

ARTI 21-CR

Focusing on Research Needs of the HVACR Community



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The mission of the *HVACR Research for the Twenty-First Century* (21-CR) program is to identify, prioritize, and undertake precompetitive research that decreases energy consumption while improving indoor environmental quality within buildings. Collaborative, pre-competitive research offers the following benefits:

- Mechanism for cost sharing/diversifying risks,
- Economies of scale; permitting larger research efforts,
- Reduces duplication of effort by addressing generic industry issues,
- Allows the assembly of a critical mass of technical expertise,
- Pools and intensifies human talent while engaging the interest of talented persons,
- Fosters a creative environment for cross fertilization of ideas,
- Multiple approaches to a problem can be pursued,
- Strategic research provides pre-competitive information... companies then compete through development of their own unique product lines.

Through September 2001, 36 projects (valued at \$5.2 million) were authorized by the 21-CR program. During the ensuing months, additional projects will be released for competitive solicitation. Subcommittee focus areas are:

- *alternative equipment* (investigations of HVACR cycles other than today's fluorocarbon vapor compression cycles);
- *higher efficiency equipment* (improved heat exchangers, motor systems, compressors, controls and sensors, air handlers, testing, diagnostics, pumps and pump controls, etc.);
- *system integration* (improved distribution systems, zone control, waste heat recovery, integration of envelope and lighting with mechanical systems, advanced controllers, communications, etc.);

- *indoor environmental quality* (enhanced control of temperature, moisture, indoor contaminants, ventilation, etc.); and
- *environmentally-friendly working fluids* (refrigerants, lubricants, secondary heat transfer fluids, eutectics, process fluids, etc.).

A committee structure guides the 21-CR program and directs the research. Volunteers for the various subcommittees are drawn from industry, research organizations, universities, utilities, scientific laboratories, and government.

The 21-CR program establishes an environment where *technical barriers are identified, solutions investigated, and information shared*. The effort undertakes precompetitive research that focuses on resolving technological hurdles and difficulties that prevent or impede manufacturers from commercializing next generation systems and components. Once these technical challenges have been addressed, the various stakeholders are positioned to apply the 21-CR research results and to produce the products/ services that satisfy market needs within the HVAC&R sector.

ARTI 21-CR Research Results Becoming Available

Many of the early 21-CR projects are nearing completion, and final reports becoming available in each of the five focus areas. Reports from completed projects can be downloaded at no-charge from the ARTI website at www.arti-21cr.org. Also on the website are descriptions on each project (i.e., objectives, information expected, how results are likely to be applied, contractor identification, and brief status).

Table 1: Projects of the 21-CR Alternative Equipment Subcommittee

Focus: Investigations of HVAC&R cycles other than today's fluorocarbon vapor compression cycles.		
Project	Contractor	Status
Efficiency Limits of H ₂ O Vapor Compressors, Phase I (AE 605-10010)	Concepts ETL, Inc.	Report available
Assessment of the State-of-the-Art (SAO), and Potential Design Improvements, for Flat-Tube Heat Exchangers in Air-Conditioning and Refrigeration Applications – Phase I (AE 605-10020)	University of Maryland	Report available
Evaluation of the Performance Potential of CO ₂ as a Refrigerant in Air-to-Air Air Conditioners and Heat Pumps: System Modeling and Analysis (AE 610-10030)	Purdue University	Report expected Mar. 2002
Evaluating the Performance of Thermoacoustic Cooling (AE 610-10040)	Purdue University	Report expected Nov 2001
CO ₂ Compressor-Expander Analysis (AE 611-10060)	University of Maryland	Report expected 1 st Q 2003
Measurement of Performance of CO ₂ Compressors (AE 611-10070)	Purdue University	Report expected 4 th Q 2002

