CONTENTS

	ter: British Columbia	Х
State of the Plenary Ad	Committee and Transactions Staffe Society by Louis F. Flagg, ASHRAE 1988-89 Presidentddress by Randall Root	x xi xiii
Technical I	Program Abstracts	xvii
	TECHNICAL PAPERS	
	First Technical Session	
3254	A Power Balance Model for Converging and Diverging Flow Junctions by S.E. Guffey and D.A. Fraser	3
3255	Kinetic Power Model of Junction Losses by S.E. Guffey and D.A. Fraser	10
3256	Numerical Solutions of Navier-Stokes Equations for Push-Pull Flow by Z. Damin, K. Tsuji, and I. Fukuhara	23
3257	3-D Numerical Simulation of Turbulent Air Flow In and Around Buildings Based on the k - ϵ Model with Generalized Curvilinear Coordinates by S. Murakami, S. Kato, and Y. Ishida	30
3258	An Algorithm for Generating a Polynomial Form of the s-Transfer Matrix for One-Dimensional Multilayered Slabs by D.H. Eunilkim	58
	by D.H. Eunlikim	50
	Second Technical Session	
3259	Active Attenuation of Acoustic Noise: Past, Present, and Future by D.C. Swanson	63
3260	Vibration Response of Propeller Fans under Actual Operating Conditions—I: Operational Tests of Four-Blade Propeller Fans (RP-477) by D.D. Reynolds, J.M. Bledsoe, W. Culbredth, and S.G. Ladkany	77
3261	Vibration Response of Propeller Fans under Actual Operating Conditions—III: Finite Element Studies of the	
	Influence of Welded and Riveted Connections on the Vibration Response of Propeller Fans (RP-477) by S.G. Ladkany, D.D. Reynolds, and M.S. Rouas	82
3262	Vibration Response of Propeller Fans under Actual Operating Conditions—IV: Automatic Generation of Curved and Twisted Propeller Fan Surfaces for a Dynamic Analysis by Finite Elements (RP-477) by S.G. Ladkany, M.S.	Uz
	Rouas, and D.D. Reynolds	88
	Third Technical Session	
3263	Dust Concentration Modeling for Industrial Operations (RP-531) by W.T. Fay, T.H. Kuehn, D.Y.H. Pui, and M.H.	
	Bergin	92
3264	Laboratory and Field Measurements of Fractional Efficiency of Industrial Dust Collectors (RP-531) by M.H. Bergin, D.Y.H. Pui, T.H. Kuehn, and W.T. Fay	102
3265	Numerical Study on Diffusion Field as Affected by Arrangement of Supply and Exhaust Openings in Conventional Flow Type Clean Room by S. Murakami, S. Kato, and Y. Suyama	113
3266	Airflow Measurements at Coil Faces with Vane Anemometers: Experimental Results (RP-451) by R.H. Howell	128
3267	and H.J. Sauer, Jr	141
	Fourth Technical Session	
3268	A Comparison Test of Two Solar Air Heating Systems with Phase Change Energy Storage by E.F. Thacher and	
0200	M.A. Penik, Jr	147
3269	Flame Structure in a Portable Oil Heater with Cylindrical Tubes and a Wick by Y. Arai, T. Otsuki, and N. Hirata	157
3270	Effectiveness Models for Cooling Towers and Cooling Coils by J.E. Braun, S.A. Klein, and J.W. Mitchell	164
3271	Experimental Studies on Characteristics of a Two-Stage Absorption Heat Transformer by T. Yumikura, M. Ikeuchi, E. Ozaki, G. Yamanaka, and T. Arai	175
	Fifth Tachwinal Consists	
3272	Fifth Technical Session Stair Pressurization Systems for Smoke Control: Design Considerations (RP-559) by G.T. Tamura	184
3272	Dynamic Control—A Case Study by D.K. Spratt, G.W. Sadler, and K.R. Moodie	193
3273	Sub-Optimal Controller for a Space Heating System by M. Zaheer-uddin	201
3275	Pipe Spacing for Double-Layer Ground Heat Exchangers by V.R. Tarnawski and W.H. Leong	209
3276	Model Validation for Three Ground-Coupled Heat Pumps by Y. Mohammad-zadeh, R.R. Johnson, J.A. Edwards, and P. Safemazandarani	215
