Midwest Energy Solutions Conference, 2024

Chicago, Illinois
January 30th – February 1st

Energy Studies, Results and ECM's For
Willis Tower - Chicago
110 Story - 4.8 Million Square Foot
Built 1973

Audit Master PRO
by UniBES Inc.

Lance Rock

- Patents: Holder of 3 Energy Technology Patents and 2 Energy Technology Patents Pending:
  - US 9,470,431 B2
  - US 9,696,057 B2
  - US 10,302,327 B2

The scope of this presentation is quite extensive, with several slides that go beyond the time I have been allocated to speak. The purpose of this presentation is to encapsulate the testing procedures, the executed work, and the cost savings that have been achieved to date for Willis Tower in Chicago.

- **At your earliest convenience, please take the time to go through the slides to gain a comprehensive understanding of the capabilities of AMP's software and how it can benefit your building as a representative, or enhance the services offered by your company as an energy professional.**

Audit Master PRO by UniBES Inc.

AMP Software is Energy Auditor and Energy Professional Technician Based

- AMP Software offers a subscription-based service that guides users through the energy audit process, ensuring accurate data collection and entry. Each subscription comes with the necessary training for performing energy audits, collecting data, and entering it effectively.
- The software ensures standardized and normalized data collection, yielding consistent results and optimal prescriptive Energy Conservation Measures (ECMs), guaranteeing thorough and effective testing.
- AMP's "field software" isn't installed directly in or on a building's HVAC Building Automation System (BAS) or components. Instead, it's accessible to mechanical engineering firms, energy auditing professionals, Energy Service Companies (ESCOs), mechanical contractors, building engineer professionals, and anyone interested or involved in the building energy auditing field.
- AMP is currently in the process of developing their "Green Box," a mechanical device for installation on building HVAC systems to automate energy auditing tests and analyses. This innovation aims to maintain optimal energy efficiency in HVAC systems using system heat transfer and fluid flows.

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Project Approach

- **To maximize heat transfer:**

1. Identify water flow/GPM Sensible & Total BTU/h values.
2. Identify coil airflow/CFM Total BTU/h transfer via Enthalpy.
3. Identify coil airflow Sensible BTU/h transfer.
4. Identify viable ECM (Energy Conservation Measure) adjustments.
5. Determine the necessary ECM hardware (pulleys, belts, motors).
6. Determine the necessary ECM services (coil cleaning, duct sealing).

Gallons Per Minute (GPM) – Cubic Feet per Minute (CFM) –
Energy Conservation Measures (ECM's)

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AMP | WILLIS TOWER PROJECT

WILLIS TOWER

Built in 1973 as the Sears Tower in Chicago | 110 stories – 4.8M SF

Ownership: Blackstone | Property Management: EQ Office

RESULTS

First phase: 35.0%to 45.0%HVAC energy savings | ROI <3 mos. – COMPLETE
Energy Savings Validation internally performed by: Aquicore, and Cyclone Energy Group

Second phase: projected 40-60%HVAC energy savings – PLANNED

METHODOLOGY

AMP's patented process &software used to test HVAC system performance versus the HVAC system's designed performance.

AMP software prescribed solutions to optimize all system components, mechanical, and heat transfer devises.

AMP report provides full visibility of pre and post test results to building management for improved governance of work related to recommended solutions.

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HVAC systems have become the most accessible opportunity for energy conservation.

- Realized energy savings start at a significant 20%, reaching upwards of 65% on less efficient HVAC systems.
- On average, energy savings range from 30% to 55%. With lighting costs markedly decreased due to high-efficiency upgrades and energy conservation measures (ECMs), HVAC systems now represent 65% to 70% of a facility's total energy bill.
- Return on investments (ROIs) for these energy savings measures are typically seen within one year. The focus is on implementing ECMs for both new and existing systems before considering the replacement of HVAC equipment that may not be necessary.

Sciences and Principles Used at Willis Tower

- **Tracer Gas Principles:**
- Ambient tracer gas process using
- 0.0 Carbon Emissions Versus
- Avoided using the ideal tracer gas, Sulphur Hexafluoride (SF-6).
  SF-6 has 23,500 times the global warming potential of carbon dioxide (CO2).