Table 2: Projects of the 21-CR Energy Efficient Equipment Subcommittee

Focus: Improved heat exchangers, motor systems, compressors, controls and sensors, air handlers, testing, diagnostics, pumps and pump controls, etc.		
Project	Contractor	Status
Evaluating the Ability of Unitary Equipment to Maintain Adequate Space Humidity Levels (EEE 605-20010)	ASHRAE (work being undertaken by the University of Colorado)	Report available
Assessment of the State-of-the-Art (SOA), and Potential Design Improvements, for Flat-Tube Heat Exchangers in Air-Conditioning and Refrigeration Applications, Phase I (EEE 605-20020)	University of Illinois	Report available
High Temperature Mold Materials to Die-Cast Copper Motor Rotors (EEE 605-20030)	Copper Development Association (CDA) (work being undertaken by ThermoTrex Corporation & Buhler Corporation)	Report expected 1 st Q 2002
Refrigerant Evaporation Characteristics Inside Flat Passages (EEE 605-20040)	Swiss Federal Institute of Technology	Report expected 4 th Q 2003
Potential Benefits of Smart Refrigerant Distributors (EEE 610-20050)	NIST	Report expected 2 nd Q 2002
High Condensing Temperature Heat Transfer Performance of Low Critical Temperature Refrigerants (EEE-20060)	Iowa State University	Report expected 4 th Q 2003
Variable Primary Flow Potential Benefits and Application Issues (EEE 611-20070)	Penn State University	Report expected 4 th Q 2002
Flat-Tube Heat Exchangers in Air-Conditioning and Refrigeration Applications, Phase II (EEE 611-20021)	University of Illinois	Project commenced in the 4 th Q 2001

Table 3: Projects of the 21-CR System Integration Subcommittee

Focus: Improved distribution systems, zone control, waste heat recovery, integration of envelope and lighting with mechanical systems, advanced controllers, communications, etc.		
Project	Contractor	Status
SOA Review of Whole Building and Building Envelope Simulation and Design Tools (SI 605-30010)	Architectural Energy Corporation	Report expected Dec 2001
SOA Review of HVAC Component and System Simulation and Design Tools (SI 605-30020)	CDH Energy Corporation	Report expected Dec 2001
Flexible and Adaptive HVAC Distribution Systems, Phase I (SI 605-30030)	Carnegie Mellon University / ORNL	Report expected Nov 2001
Methods for Automated and Continuous Commissioning of Building Systems (SI 610-30040)	Portland Energy Conservation Inc.	Report expected 3 rd Q 2002
Automatic Integration of Real-Time Information Into Building Management Systems (SI 611-30050)	GeoMet Technologies Inc.	Report expected 3 rd Q 2002
System Optimization of Residential Ventilation, Space Conditioning, and Thermal Distribution (SI 611-30060)	Project proposals received July 2001. Contract being negotiated with successful proposer.	Project commenced 4 th Q 2001
Building Subsystems Integration Performance Benchmarking (SI 611-30070)	RFP released in August 2001	Project to commence 1 st Q 2002
Unitary Equipment Real Building Operating Conditions (SI 611-30080)	Project proposals received July 2001. Contract being negotiated with successful proposer.	Project commenced 4 th Q 2001

Table 4: Projects of the 21-CR Indoor Environmental Quality Subcommittee

Focus: Enhanced control of temperature, moisture, indoor contaminants, ventilation, etc.		
Project	Contractor	Status
Investigation of the Causes of Black Soot Phenomena (IEQ 605-40010)	Energen Consulting	Report expected 1 st Q 2002
Health, Energy and Productivity in Schools (IEQ 605/611-40020)	HP-Woods Research Institute	Report expected 1 st Q 2002
Defining the Effectiveness of UV Lamps Installed in Circulation Air Ductwork (IEQ 610-40030)	Research Triangle Institute	Report expected 3 rd Q 2002
Investigation of Building Exhaust Air Re-entrainment into Outside Air Intakes of Packaged Outdoor HVAC Equipment – Phase I (focus on equipment without environmental-, site-, or building-related factors) (IEQ 610-40040)	Battelle Energy Products Division	Report expected 1 st Q 2002
Development of a Residential Indoor Air Quality Evaluation Protocol (IEQ-610-40045)	ENERGEN Consulting Inc.	Report expected 2 nd Q 2002
Role of Filtration in Maintaining Clean Exchange Coils (IEQ 611-40050)	Contract being negotiated with successful proposer	Project commenced in the 4 th Q 2001
Simulating the Performance of Natural and Hybrid Ventilation Systems in U.S. Office Buildings (IEQ-611-40076)	U.S. National Institute of Standards and Technology	Project commenced in the 4 th Q 2001