3277	Research on Prevention of Vapor Condensation in Dwellings by T. Ikeda, Y. Kobayashi, and Y. Dobashi	222

Sixth Technical Session

3278	Moisture Measurements in Single-Family Houses with Attics Containing Radiant Barriers by W.P. Levins, M.A. Karnitz, and J.A. Hall	235
3279	Approximate Attic Air Temperatures and Ceiling Heat Fluxes with Radiant Barriers by W.E. Stewart, Jr., B.R. Becker, L.A. Stickler, and M.E. Greer	244
3280	Equipment Sizing Procedures for Combination Space-Heating/Water-Heating Systems by J.A. Pietsch and S.G. Talbert	250
3281	A Method of Forming China's Meteorological Data Used for Analyzing Building Annual Energy Consumption by L. Baizhan and T. Shengyuan	259
	Seventh Technical Session	
0000		
3282	Measurement and Formulation of the Thermodynamic Properties of Refrigerants 134a (1,1,1,2-Tetrafluoroethane) and 123 (1,1-Dichloro-2,2,2-Trifluoroethane) by M.O. McLinden, J.S. Gallagher, L.A. Weber, G. Morrison, D. Ward, A.R.H. Goodwin, M.R. Moldover, J.W. Schmidt, H.B. Chae, T.J. Bruno, J.F. Ely, and M.L. Huber	263
3283	Test Results on a Supercharged Compressor for Commercial Refrigeration by J.W. Andrews, T.A. Butcher, and W.G. Wilhelm	284
3284	Refrigerator-Freezer Energy Testing with Alternative Refrigerants by E.A. Vineyard, J.R. Sand, and W.A. Miller.	295
3285	Effect of Freezing Rate and Storage Time on Shelf-Life Quality of Hot-Boned and Cold-Boned Ground Beef—Part II, Sensory Quality Evaluation (RP-350) by V.G. Gapud, D.V. Schlimme, and M.A. Smith	300
	Eighth Technical Session	
3286	The Influence of the Vapor Permeability of Clothing on Thermal Discomfort by G. Alfano, S. Cicolecchia, and	309
3287	F.R. d'Ambrosio A Data Base for Determining the Evaporative Resistance of Clothing by E.A. McCullough, B.W. Jones, and T. Tamura	316
3288	Optimal Globe Temperature Respecting Human Thermoregulatory Range by M.V. Jokl and P. Moos	329
3289	Impact of Air Humidity on Thermal Comfort During Step-Changes (RP-503) by R.J. de Dear, H.N. Knudsen, P.O. Fanger	336
3290	Water Spray for Humidification and Air Flow Reduction by W.J. Davis	351
3291	Impact of Thermal Storage on Closed-Loop Heat Pump System Performance by R.H. Howell and J.H. Zaidi	357
3292	Analysis of Ice Formation with Flow Reversal for Application to a Water Source Heat Pump by S.M. Aceves-Saborio, G.M. Reistad, and H. Nakamura	366
3293	Heat Transfer and Pressure Drop Performance of Smooth and Internally Finned Tubes with Oil and Refrigerant 22 Mixtures (RP-469) by L.M. Schlager, M.B. Pate, and A.E. Bergles	375
3294	Experimental Study on Condensation of Refrigerant-Oil Mixtures, Part III: R-12 and R-22 on the External Surface of Single and Multiple Horizontal Finned Tubes (RP-378) by J.C.Y. Wang, S. Lin, P. Fazio, and Z. Jiang	386
3295	Performance of a Condensing Copper Finned Tube Heat Exchanger: Effects of Baffles by S.A. Idem and V.W. Goldschmidt	393
3296	Performance Comparison of Refrigerants R-134a and R-12 in a Residential Exhaust Air Heat Pump (RP-479) by J.W. Linton, W.K. Snelson, and P.F. Hearty	399
3297	Testing and Modeling of a Water-to-Air Heat Pump Operating with a Nonazeotropic Refrigerant Mixture (RP-479) by D. Parent and P.A. Larue	405
	SYMPOSIUM PAPERS	
	a kerengan dan bagai berbagai dalah dari kerangan berbagai dan berbagai berbagai berbagai berbagai berbagai be	
VA-89-1	Current Status of Adaptive Control in EMCS	
