conference Program

18:30 – 23:00 **Reception and Conference Banquet** – Emperors Ballroom

Speaker: William G. "Woody" Sutton, Air-Conditioning and Refrigeration Institute

Thursday, June 2, 2005

08:00 – 12:20 **Session 6: Advanced Concepts – Components**

Chairperson: Prof. Thomas Kopp, Switzerland

Co-chairperson: Mr. Glenn Hourahan, ACCA

08:00 – 08:30 Keynote: KN-6 Innovative components for advanced systems – Clark Bullard, University of Illinois; Pres. IIR B2, Refrigerating Machinery

08:30 – 08:55 O6-1 Demonstration of a microchannel heat exchanger for operation in a reversible heat pump system – D. Hantz, G. Gulyas, A. Bensafi, K. B. Mercer

08:55 – 09:20 O6-2 Split-System Residential Heat Pump with Separate Dehumidification Operating Mode – Oved W. Hanson, Robert B. "Dutch" Uselton

09:20 – 09:45 O6-3 Unitary a/c: the influence of product design and air flow rates on sensible heat ratio – Wayne R. Reedy, Charles E. Bullock

09:45 – 10:15 Coffee Break

10:15 – 10:40 O6-4 Experimental study on heat pump cycle of flash-tank economizer with scroll compressor – Zhao Hui-xia, Liu Si-guang, Ma Guo-yuan

10:40 – 11:05 O6-5 CO_2 thermosyphons as heat-source systems for heat pumps – 4 years of market experience – René Rieberer, Karl Mittermayr, Hermann Halozan

11:05 – 12:20 Summary of Poster Session 6

11:20 – 12:20 **Poster Session 6**

P6-1 Modeling of a CO_2 thermosyphon for a ground-source heat pump application – Stefan Bertsch, Eckhard A. Groll, Kevin Whitacre

P6-2 Novel CO2-heat pipe as earth probe for heat pumps without auxiliary pumping energy – H. Kruse, H. Rüssmann

P6-3 Optimizing and controlling media flows in heat pump systems – P. Fahlén, F. Karlsson

P6-4 Theoretical design of a high-speed, oil-free radial compressor for domestic heat pumps – J. Schiffmann, D. Favrat, Alex Molyneaux

P6-5 Comparison of flow fields of a pure fluid and a zeotropic mixture for condensation in a shell-and-tube condenser – T. Karlsson

P6-6 Performance of compact brazed plate heat exchanger operating as condenser in domestic heat pump system – an experimental investigation – Joachim Claesson, B. Palm

P6-7 Experiences with hermetic scroll compressors with intermediate vapor injection port in heat pumps for high-temperature lift-heating application – M. Zehnder, D. Favrat

P6-8 Flow distribution in a herringbone microfin evaporation tube – S. Wellsandt

P6-9 Experimental study on heat transfer enhancement of a new heat exchanger for heat pump system – Li Xiao-yan, Li Hai-Tao

P6-10 Modeling of avoiding window-type heat pump frost through heat recovery system – Di Liu, Guangfa Tang, Fuyun Zhao

P6-11 Two-phase pressure drop of R-410A, R-407C, and CO_2 in horizontal evaporator with minichannels – A.S. Pamitran, Kwang-Il Choi, Jong-Taek Oh

P6-12 Thermal characteristics of steel foundation piles as ground heat exchangers – K. Nagano, T. Katsura, S. Takeda, E. Saeki, Y. Nakamura, A. Okamoto, S. Narita

P6-13 Seasonal system performances for vertical ground-coupled heat exchanger and comparison with air-to-water heat pump system – G. Romero, J. Urchueguía, H. Witte, W. Cambien, T. Magraner, M. Zacarés

(continued on next page)

Conference Program

08:00 – 12:20 **Session 7: Advanced Systems and Equipment**

Chairperson: Dr. Rune Aarlien, SINTEF Energy Research, Norway

Co-chairperson: Prof. Eckhard Groll, Purdue University

08:00 – 08:30 Keynote: KN-7 Challenges in heat-pumping technologies – Eric Granryd, Pres., IIR General Assembly

08:30 – 08:55 O7-1 Development of high performance turbo chiller – W. Seki, K. Ueda, Y. Shirakata, K. Nishii, Y. Hasegawa, T. Komuro, Y. Iritahi

08:55 – 09:20 O7-2 The exhaust air heat pump – a rational way of heating low-energy houses – Mats Fehrm

09:20 – 09:45 O7-3 Development and measurements of compact heating and ventilation devices with integrated exhaust air heat pump for high performance houses – A. Bühring

09:45 – 10:15 Coffee Break

10:15 – 10:40 O7-4 Integrated heat pumps for combined space conditioning and water heating – J. Tomlinson, C. K. Rice, E. Baskin

10:40 – 11:05 O7-5 A multi-function solar heat pump system – M. N. A. Hawlader, Ye Shaochun, K. A. Jahangeer

11:05 – 12:20 Summary of Poster Session 7

11:20 – 12:20 **Poster Session 7**

P7-1 Hermetic gas-fired residential heat pump – David M. Berchowitz, Yong-Rak Kwon

P7-2 A heat pump for automotive applications – Amir Jokar, Mohammad H. Hosni, Steven J. Eckels

P7-3 Residential heat pump water heater (HPWH) development status - USA – V. D. Baxter, J. J. Tomlinson, R. W. Murphy, B. G. Ashdown, M. V. Lapsa

Conference Program

P7-4 Summary of advanced supermarket R&D activities conducted under International Energy Agency (IEA) Annex 26 – V. D. Baxter

P7-5 Non-reversing, 100%-outside-air heat pump for heating and cooling – Danny Hall

P7-6 Low-energy cooling technologies – Johnny Andersson

P7-7 Performance measurement and modeling of air-source residential heat pumps – Eric Dumont, Marc Frère

P7-8 A generic calculation scheme to estimate seasonal performance of combined systems and experimental results – Thomas Afjei, C. Wemhöner, R. Dott, H. Huber, P. Keller

P7-9 IEA HPP Annex 28 – a uniform energy-related characterisation of heat pump systems – C. Wemhöner, T. Afjei

P7-10 Heat pump with high outlet-temperatures – Bernd Hafner

P7-11 Development of a two-circuit heat pump for heating and domestic hot water supply – Bernd Müller

P7-12 Airflow in multi-air ducts of semiconductive thermoelectric heat pumps – Fuyun Zhao, Guangfa Tang, Di Liu, Zhiqiang Liu

12:30 – 13:30 Lunch

13:30 – 17:00 **Session 8: Experiences with Alternate Refrigerants**

Chairperson: Dr. Ranier Jakobs, IZW e.V.