- **Related Fields:**
- Thermodynamics – 1st & 2nd Laws
- Psychrometrics
- Testing and Balancing
- Mechanical Engineering

Method of Performance
Psychrometrics

- **Key: Set the system up for "Steady State Operation"**

1. Select a reliable fluid flow source (H2O). (Other sources can be refrigerants, electric resistance heating coils, gasses)
2. Identify the fluid flow sources in BTU/h (H2O Sensible).
3. Identify other fluid flow sources in terms of Enthalpy (Air).
4. Identify O/A (Outdoor Air) and R/A (Return Air) Sensible Dry Bulb Temperatures (Air).
5. Remove any Motor Heat if added to the fluid flow (Air).
6. Remove any Fan Heat of Compression (Air).
7. Perform all testing and record all performance data in AMP's Software within 20 minutes or less of starting the test.

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Page from report

Have Hydronic Control Valve open for the flow of fluids through the coil:	Yes
Open any Coil Valve previously closed off allowing flow at the inlet and discharge to the (Chilled / Hot) coil being tested:	Yes

PERFORM TEST

ENERGY FIRST ON, BEGIN TEST TIME STAMP: 9/18/2022 2:02:50 PM

	DB (F°)	DB Drift #1	DB Drift #2	RH %	SP	SP Drift #1	SP Drift #2
O/A:	68.23	0.00	0.00	53.91	- 4.90 In/WC	0.00	0.00
R/A	72.92	0.00	0.00	48.18	+ 0.07 In/WC	0.00	0.00
M/A:	74.82	N/A	0.00	47.07	+ 1.10 In/WC	0.00	0.00
E/A:		0.00	0.00		+ In/WC	0.00	0.00

ENERGY FIRST ON, END TEST TIME STAMP: 9/18/2022 2:03:23 PM

ENERGY ON STEADY STATE, BEGIN TEST TIME STAMP: 9/18/2022 2:03:26 PM

Steady State is considered when the energy going across the DB and WB sensors stabilize and rise or fall slightly:	Yes
Once the Primary Steady State DB & WB is reached record their values:	Yes

POINT OF ENERGY ON STEADY STATE

	DB (F°)	DB Drift #1	DB Drift #2	DB Final Drift	RH %	SP	SP Drift #1	SP Drift #2	SP Final Drift
O/A:	69.72	0.00	0.00	1.49	57.30	- 4.90 In/WC	0.00	0.00	0.00
R/A:	71.97	0.00	0.00	-0.95	44.89	+	0.00	0.00	0.00
M/A:	56.48	N/A	0.00	-18.34	84.79	+ 1.10 In/WC	0.00	0.00	0.00
E/A:		0.00	0.00	0.00		+ In/WC	0.00	0.00	0.00

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Page from report

System OA / RA — System is at 41.95% OA and 58.05% RA

(Required) System Total BTU/H:			
(Actual) System Total BTU/H:	612,484.76		
(Percentage of Design) BTU/H %:	0.00		

Coil Delta T Air DB Temperature

(Required) ΔT Air DB F°:	0.00	**Air Upstream** Coil DB:	70.95
(Actual) ΔT Air DB F°:	18.34	**Air Downstream** Coil DB:	52.61
(Percentage of Design) ΔT Air DB F° %:	0.00		

Upstream Coil Entering Enthalpy

(Design) Enthalpy / h:	0.00
(Actual) Upstream Entering Coil Air Enthalpy / h:	27.38
(Percentage of Design) Enthalpy / h %:	0.00

System Coil Static Pressure

(Design) Coil Static Pressure Factor:	0.00
(Actual) Coil Static Pressure:	0.00

System Filters Schedule

	Expect Energy Consumption (Chillers, Boilers, HVAC Fans, Pumps, etc.) to Increase Energy Consumption by	Expect Heat Transfer and Efficiency to drop	(2 Sets) Pre & Final Filter - Change @ indicated SP In/WC
Filters Changed @ 5% Loaded:	105.26%	5%	1.04