f st	An Effective Approach for Dynamically Compensated Adaptive Control by J.W. MacArthur, E.W. Grald, and A.F. Konar	415
	Response of Self-Tuning Single-Loop Digital Controllers to a Computer-Simulated Heating Coil by	404
	D.M. Underwood	424 431
	A Robust Self-Tuning Predictive Controller for HVAC Applications by A.L. Dexter and P. Haves	439
VA-89-2	Residential Air-to-Air Heat Recovery Ventilator Performance with and without Moisture Recovery	
rise	Development of a Dynamic Model for Simulating Indoor Air Temperature and Humidity by C.G. Barringer and	4 40
	C.A. McGugan	449
	Effect of Residential Air-to-Air Heat and Moisture Exchangers on Indoor Humidity (RP-544) by C.G. Barringer and C.A. McGugan A Model to Compare Freezing Control Strategies for Residential Air-to-Air Heat Recovery Ventilators (RP-543)	461
	by E.G. Phillips, R.E. Chant, B.C. Bradley, and D.R. Fisher	475
	Comparison of Freezing Control Strategies for Residential Air-to-Air Heat Recovery Ventilators (RP-543) by E.G. Phillips, R.E. Chant, D.R. Fisher, and B.C. Bradley	484
		1

VA-89-3	Non-Residential Heat Pump/Heat Recovery Systems Applied Heat Pump Opportunities in Commercial Buildings by R.C. Niess	
	Process Heat Recovery Heat Pumps by F.J. Pucciano and P.A. Rowles	499
VA-89-4	Heat Transfer Enhancement in HVAC Applications Experimental Study of Particulate Fouling in Enhanced Water Chiller Condenser Tubes by N-H. Kim and	F07
	R.L. Webb	507
	N. Kaushik and N.Z. Azer	516
VA-89-5	Residential Duct Leakage and Infiltration	
	Evidence of Increased Levels of Space Heat Consumption and Air Leakage Associated with Forced Air Heating Systems in Houses in the Pacific Northwest by D.S. Parker	527
	Effects of Ducted Forced-Air Heating Systems on Residential Air Leakage and Heating Energy Use by L.A. Lambert and D.H. Robison	534
	Field Investigation of Residential Infiltration and Heating Duct Leakage by D.H. Robison and L.A. Lambert Infiltration and Pressure Differences Induced by Forced Air Systems in Florida Residences by J.B. Cummings	542
	and J.J. Tooley, Jr.	551
	Residential Duct System Leakage: Magnitude, Impacts, and Potential for Reduction by M.P. Modera	561
VA-89-6	Calculation of Interzonal Heat and Mass Transfer in Buildings Some Aspects of Gravity Driven Air Flow through Large Apertures in Buildings by J. van der Maas, C.A. Roulet,	
	and J.A. Hertig	573
	A Study of Heat and Mass Transfer through a Doorway in a Traditionally Built House by S.B. Riffat	584
	Combining Door Swing Pumping with Density Driven Flow by D.E. Kiel and D.J. Wilson	590
	and J.C.Y. Wang	600
	Airflow Network Models for Element-Based Building Airflow Modeling by G.N. Walton	611
	The Coupled Airflow and Thermal Analysis Problem in Building Airflow System Simulation by J. Axley and R. Grot	621
VA-89-7	DDC System Documentation	
er in	Object-Oriented DDC Documentation by C.A. Gulotta	631
	Desk Top Personal Computers Transform the Documentation of DDC Systems by D.I. McGeown	637 641
	Design Documentation Instead of Design/Build Documentation for Controls by J.R. Sosoka and K.W. Peterson	643
VA-89-8	Reflective Insulation Performance in Buildings	
	Literature Review of Measurement and Predictions of Reflective Building Insulation System Performance, 1900-1989 by W.P. Goss and R.G. Miller	651
	Thermal Performance of Reflective Insulation Materials and Systems: A Detailed Program by A.O. Desjarlais and R.P. Tye	665