Co-chairperson: Dr. Donald Bivens, Dupont

13:30 – 13:55 O8-1 Development of two-phase flow expander for CO_2 heat pumps and air-conditioners – Katsumi Sakitani, Michio Moriwaki, Masakazu Okamoto, Eiji Kumakura, Tetsuya Okamoto

13:55 – 14:20 O8-2 Transcritical CO_2heat pumping systems – Kjell Stenstadvold, Petter Nekså

(continued on next page)

Conference Program

14:20 – 14:45 O8-3 HFC410A - Best Alternative to HCFC22 in Residential and Light Commercial Product – S. Stanbouly

14:45 – 15:10 O8-4 Effect of climatic conditions on the performance of an air-to-water reversible heat pump using R290 as refrigerant: seasonal system performances evaluation by means of experiments and modelling – J. Blanco Castro, G. Romero, J. F Urchueguía, J. M Corberán, J. Gonzálvez

15:10 – 15:35 O8-5 Heat pumps with hydrocarbons as refrigerants for small residential buildings – E. Wobst

15:35 – 16:00 O8-6 Brine-to-water CO_2 heat pump system for space heating and hot water heating in residences – Jørn Stene

16:00 – 16:15 Summary of Poster Session 8

16:15 – 17:00 **Poster Session 8**

P8-1 Air-conditioning and refrigeration technologies database – Dan Manole

P8-2 Natural refrigerants contra HFC – risks and benefits – Mats Fehrm

P8-3 Design analysis of a finned tube heat exchanger for an air-to-water reversible heat pump working with propane (R290) as refrigerant – J. Blanco Castro, J. F Urchueguía, J. M Corberán

P8-4 Screening for refrigerant blends in high-temperature lift heat pumps for retrofit in residential heating – M. Zehnder, D. Favrat

P8-5 Space heating and hot water supply system with a transcritical CO_2 heat pump – M. J. Friedl, R. Kern, K. Schiefelbein

P8-6 Designing a heat pump for minimum charge of refrigerant – B. Palm, P. Fernando, K. Andersson, P. Lundqvist, O. Samoteeva

P8-7 Mass-transfer characteristics of the rectifier for absorption refrigeration cycle using TFE/NMP as a working fluid – A.Tsujimori, M. Kato, T. Matsushita, T. Oya

Conference Program

P8-8 Comparison of CO_2 heat pump cycles for water heater – N. Okaza, M. Mekata, K. Nakatani, K. Murozono

P8-9 Experimental results and evaluation of two-stage compression and expansion cycle using CO_2 – Satoshi Imai, Hiroyuki Itsuki, Masahisa Otake, Hiroshi Mukaiyama, Ichiro Kamimura

P8-10 Characteristics of two-phase ejector in carbon-dioxide-operated refrigeration cycle – S. Akagi, J. F. Wang, E. Hihara

P8-11 Performance of HCFC22 alternative natural refrigerants for air-conditioning and heat-pumping applications – Dongsoo Jung, Yoonsik Ham

P8-12 Commercial CO_2 Hot Water Heat Pump Field Trials – H. J. Huff, T. Sienel, Y. K. Park

13:30 – 17:00 **Session 9: Country Research Program Overviews**

Chairperson: Dr. Claus Börner, Germany

Co-chairperson: Mr. Arun Vohra, U.S. Department of Energy

O9-1 An overview of national R&D projects in heat pump technology in Japan – Shigeaki Tonomura

O9-2 Ten years of Swedish research and development in heat-pumping technology – Johnny Andersson

O9-3 Heat-pumping technologies research and development in Canada – past, present, and future – Sophie Hosatte, Roberto Sunyé

O9-4 The Switzerland research program – Thomas Kopp

O9-5 U.S. HVAC&R research programs – Steven R. Szymurski

O9-6 Research activities of heat pumps in China – Wei XU

17:00 **Conference Summary and Closing Session**

P. Rohlin, IOC Chairman, and J. Ryan, U. S. Department of Energy

Program-At-A-Glance

	Monday May 30	Tuesday May 31	Wednesday June 1		Thursday June 2	
AM	**WORKSHOP 1** 08:30 -12:30 Messina 3rd floor "Test Procedures and Seasonal Performance Calculations for Residential Heat Pumps with Combined Space and Domestic Water Heating" (IEA HPP Annex 28)	**SESSION 1*:** 09:00-12:00 Emperors Ballroom 4th floor **OPENING PLENARY** Welcoming Addresses • U.S. Department of Energy (Mr. John Ryan) • National Org. Committee (Mr. John Tomlinson) • Mayor of Henderson, Nevada (Mr. Jim Gibson) • International Energy Agency (Dr. Antonio Pflüger) • ASHRAE (Mr. Jeff Littleton) Regional Reports • North America (Mr. Mark Menzer) • Europe (Dr. Monica Axell & Mr. Fredrik Karlsson) • Asia/Pacific (Mr. Takeshi Yoshii & Mr. Wei Xu)	**SESSION 4:** 08:30-12:20 **Ground- and Water-Source Heat Pump Systems (Design and Application Tools)** Chairperson: Prof. Hermann Halozan Co-chairperson: Mr. Steve Szymurski Keynote Address: Dr. James Bose • 5 oral papers • 13 poster presentations	**SESSION 5:** 08:30-12:20 **Integration of Heat Pumps in Cooling, Heating, and Power (CHP) Systems** Chairperson: Mr. Ron Fiskum Co-chairperson: Mr. John Tomlinson Keynote Address: Mr. Robert DeVault • 5 oral papers • 9 poster presentations	**SESSION 6:** 08:30-12:30 **Advanced Concepts—Components** Chairperson: Prof. Thomas Kopp Co-chairperson: Mr. Glenn Hourahan Keynote Address: Dr. Clark Bullard • 5 oral papers • 13 poster presentations	**SESSION 7:** 08:30-12:30 **Advanced Systems & Equipment** Chairperson: Dr. Rune Aarlien Co-chairperson: Prof. Echard Groll Keynote Address: Prof. Eric Granyrd • 5 oral papers • 12 poster presentations
	12:15-13:30 LUNCH — Florentine Ballroom 3rd Floor					