Page from report

Ultrasonic Meter / Doppler	**(Plans/Print) Design Coil Water Delta PSI:**
Ultrasonic/Doppler Meter Mfg: FUJI	**Actual Coil Delta PSI Water**
Transducers Used: FSSC	**Entering Water PSI:**
Transducers Spacing Set Inches": 2.58	**Delta PSI:** 0.00
Design Hydronic Coil BTU/H Total	**Leaving Water PSI:**
(Plans/Print) Design Coil BTU/H Total:	**Design Airflow - DeltaT F° DB**
% of Design: %	**(Plans/Print) Design Coil Air Temperature DeltaT F° DB:**
Actual Hydronic Coil BTU/H	**Actual Airflow - DeltaT F° DB**
Actual Hydronic Coil BTU/H Total: 756,450.00	**Up Stream Coil Air Temperature Dry Bulb F°:** 74.82
Actual Hydronic Coil BTU/H Latent: 73,408.92	**DeltaT F° DB:** 18.34
Design DeltaT F° Water Temperature	**Down Stream Coil Air Temperature Dry Bulb F°:** 56.48
(Plans/Print) Design Coil Water DeltaT F°	**Design Airflow - Coil Delta SP In/WC"**
Actual DeltaT F° Water Temperature	**(Plans/Print) Design Coil Delta SP In/WC":**
Entering Coil Water Temperature F°: 43.30	**Actual Airflow - Coil Delta SP In/WC"**
DeltaT F°: 9.00	**Up Stream Coil SP In/WC:** 1.10
Leaving Coil Water Temperature F°: 52.30	**Delta SP In/WC:** 0.00
	Down Stream Coil SP In/WC: 1.10
	Actual Airflow CFM
	(Plans/Print) Design Airflow CFM: 33,000.00
	Actual Raw/Non-Corrected Airflow CFM 34,408.02
	% Design: 104.27%
	Design Pipe Information
	(Plans/Print) Design Pipe Size In:
	(Plans/Print) Design Pipe Fluid Velocity Ft/min: 0.00
	Alarm present, see details in the top of this page
	Actual Pipe Information
	Dimensions are for the full flow of the Coil, not the bypass if present

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Page from report

Engineered Energy Test Report

Current motor operating (BHP)	11.38 (BHP)
Maximum Operating % Airflow Value with Installed Motor HP	121.10 %
Motor PD Required to Maximize Installed Motor HP	0.00 PD (In)
Belt Length Required at Maximum Installed Motor HP	0.00 In
BTU/H (sensible heat) as operating and generated by installed motor	31,143.43 BTU/H
Operating kW demand when operating wth current (BHP) & motor efficiency	9.13 kW
Projected kW demand if same motor was upgraded to 95% efficiency	8.94 kW
kW saved with installed motor eff of 93.00% versus upgrade to 95% eff	0.19 kW
Motor (BHP) "required" to meet 100% system design flow CFM	8.45 (BHP)
Required Motor PD to Meet Design Flow	0.00 PD (In)
(BHP) between actual operating motor (BHP) versus required motor (BHP)	2.94 (BHP)

Voltage Imbalance

Temperature rise	0.00 %
Motor temperature rise due to voltage imbalance	0.00 (F°)

kVA & kVAR

kW for Motor Based on Motor Full Load

Current Motor Operating (BHP)	11.38
Full Load Operating (kW)	9.13

Power Factor kVA - kVAR

Actual Volt	460.00
Actual Amp	13.66
Apparent Power	10.88
Reactive Power	5.93
Power Factor	0.84

AMP's Patented Process Software

Overview

- **To optimize system performance using AMP Software:**

1. Input the field-testing data.
2. Software partitions the collected data and compares the actual system performance data against the design performance data.
3. Computes all fluid flows, including Latent Heat and Sensible Heat.
4. Computes the performance of all individual system components and provide solutions to optimize all system components, mechanical, and heat transfer devices to within a 1.0% margin of error.

   (Note: Above mentioned error of 1.0% is based on the inherent error of the testing devices used).

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AMP's Patented Process Software

Overview Continued

- **To optimize HVAC system efficiency, AMP software:**

1. Computes the actual Brake Horsepower (BHP) and the required BHP.
2. Computes the necessary fluid flow adjustments, including Cubic Feet per Minute (CFMs), Gallons per Minute (GPMs), Feet per Minute (FPMs)/Velocities, and Freons.
3. Computes the required individual system components, ensuring pulleys, belts, and impellers are void of error.
4. Computes the ideal system Static Pressure (SP) setpoints.
5. Computes Kilovolt-Amps (KVA) & Kilovolt-Amp Reactive (KVAR) Power Factor (PF) issues and compute the corrective/required capacitance to mitigate utility revenue PF penalties.