	Thermal Performance of Typical Light Frame Walls with Reflective Surface Insulations by G.L. Riskowski, L.L. Christianson, and R.G. Miller	671
	Contamination of Reflective Foils in Horizontal Applications and the Effect on Thermal Performance by J.C. Cook, Jr., D.W. Yarbrough, and K.E. Wilkes	677
	Radiation Control Coatings: An Underutilized Energy Conservation Technology for Buildings by R.W. Anderson	682
VA-89-9	Performance Evaluations for Reverse Cycle Defrost, Exhaust Air and Water-to-Air Heat Pumps	
	Refrigeration System Dynamics during the Reverse Cycle Defrost by D.L. O'Neal, K.T. Peterson, N.K. Anand, and J.S. Schliesing	689
	Effects of Outdoor Coil Fan Pre-Start on Pressure Transients during the Reverse Cycle Defrost of a Heat Pump by N.K. Anand, J.S. Schliesing, D.L. O'Neal, and K.T. Peterson	699
VA-89-10	Calculating Air Flow around Buildings	707
	The Estimation of Wind Pressures at Ventilation Inlets and Outlets on Buildings by R.M. Aynsley Wind-Induced Ventilation by F. Allard and M. Herrlin	707 722
	Analytical Versus Wind Tunnel Determined Concentrations Due to Laboratory Exhaust by R.L. Petersen and	
	D.J. Wilson	729
	Comparison of Wind Tunnel Test Results with Empirical Exhaust Dilution Factors by G.D. Schuyler and G.G. Turner	737

VA-89-11	Comparative Thermal Performance of Fenestration Systems Comparison of Experimental Test Results and Analytical Calculations of Window Thermal Performance by	747
	F.M. Dubrous and S.J. Harrison	755
	Thermal Resistance Measurement of Glazing System Edge-Seals and Seal Materials Using a Guarded Heater Plate Apparatus by J.L. Wright and H.F. Sullivan	766
	Canadian Project to Develop Energy Labels for Windows by T.P. Mayo and S. Carpenter	772
VA-89-12	Market-Linked Building Energy Requirements: Prototypes, Data Bases, and Equipment Simulations The Equipment R&D Benefits of Characterizing the Energy Requirements of Office Buildings and Multifamily	
	Housing by J.B. Brodrick	779
	DOE-2.1D Data Base of Building Loads for Prototypical Multifamily Buildings in the U.S. by Y.J. Huang, R.L. Ritschard, and J.M. Fay	786
	A Comparison of Central and Individual Systems for Space Conditioning and Domestic Hot Water in New Multifamily Buildings by S.J. Byrne and J.M. Fay	798
	Using the Office Building and Multifamily Data Bases in the Assessment of HVAC Equipment Performance by D.B. Crawley and Y.J. Huang	805
VA-89-13	User's Experiences with Variable-Volume Laboratory Fume Hood Exhaust Systems	817
	Observed Performance of VAV Hood Controls by D.R. Lacey User's Experiences with Variable-Volume Laboratory Fume Hood Exhaust Systems by R.B. Shumaker	825
	A Practical Laboratory Ventilation Control System by R.G. Wenz	830
	Comparisons of Variable-Volume Fume Hood Controllers by T.M. Rabiah, R.P. Garrison, and R.K. Sachdev Practical Solutions to Retrofitting Existing Fume Hoods and Laboratories by R.R. Monsen	837 845
VA-89-14	HVAC for Nuclear Facilities and Its Many Aspects—Part 1	855
	Nuclear Power Station Main Control Room Habitability by W.B. Paschal and W.S. Knous HEPA Filters of High Structural Strength for Nuclear Air Cleaning Systems by V. Ruedinger, C.I. Ricketts, and J.G. Wilhelm	865
	Analysis and Consequences of Fire Inside the Ventilation Ducts of a Nuclear Facility by A.R. Briand, J.C. Laborde, P.R. Mulcey, J.H. Savornin, and J.L. Tessier	878
	The Role of Fire Dampers in the Event of Fire in a Nuclear Facility—Selection Criteria for Devices by J.H. Savornin and J.C. Laborde	885