PM	**WORKSHOP 2** 13:30 – 17:30 Messina 3rd floor "Ground Source Heat Pumps – Overcoming Market and Technical Barriers" (IEA HPP Annex 29) **REGISTRATION** 13:30-17:30 4th floor	**SESSION 2:** 13:30-18:00 **Energy & Environment** Chairperson: Dr. Sophie Hosatte Co-chairperson: Mr. David Lewis Keynote Address: Prof. Hermann Halozan • 5 oral papers • 7 poster presentations	**SESSION 3:** 13:30-18:00 **Heat Pump Applications** Chairperson: Dr. Peter Rohlin Co-chairperson: Mr. Wayne Reedy Keynote Address: Mr. Gerald Groff • 5 oral papers • 11 poster presentations	**TECHNICAL TOUR 1** 13:30-18:00 **Lake Las Vegas** Space conditioning (heating and cooling) for LLV buildings is provided by water-source heat pumps and pond heat pumps with loops that are submerged in the lake.	**TECHNICAL TOUR 2** 13:30-18:00 **Rocky Research** A R&D organization that has performed cutting-edge research in solid-vapor sorption technologies that can be used in thermally activated heat pumps.	**SESSION 8:** 13:30-17:00 **Experiences with Alternate Refrigerants** Chairperson: Dr. Ranier Jakobs Co-chairperson: Dr. Donald Bivens • 5 oral papers • 12 poster presentations	**SESSION 9:** 14:00-16:45 **Country Research Program Overviews** Chairperson: Dr. Claus Börner Co-chairperson: Mr. Arun Vohra • 6 oral papers
	WELCOME RECEPTION 18:00-20:00 Emperors Ballroom 4th floor	**FREE EVENING** OR 19:00 **BLUE MAN GROUP (OPTIONAL)** Live at the Luxor Hotel		**RECEPTION & CONFERENCE BANQUET** 18:30-23:00 Address: William G. "Woody" Sutton Emperors Ballroom 4th floor		**SUMMARY AND CLOSING SESSION** 17:00 • Mr. Peter Rohlin, Chairman International Organizing Committee, Swedish Energy Agency • Mr. John Ryan, U.S. Department of Energy	

***All conference sessions are in the Emperors Ballroom 4th floor; EXHIBITION will run simultaneouly with the sessions in the Florentine Ballroom 3rd floor**

Technical Tours

1. Tour of Lake Las Vegas*

13:30 – 18:00, Wednesday, June 1

http://www.lakelasvegas.com

Due to its favorable climate, location, and other amenities, Las Vegas has the highest growth rate among all U.S. cities. Over the last ten years, the population of Las Vegas has grown by a full 55 percent. This growth provides the opportunity for development of new communities with energy-efficient housing. Lake Las Vegas is a premier new community located 28 km (17 miles) from central Las Vegas. The community is comprised of luxury residential villas, yacht and beach clubs, golf courses, restaurants, and hotels surrounding a large (1.4-sq. km) manmade lake.

Space conditioning (heating and cooling) for the Lake Las Vegas buildings is provided by water-source heat pumps and pond heat pumps with loops that are submerged in the lake. A major goal for Lake Las Vegas is an attractive, desirable setting for its occupants and owners as well as reduced energy consumption provided through heat pumping technologies.

We will travel by bus to the site, and our guide and presenter for the tour will be Mike Kapps, International Sales Development/ClimateMaster. We will tour the development including the Yacht and Beach Club and see first-hand how the lake meets the heating and cooling needs of the community. The tour promises to be both scenic and informative.

Technical Tours

2. Tour of Rocky Research*

13:30 – 18:00, Wednesday, June 1

http://www.rockyresearch.com

Rocky Research, located in nearby Boulder City and near Hoover Dam, is a research and development organization that has performed cutting-edge research in solid-vapor sorption technologies that can be used in thermally activated heat pumps. Rocky conducts research for the U.S. Department of Energy as well as for other customers in key areas required for the development and commercialization of sorption-based heating and cooling systems for residential and small commercial buildings. Rocky has had notable commercial successes with solid-vapor (ammoniated compounds) systems including large systems that can be used in conjunction with ammonia refrigeration (frozen-food processing and storage) and small systems such as hot/cold coolers for recreational vehicle applications.

We will travel by bus to Rocky Research, meet with our host and guide, Dr. Uwe Rockenfeller (Rocky's President), tour their 1200-sq.-m laboratory, and view some of the activities under way in solid-vapor sorption technology and thermal and vapor-compression heat pump research.

*Note: Tours will be departing via coach from the Caesars Palace Events Center Entrance (see map "Guide to the Empire" in the back of this booklet on page 42).

Exhibition

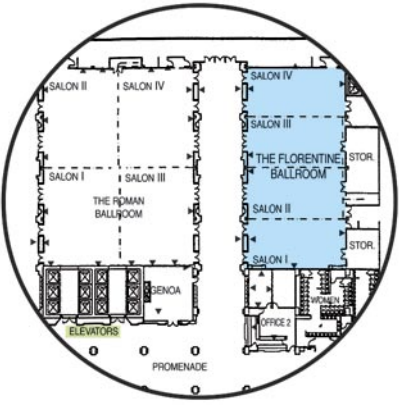
Conference Displays

Tuesday, May 31 through Thursday, June 2
Florentine Ballroom 3rd Floor, Caesars Palace

09:00 – 18:00 Tues. & Weds.; 09:00 – 17:00 Thurs.
(running simultaneously with sessions)

The conference will feature an exhibition of displays by national teams, R&D organizations, manufacturers, associations, and societies. A sampling of the exhibitors include ClimateMaster, Inc.; Desert Aire Corp.; Fiotherm Ag Winterhur Switzerland; and the IEA Heat Pump Centre to name just a few.

Conference participants are encouraged to visit the exhibition, which runs at the same times as the conference sessions, in the Florentine Ballroom on the 3rd floor of the Palace Tower in Caesars Palace from Tuesday, May 31 to Thursday, June 2.



See entire 3rd floor plan on page 44.

Social Events

Welcome Reception

Monday, May 30, 18:00 – 20:00, Emperors Ballroom, 4th Floor, Palace Tower, Caesars Palace

The Welcome Reception (for registered conference attendees) will be held in the Emperors Ballroom—a regal ballroom rimmed in beautiful murals and faux colonnade that will enable conference attendees and their spouses to greet old friends and to make new acquaintances in luxury and style. Hors d'oeuvres and refreshments will be served. Mr. Ted Fox, Director, Engineering Science & Technology Division, Oak Ridge National Laboratory and Mr. John Tomlinson, Chairman, National Organizing Committee will welcome attendees. Casual business attire (shirts with collars—coats and ties optional) is suitable for the Reception. Additional Reception tickets ($60) may be purchased at the conference registration desk.