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Page from report

WATER ACTUALS

Water Actuals Data

(Actual) Coil GPM:	168.10

Actual Coil ΔT F° Water Temperature

Entering Coil Water Temperature F°:	43.30
ΔT F°:	9.00
Leaving Coil Water Temperature F°:	52.30

Actual Coil Δ PSI Water

Entering Water PSI:	
Δ PSI:	0.00
Leaving Water PSI:	

AIR ACTUALS

System CFM

(Actual) System CFM:	34,389.31

Actual Airflow - ΔT F° DB

Up Stream Coil Air Temperature Dry Bulb F°:	70.95
ΔT F° DB:	18.34
Down Stream Coil Air Temperature Dry Bulb F°:	52.61

Actual Airflow - Coil Δ SP In/WC

Up Stream Coil SP In/WC:	-
Δ SP In/WC:	0.00
Down Stream Coil SP In/WC:	

Components

ID	Point	Component	Size	Pressure Designation	Pressure In/WC	Total S.P. Drop	TP	FTP	FSP
A	Up	Outside Air Intake/Return Air > None > Louvers		-	0.36	2.49			
A	Down	Outside Air Intake/Return Air > None > Louvers		-	2.85				

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Page from report

Power Factor Correction Capacitor µf =	78.55
Initial (currently as running) kVAR =	6.27
Operating Point when Corrected kVAR =	3.59
kVAR Correction Required =	2.67
Current/Amperage Load Reduction Brought Down to =	0.88
With a Target PF Correction of	95.00
Which is a Current/Amperage % Reduction of =	11.72
Projected kVA With kVAR Correction Implemented =	10.16
kVA Reduction =	1.35

System Space Pressurization Data

Space Pressurization (In/WC)	Space Pressurization To	System Pressurization Comment

AMP's Patented Process Software

Additional Features

- **AMP's HVAC system software:**

1. Calculates the actual operation kilowatts (kW) of the motor.
2. Determines the Fan Tip Speed (FTS).
3. Identifies and addresses issues and errors in piping fluid velocity.
4. Assesses and computes duct fluid velocity issues and errors.
5. Schedules specific and optimized filter changes.

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Page from report

COIL AHU MIXED AIR REPORT

SYSTEM: ACS-44
DESCRIPTION:
DATE & TIME COMPLETED: 9/18/2022 7:55:13 PM

System at Steady-state for this test:	**Yes**
System steady-state will be monitored for this test:	**Yes**

Airflow(s) that effect the coils was/were balanced with "known flows/ values" prior to performing detailed Coil Heat Transfer Performance Recordings: Unknown

#	Throttled Device Set @	Fins per In	Rows	Design H2O PDW Feet	Device Actual PDW Feet	Device Actual PDW PSI	Coil Width	Coil Length	Design GPM	% of Design	Actual GPM	Auto Ghost Min/Max
1		0	0				124.00	74.50		%	168.10	

Item: 1
Missing: No **Extra:**No
Manual: No **Auto-Flow:**No

WARNING: Design Fluid Velocity is considered insufficient for the Piping installed in this terminal device, discuss with the design engineer if this is oversized for this installation.

Design Pipe Size In	Design Pipe Fluid Velocity Ft/min
	0.00

WARNING: Actual Fluid Velocity is considered excessive for the Piping installed in this terminal device, discuss with the design engineer if this is undersized for this installation.

Actual Installed Pipe Size ID In	Actual Pipe Fluid Velocity Ft/min
4.50	8.37

WARNING: Smallest Segment Fluid Velocity is considered insufficient for the Piping installed in this terminal device, discuss with the design engineer if this is oversized for this installation.

Smallest Segment Installed Pipe Size ID In	Smallest Segment Pipe Fluid Velocity Ft/min
	0.00

Device Mfg:	**Design Coil Delta PSI Water**

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Page from report

System OA / RA — System is at 41.95% OA and 58.05% RA

	Expect Energy Consumption (Chillers, Boilers, HVAC Fans, Pumps, etc.) to Increase Energy Consumption by	Expect Heat Transfer and Efficiency to drop	(2 Sets) Pre & Final Filter - Change @ indicated SP In/WC
Filters Changed @ 10% Loaded:	111.11%	10%	1.16
Filters Changed @ 15% Loaded:	117.65%	15%	1.30
Filters Changed @ 20% Loaded:	125.00%	20%	1.47