VA-89-15	Developments in HVAC&R Education Enhancing HVAC&R Curriculum with Practicing Engineers and Laboratory Experiences by S.P. Kavanaugh	893
	Integration of a Comprehensive Design Project in a One-Semester HVAC Course by A.S. Lau Teaching Computerized Techniques for the Design of Energy-Efficient HVAC Systems by R. Zmeureanu and	899
	P. Fazio	906 912
	Teaching HVAC in a School of Architecture by C.H. Bovill and R.M. Kelso Integrating HVAC System Design and Analysis in a Graduate Architectural Studio by G.W. Siebein and T.R. Wood	919
VA-89-16	and the Committee of Pulldings	
٠, ٠٠٠ ان	A Heat Exchanger Expert System by D.G. Bagby and R.A. Cormier Decision Analysis for Prioritizing Recommended Energy Conservation Options by K.L. Meadows and	927
	P.W. Brothers	934
	and V Antipa	938 947
	Development of an Expert System for Fire Management in Buildings by H. Abtahi A Quasi-Real-Time Expert System for Commercial Building HVAC Diagnostics by D. Anderson, L. Graves, W. Reinert, J.F. Kreider, J. Dow, and H. Wubbena	954
VA-89-17	Water Treatment in Cool Storage Systems	
	Overview of Water Treatment Practices in Thermal Storage Systems by R.M. Ahlgren Inhibited Glycols for Corrosion and Freeze Protection in Water-Based Heating and Cooling Systems by	963 969
	D.W. Born	976
VA-89-18	HVAC for Nuclear Facilities and Its Many Aspects—Part 2	007
	Chemical Gaseous Filtration by R.D. Porco	994

	Heat and Mass Transfer around One-Row Tube Bank Simulating Containment Fan Cooler under Post-Accident Condition in Nuclear Power Plant by K. Aoki, T. Yano, K. Tazawa, H. Taniguchi, K. Kudo, T. Kusakai, and T. Okamoto Nuclear Facility Air Lock Design Criteria by R.E. Perry, K.R. Scaggs, and B.M. Allen, Jr.	
VA-89-19	Case Studies of Displacement Ventilation in Public Halls by H.M. Mathisen Comparison of Conventional Mixing and Displacement Air-Conditioning and Ventilating Systems in U.S. Commercial Buildings by O.A. Seppänen, W.J. Fisk, J. Eto, and D.T. Grimsrud Displacement Ventilation Systems in Office Rooms by M. Sandberg and C. Blomqvist Local Thermal Discomfort Due to Draft and Vertical Temperature Difference in Rooms with Displacement	1013 1018 1028 1041 1050
VA-89-20	Commercial Building Energy End-Use Monitoring: Approaches, Experiences and Results—Part 2 Maintaining Adequate Data Capture Rates from Remote Sites with End-Use Monitoring Equipment by J.L. Stoops Monitoring Electric End-Uses in Commercial Buildings by J.D. Acherman Monitoring of Electrical End-Use Loads in Commercial Buildings by M. Martinez, T. Alereza, and D. Mort Predicted vs. Actual Conservation Opportunities in Commercial Buildings: Lessons Learned from Measured Energy Performance by C.M. Cleary and M.A. Schuldt	1065 1070
VA-89-21	Topics in Desiccant Technology Integrated Desiccant Cold Air Distribution System by M. Meckler Polymers as Advanced Materials for Desiccant Applications: 1—Commercially Available Polymers by A.W. Czanderna Testing of Novel Desiccant Materials and Dehumidifier Matrices for Desiccant Cooling Applications by A.A. Pesaran and C.E. Bingham Two-Stage Desiccant Dehumidification in Commercial Building HVAC Systems by G. Meckler	1098
VA-89-22	Psychrometrics and Coil Frosting at Freezer Temperature A Simple Method for Modeling the Frost Formation Phenomenon in Different Geometries by M.M. Padki, S.A. Sherif, and R.M. Nelson	1138