Optional Show — Blue Man Group

Tuesday, May 31, 19:00, at the Luxor Resort & Casino

The "Blue Man Group – Live at Luxor" is much more than entertainment. The show consists of three men with blue faces, heads, and hands, clad in industrial-looking uniforms, who are the main focus of the show. They are backed by a live, 17-piece band of plugged-in musicians that are augmented by a group of laser artists. These "techno-shamans" involve the audience in group activities during

(continued on next page)

Social Events

their performance. The show relies on sound and visual effects. No words are spoken, placing emphasis on the music. The sounds are percussion-based and have a tribal rhythm. Conventional instruments, as well as instruments designed and created by the group, are used. Casual attire is recommended for the show. Show tickets can be purchased at the conference registration desk ($77.00).

Transportation options to the show include taxi service available just outside the hotel main entrance and the brand new monorail that travels every 4-12 minutes—monorail tickets are $3.00 per person. The Flamingo/Caesars Palace Station is located on the east side of Las Vegas Boulevard at the Flamingo Las Vegas Hotel (across the street from Caesars Palace) and arrives at the MGM Grand Station, which is across the street from the Luxor. For those who prefer to walk, please allow 25 minutes to travel.

Courtesy Las Vegas Tourism

Conference Reception and Banquet

Wednesday, June 1, 18:30 – 23:00, Emperors Ballroom, 4th Floor, Palace Tower, Caesars Palace

All conference participants, spouses, and exhibitors are invited to attend the Banquet (admission by ticket only). Cocktails (cash bar) will begin at 18:30 with dinner at 19:00. This Banquet is an excellent opportunity for conference participants and exhibitors to meet old friends from around the world—while making news friends in the heat pump community. William G. "Woody" Sutton, President of the Air Conditioning and Refrigeration Institute (ARI) will be the featured speaker. Coats and ties (men) and cocktail or evening dresses (women) are appropriate attire for the Banquet.

CAESARS PALACE

Spouse Program

Museum and Shopping Excursion

TUESDAY, MAY 31

Schedule:

09:30	Depart Caesars Palace Event Center Entrance
10:00	The Wynn Collection
11:30	Lunch at Andre's downtown
13:00	Depart Andre's
13:30	Shopping at the new Premium Outlet Mall on Charleston
16:00	Depart Premium Factory Outlet
16:30	Approximate return to Caesars Palace

The guests set off to enjoy a whirlwind day of touring one of the most fabulous art collections in the city, dining at a favorite luncheon locale and shopping at one of the city's newest outlet malls.

The morning begins as guests venture to the recently opened **Wynn Las Vegas** hotel. Opulent, refined and ultra-sophisticated, guests will love entering this property a mere month after its grand opening. The exact pieces to be on display are yet to be announced, but from his previous collection, Wynn proudly displayed 13 works, including Picasso's *La Reve* and a Warhol of Wynn.

Following their art gallery tour, guests venture to the heart of glitter city for a sensational lunch at Andres French Restaurant, downtown.

Andre's French Restaurant

Since 1980, one of the most honored, awarded and respected restaurant in Las Vegas. Tucked away from the bright lights of the "Strip," Andre's is located in a quiet residential neighborhood just one block east of Las Vegas Boulevard. The building was one of Las Vegas' early homes, built around 1930. Chef Andre converted the home into a Country French Restaurant with a very warm and inviting atmosphere. Most of the year, diners enjoy outdoor Patio Dining under the cool canopy of a beautiful Mulberry tree and surrounded by large planters of lush greenery.

(continued on next page)

Spouse Program

Over the years, Andre's French Restaurant has attracted a very loyal local following as well as an international clientele. With exquisite Classic French cuisine, superior service and an award winning wine list, Andre's continues to be the premier French and gourmet restaurant in Las Vegas.

After lunch, guests setoff for an afternoon of shopping under the brilliant desert sky at the city's latest, hottest new factory outlet mall.

Las Vegas Premium Factory Outlet

The Factory Outlet Stores are Las Vegas' latest craze. Located in the heart of Las Vegas, guests will enjoy 25% - 65% savings every day…what a better way to shop. Over 100 stores can visited with names such as **Adidas, A/X Armani Exchange, Ann Taylor Factory Store, Benetton, Calvin Klein,** Dockers Outlet by Most, Dolce & Gabbana, **Guess, Izod,** Kenneth Cole, **Levi's Outlet by Most,** Nautica, **Polo Ralph Lauren Factory Store, Wolford, Ecco,** The Children's Place Outlet, Coach, **Le Gourmet Chef, Yves Delorme,** Crabtree & Evelyn, **L'Occitane** and more.

Inclusions:

- Round trip transfers via luxury motor coach
- Admission to the Wynn Gallery inside the Wynn Las Vegas Hotel
- Lunch at Andre's French Restaurant Downtown
- Two (2) entrée choices available for a three (3) course lunch
- Shopping on own at Las Vegas Premium Outlets
- Coupon Books & Mall Brochures

Spouse Program

Caesars Palace

WEDNESDAY, JUNE 1

Schedule:

09:30 Spa session and tour
10:30 F&B back-of-the-house tour/food preparation demonstration
11:30 Lunch in the Juice Bar overlooking the pool

The Spa at Caesars Palace

The lead therapist for the Spa at Caesars Palace will discuss the various Spa services. She will describe the products used in the services and provide attendees with samples.

The Spa Director will then give a tour of the spa, salon, and fitness center. Tour participants will have a chance to win one of ten free passes for one day use of the Spa and will each be given special discount coupons.

The Food & Beverage Department Tour

The guests will proceed to the back-of-the-house tour with the head of the food and beverage department for a food preparation demonstration and a sampling of the house recipes.

Lunch will be served in the beautiful juice bar overlooking the pool.

Organization

International Organizing Committee (IOC)

Dr. Peter Rohlin	Chairman, Sweden
Dr. Monica Axell	Heat Pump Centre, Sweden
Dr. Claus Börner	Germany
Mr. Gerald Groff	USA
Prof. Hermann Halozan	Austria
Dr. Sophie Hosatte	Canada
Prof. Thomas Kopp	Switzerland
Mr. John D. Ryan	USA
Ms. Trude Tokle	Norway
Mr. Shigeaki Tonomura	Japan
Mr. Takeshi Yoshii	Japan

Regional Coordinators

North and South America:

Mr. Gerald C. Groff
1 Audubon Drive
Cazenovia, New York 13035, USA
Fax: +1-315-655-2748
gcgroff@att.net

Europe and Africa:

Dr. Monica Axell
IEA Heat Pump Centre
SP Energy Technology
Industrigatan 4, Box 857, SE-501 15, Borås, Sweden
Fax: +46-33-13-19-79
hpc@heatpumpcentre.org

Asia, Australia and Pacific Regions:

Mr. Takeshi Yoshii
Heat Pump & Thermal Storage Technology
Center of Japan
1-28-5 Nihonbashi Kakigaracho,
Chuo-ku, Tokyo 103-0014 Japan
Fax: +81-3-5641-4501
yoshii@hptcj.or.jp

Organization

National Organizing Committee (NOC)

Mr. John Tomlinson	Chairman
Ms. Melissa Voss Lapsa	Conference Secretariat
Dr. Donald Bivens	Dupont
Prof. Clark Bullard	University of Illinois
Mr. James Crawford	Trane
Mr. Robert DeVault	Oak Ridge National Laboratory
Mr. Daniel Ellis	ClimateMaster, Inc.
Mr. Gerald Groff	Groff Associates
Dr. Eckhard Groll	Purdue University
Ms. Kim Grubb	Oak Ridge National Laboratory
Mr. Glenn Hourahan	Air-Conditioning Contractors of America
Mr. David Lewis	Lennox International
Mr. Nance Lovvorn	Lovvorn Consulting Services
Mr. Wayne Reedy	Carrier
Mr. John Ryan	U.S. Department of Energy
Mr. Steve Szymurski	Air Conditioning and Refrigeration Institute
Mr. Arun Vohra	U.S. Department of Energy

Conference Secretariat

Melissa Voss Lapsa
Oak Ridge National Laboratory
P.O. Box 2008, MS-6067
Oak Ridge, TN, USA 37831
Phone: +1-865-576-8620
Fax: +1-865-576-0279

Conference Internet Site
http://www.ornl.gov/hp2005

Author Index

All authors are listed with session/paper number(s).

Author Index

(continued on next page)

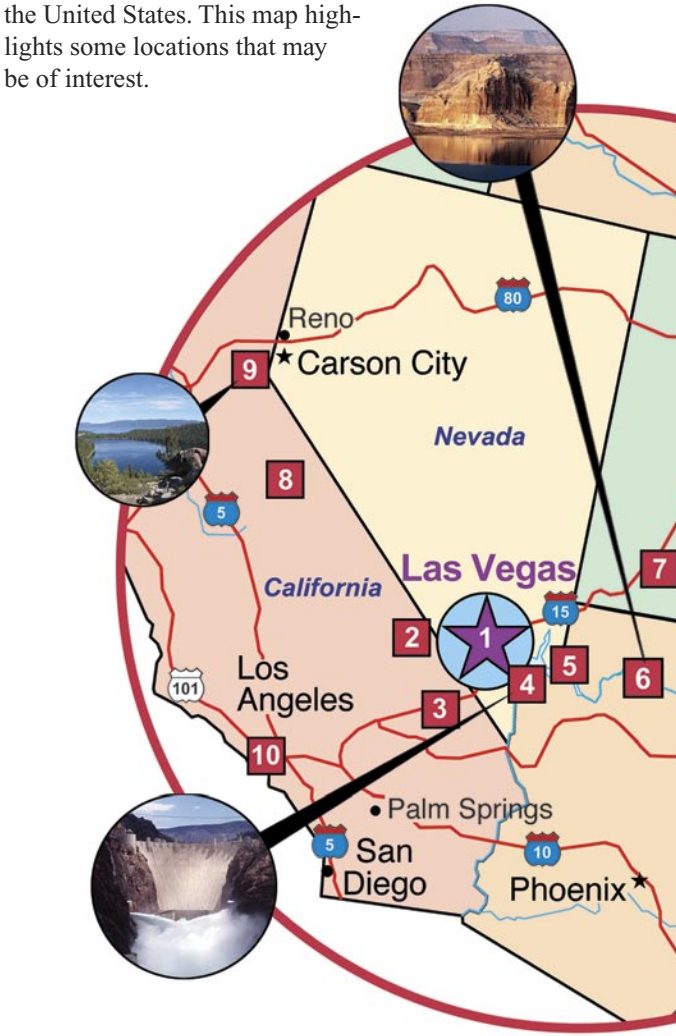
Author Index

All authors are listed with session/paper number(s).

Author Index

Post - Conference Tours

Las Vegas, Nevada, provides a gateway for families to explore the scenic western region of the United States. This map highlights some locations that may be of interest.



In addition, there are a number of post-conference tours that offer fantastic premier sightseeing (some are offered 24 hours a day) such as to Hoover Dam, the Grand Canyon, Laughlin, Colorado River, Lake Mead, Wild West, Valley of Fire, Las Vegas city and night tours, and many more.

Tours include (but are not exclusive to) cruises, luxury coaches, helicopters, horse-back riding, rafting,

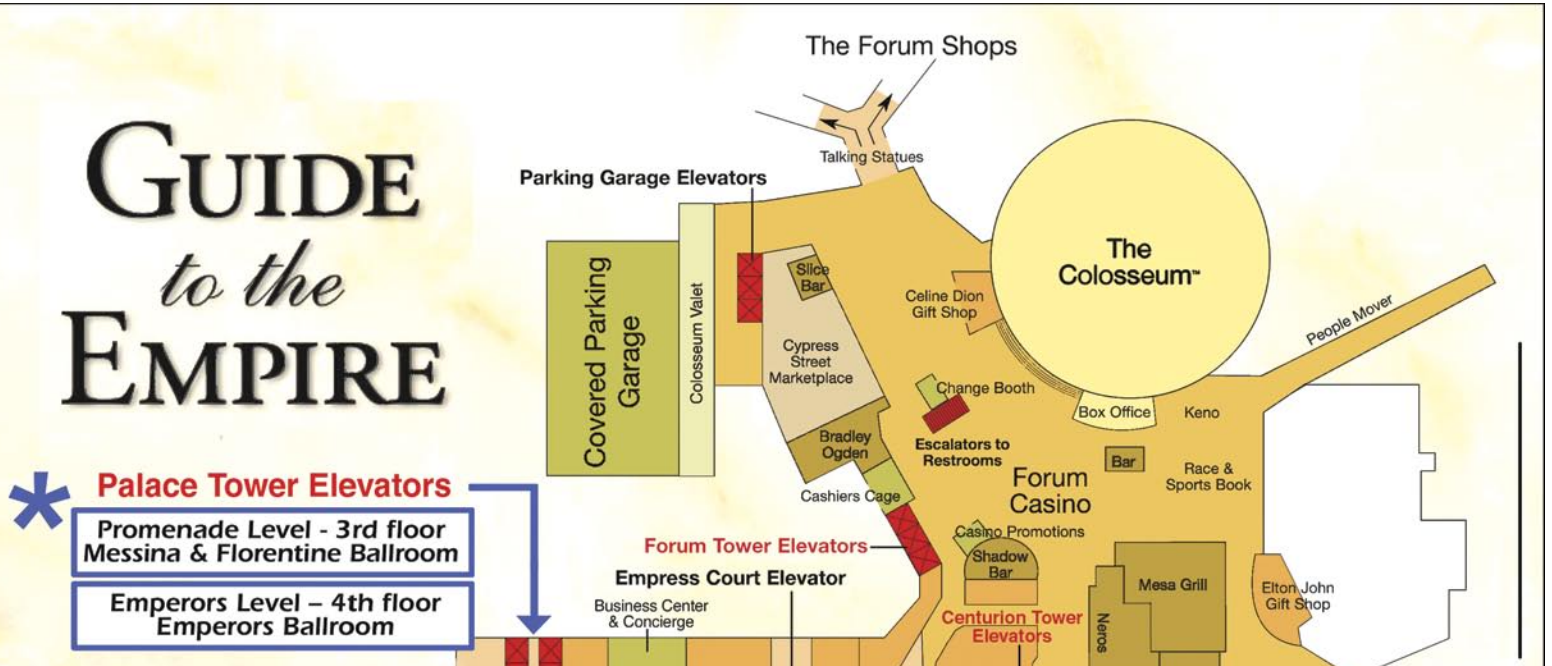
WESTERN UNITED STATES
Other Areas of Interest