Building Pressure

(Design) Positive Building Pressure Minimum:	+ 0.02 In/WC to + 0.05 In/WC

(Actual) Building Pressure:

Space Pressurization (In/WC)	Space Pressurization To	System Pressurization Comment

AMP Factor

This systems specific AMP Outside Air (O/A) Factor:	12.15

AMP Approval Process Comments History

Status	Comment created on	Comment	Comment created by
No data			

Page from report

Miss-aligned at time of report generation	No
Miss-aligned but corrected at time of report generation	No

Belt(s) Looseness:

No Issues apparent	No
Loose at time of report generation	No
Loose but corrected at time of report generation	No

Belt Tension

No Issues apparent	No
Overtightened at time of report generation	No
Overtightened but corrected at time of report generation	No

Motor Frame Alignment

No Issues apparent	No
Motor pulley is slightly out of plane (cocked) with regards to fan pulley, which is still the condition	No
Motor pulley is slightly out of plane (cocked) with regards to fan pulley, but corrected at time of report generation	No

Bolt(s) Securing Motor Frame

No Issues apparent	Yes
Bolt(s) found loose at time of report generation	No
Bolt(s) found loose but corrected at time of report generation	No

Mechanical Equipment Heat

No Issues apparent	Yes
Motor appears excessively hot	No
Motor Bearing(s) appears excessively hot	No
Fan Bearing(s) appears excessively hot	No
Motor bearing abnormal noise present	No

2022 ENERGY STAR CERTIFIED BUILDING

AMP | ONE O'HARE CENTRE PROJECT

ONE O'HARE CENTRE

Built in 1986 in Rosemont, IL | 400k SF

Ownership: SPIRE HRA ONE LP | Property Management: MDC Reality Advisors

RESULTS

Over 40% HVAC energy savings | ROI <1.5 mos.

Certified by AMP for HVAC energy efficiency & infectious disease compliance complementing existing LEED Gold certification.

METHODOLOGY

AMP's patented process & software used to test HVAC system performance versus the HVAC system's designed performance.

AMP software prescribed solutions to optimize all system components, mechanical, and heat transfer devises.

AMP report provides full visibility of pre and post test results to building management for improved governance of work related to recommended solutions.

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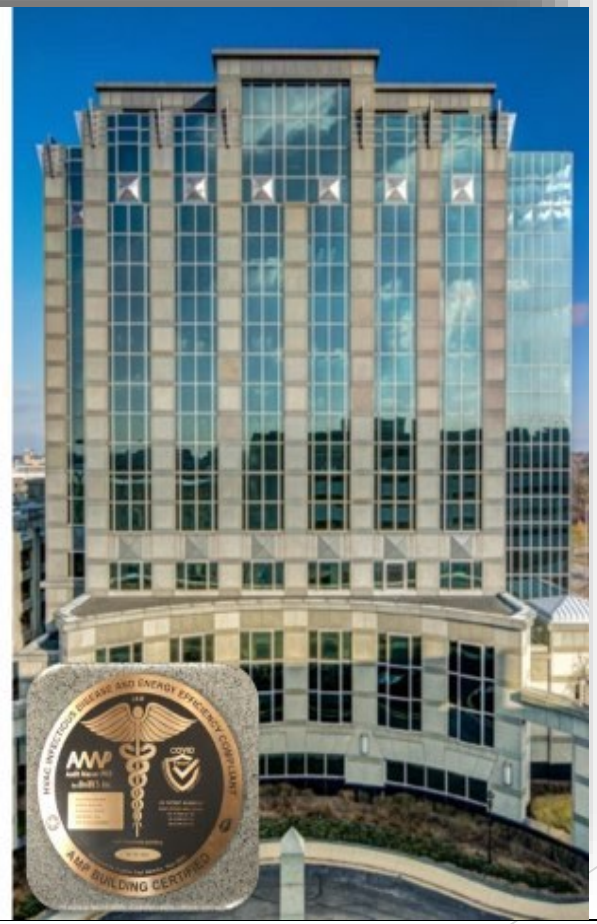

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AMP Plaques
Designate your Buildings as
Energy Efficient and Infectious Disease Compliant

Plaque

- 100% Bronze for inside or outside applications.
- 30” Round.
- 103 Pounds.
- Other styles and sizes are available.

Audit Master PRO by UniBES Inc.

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