Table 5: Projects of the 21-CR Working Fluids Subcommittee

Focus: Refrigerants, lubricants, secondary heat transfer fluids, eutectics, process fluids, etc.		
Project	Contractor	Status
Investigation of AC&R Systems Operated Near and at the Refrigerant Critical Temperature (WF 605-50010/50015)	NIST and ORNL	Report expected 1 st Q 2002
Determination of Refrigerant Lower Flammability Limits in Compliance with ASHRAE 34p (WF 605-50020)	ASHRAE (work being undertaken at Underwriters Laboratory)	Report expected 2 nd Q 2002
Assessing the Commercial Implications for ASHRAE A3 Flammable Refrigerants Used in Air Conditioning and Refrigeration Systems (WF 610-50025)	Arthur D. Little, Inc.	Report available
Study the Effects of Water in Synthetic Lubricant Systems and Clathrate Formation (WF 610-50035)	Spauschus Associates	Report available
Development of a Reproducible Screening Method to Determine the Mechanism and Effect of Organic Acids and other Contaminants on the Corrosion of Aluminum-finned Copper-tube Heat Exchanger Coils (WF-611-50055)	Contract being negotiated with successful proposer	Project commenced in the 4 th Q 2001
Refrigerant Database (SC 610-00010)	James M. Calm, Engineering Consultant	Effort complete

Strategic Planning - Positioning for the Future

In 2001, the 21-CR Steering Committee initiated a strategic planning exercise to ensure the ARTI 21-CR program continues addressing the highest priority needs of the HVACR industry. The **goal** is to *identify and prioritize research that will enable industry to develop the technology, products, and innovative applications / services for the next decade and beyond*. The **emphasis** is from a user's focus with respect to:

- *commercial buildings* (i.e., offices, universities, medical complexes, schools, etc.);
- *residential buildings* (i.e., low-rise, high-rise, and detached); and
- *commercial refrigeration* (i.e., supermarkets, warehouses, commercial transport, etc.).

This strategic planning exercise is to develop a clearer understanding of how the HVACR industry may be different in 10 to 15 years by addressing these important questions:

- What are the major drivers of change that will impact the way business is transacted?
- Where are the major opportunities?
- What are the greatest challenges and issues the industry will face?
- Which major technologies will significantly impact the industry?
- What will be the impact of government policy and regulations?
- How will international trade and global business strategies change the industry?
- What are the human resource implications resulting from changes in the industry?

Information generated during this planning activity will provide guidance as ARTI develops and implements future research within the 21-CR program. The output will also assist industry, national labs, government bodies, and academia in identifying needed activities to proactively anticipate, influence and define the ultimate global future of the HVACR community. A report summarizing the year-long assessment is to be released in December 2001.

The 21-CR Program Continues to Garner Broad Support

In 2001, the California Energy Commission (CEC) became a 21-CR program *sponsor*. CEC is providing significant program funding in 2001 and 2002. CEC monies – coupled with those of other *sponsors* (DOE, ARI, CDA, and NYSERDA) and *supporters* (RSES and HRAI) – are enabling the 21-CR program to meet its objectives.

Additionally, two new entities recently became *endorsers* of the 21-CR program:

- American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
- Association of Home Appliance Manufacturers (AHAM).

Although endorers do not provide monetary contributions, third party scrutiny and subsequent endorsement of 21-CR activities helps to strengthen the program. The breadth of 21-CR program *Sponsors, Supporters, and Endorsers* illustrates the broad importance of the 21-CR program to the HVAC&R community.

See the side bar for a listing of the current sponsors, supporters, and endorers.

Current Sponsors, Supporters, and Endorsers of the 21-CR Program:

21-CR Sponsors (ordered by magnitude of monetary commitments)

U.S. Department of Energy (DOE)
Air-Conditioning &
Refrigeration Institute (ARI)
Copper Development Association (CDA)
New York State Energy Research and
Development Authority (NYSERDA)
California Energy Commission (CEC)

21-CR Supporters

Refrigeration Service
Engineers Society (RSES)
Heating, Refrigeration Air-Conditioning
Institute of Canada (HRAI)

21-CR Endorsers

Air-Conditioning Contractors
of America (ACCA)
American Society of Heating,
Refrigerating and Air-Conditioning
Engineers, Inc. (ASHRAE)
Association of Home Appliance
Manufacturers (AHAM)
Edison Electric Institute (EEI)
Energy Center of Wisconsin (ECW)
Geothermal Heat Pump Consortium
(GHPC)
Iowa Energy Center (IEC)
Plumbing-Heating-Cooling
Contractors (PHCC)
National Association
Thermal Technology Center (TTC),
National Research
Council Canada (NRC)