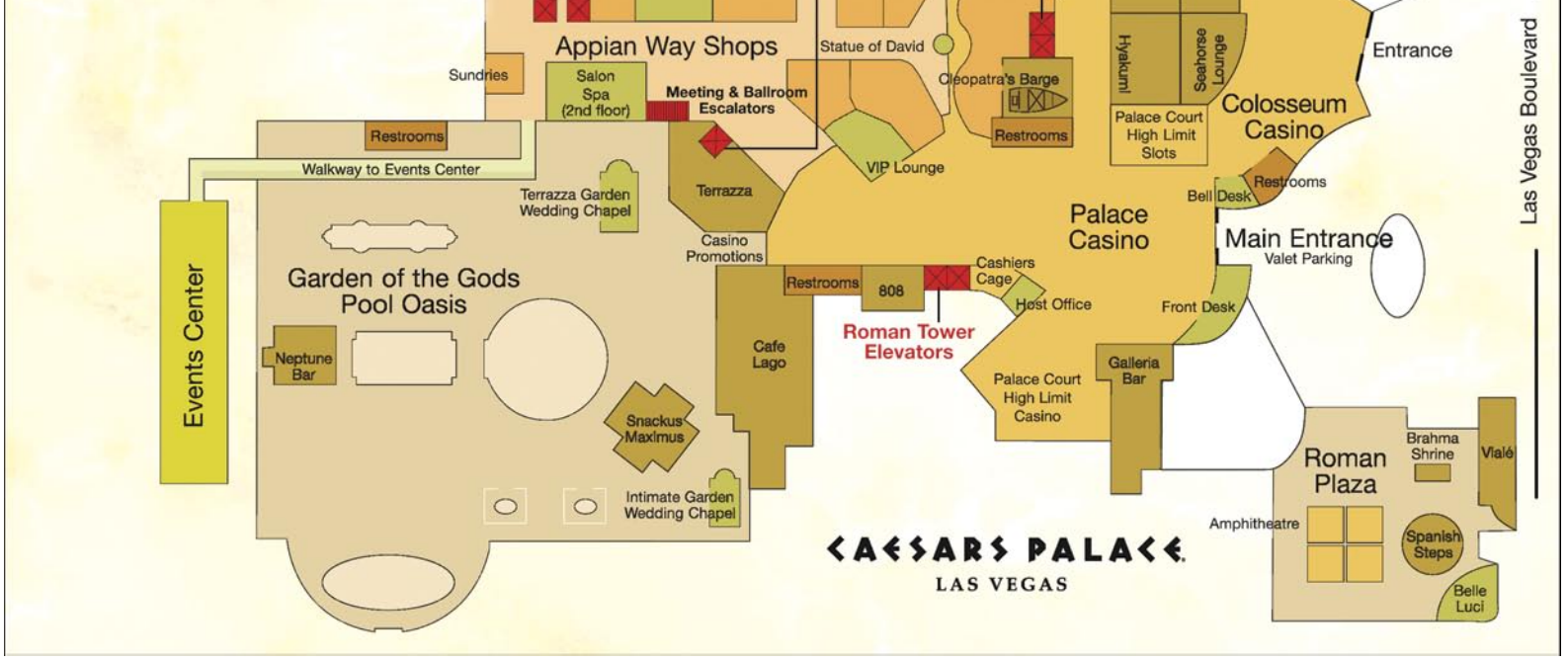
1. Las Vegas
2. Death Valley
3. Mohave Desert
4. Hoover Dam
   PHOTO: U.S. Bureau of Reclamation
5. Lake Mead Natl. Rec. Area
6. Grand Canyon National Park
   PHOTO: Getty Images
7. Bryce & Zion National Parks
8. Yosemite National Park
9. Lake Tahoe, CA
   PHOTO: Amy W. Cook
10. Los Angeles, CA
11. Monument Valley
    PHOTO: André Winter
12. Mesa Verde National Park

wine-tasting, and even a Hummer tour! Many brochures are included in your conference handouts and the hotel concierge has additional sight-seeing literature.

For more information about area sights and links to state tourist offices, please see the conference website at ***www.ornl.gov/hp2005***; also visit the National Park Service website at ***www.nps.gov/parks***.

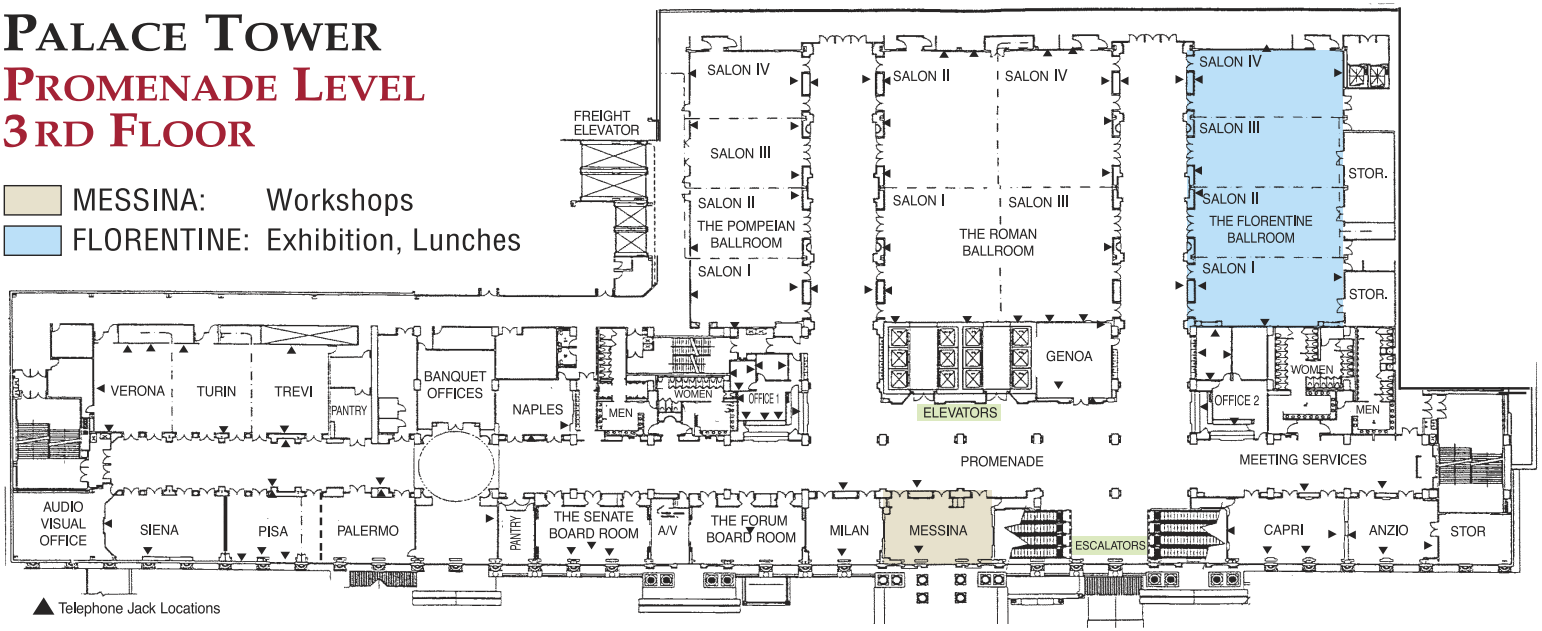
Guide to the Empire




Appian Way Shops
Sundries
Salon
Spa
(2nd floor)
Meeting & Ballroom
Escalators
Statue of David
Cleopatra's Barge
Restrooms
Hyakumi
Seahorse Lounge
Entrance
Colosseum
Casino
Palace Court
High Limit
Slots
Restrooms
Walkway to Events Center
Terrazza Garden
Wedding Chapel
Terrazza
VIP Lounge
Bell Desk
Restrooms
Palace
Casino
Main Entrance
Valet Parking
Las Vegas Boulevard
Events Center
Garden of the Gods
Pool Oasis
Casino
Promotions
Restrooms
808
Cashiers
Cage
Host Office
Front Desk
Roman Tower
Elevators
Neptune
Bar
Cafe
Lago
Palace Court
High Limit
Casino
Galleria
Bar
Snackus
Maximus
Brahma
Shrine
Roman
Plaza
Viale
Intimate Garden
Wedding Chapel
Amphitheatre
Spanish
Steps
Belle
Luci
CAESARS PALACE
LAS VEGAS

Palace Tower
Promenade Level
3rd Floor

MESSINA: Workshops
FLORENTINE: Exhibition, Lunches

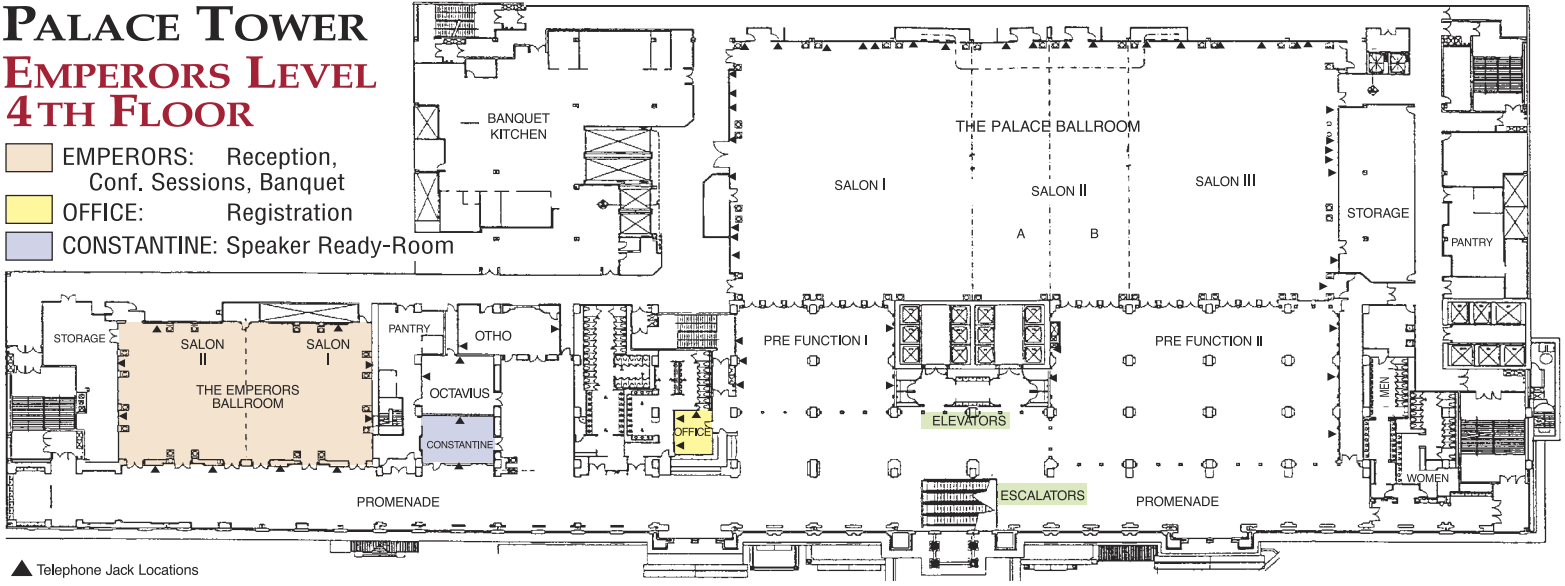


Palace Tower
Emperors Level
4th Floor

EMPERORS: Reception, Conf. Sessions, Banquet

OFFICE: Registration

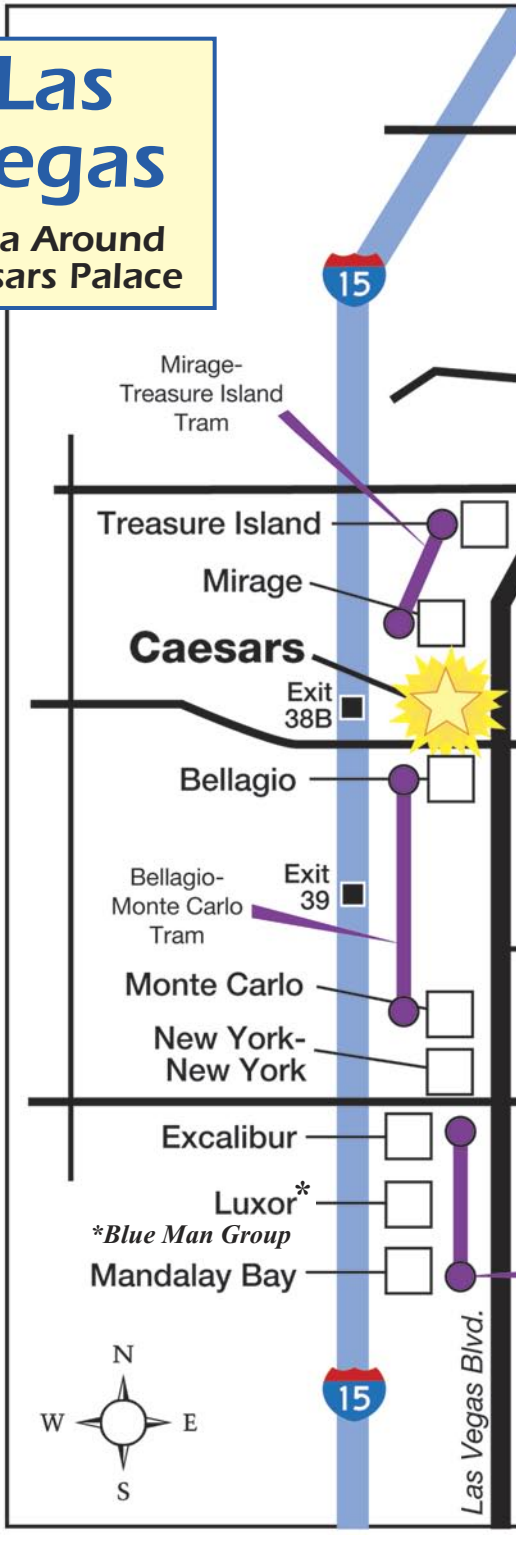
CONSTANTINE: Speaker Ready-Room

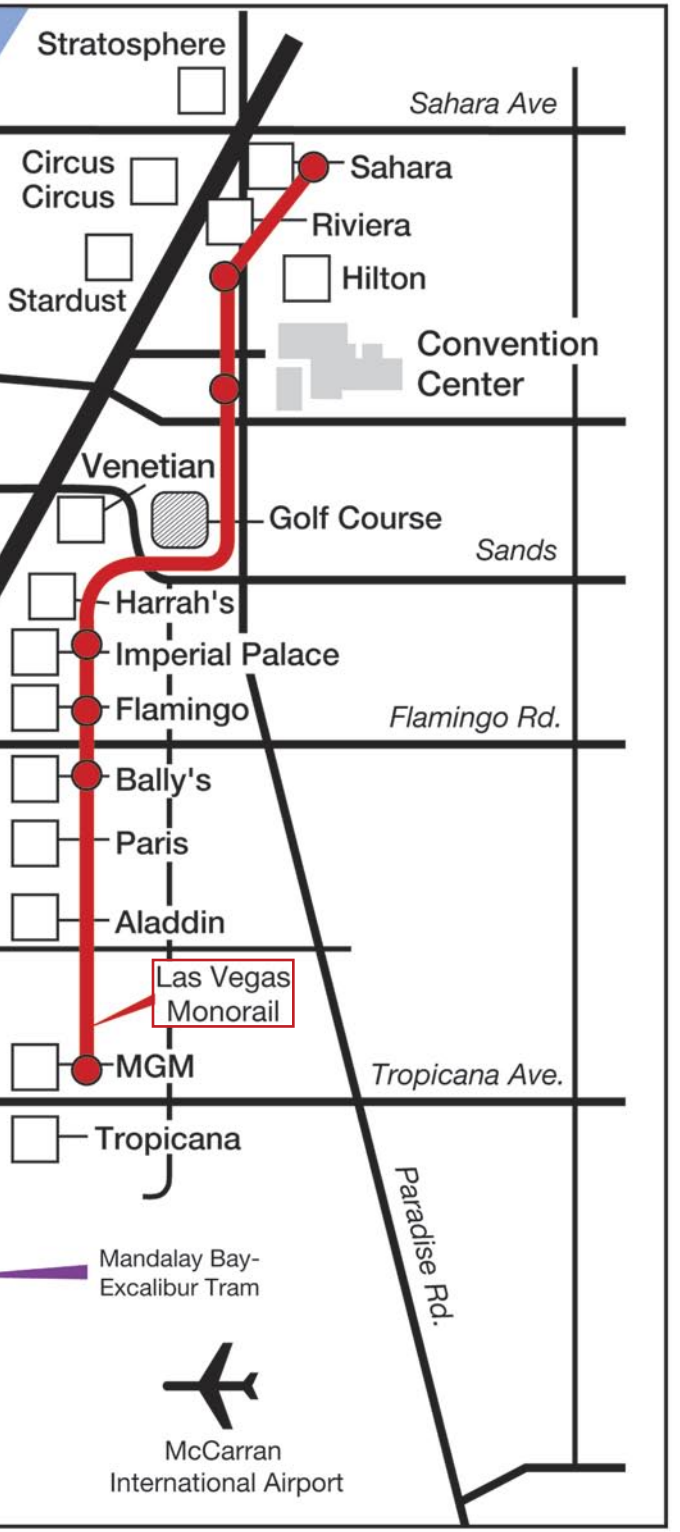


▲ Telephone Jack Locations

Las Vegas

Area Around Caesars Palace




Stratosphere
Sahara Ave
Circus Circus
Sahara
Riviera
Hilton
Stardust
Convention Center
Venetian
Golf Course
Sands
Harrah's
Imperial Palace
Flamingo
Flamingo Rd.
Bally's
Paris
Aladdin
Las Vegas Monorail
MGM
Tropicana Ave.
Tropicana
Paradise Rd.
Mandalay Bay-Excalibur Tram
McCarran International Airport

Notes

IEA Member Countries

8th International Energy Agency
HEAT PUMP CONFERENCE 2005