NEW FEATURES
IN THE
CARRIER
HOURLY ANALYSIS PROGRAM v4.40

By: Carrier Software Systems
Carrier Corporation
Syracuse, New York

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Table of Contents

Introduction

This document describes enhancements in the Carrier Hourly Analysis Program (HAP) v4.40. Most of the enhancements in v4.40 relate to two major themes, described in this introduction. Following this Introduction, section 1 provides a concise summary list of all v4.40 enhancements. Subsequent sections then describe these enhancements in more detail.

1. **Theme 1 - Making HAP Easier to use for LEED Energy and Atmosphere Credit 1 Analysis.** : HAP has been modified to streamline steps needed to perform a LEED EA Credit 1 analysis so the analysis is faster and easier to perform Specific modifications include:

   - **LEED NC 2.2 EA Credit 1 Summary Report**. This new report provides data found in sections 1.1, 1.3, 1.5, 1.8.1, 1.8.1b, 1.8.2 and 1.8.2b of the LEED NC 2.2 EA Credit 1 on-line submittal template and imitates the format of the submittal template. This report eliminates the tedious work of assembling submittal template report data from multiple HAP reports.

   - **Duplicate Building with Spaces and HVAC Eqpt option.** This new option automatically duplicates a HAP building and all the systems, plants, spaces, chillers, cooling towers and boilers it contains in one step. This option is useful when starting definition of the Baseline building based on a duplicate of data for the Proposed Building. More importantly it facilitates placing Proposed and Baseline buildings in a single project so the Credit 1 Summary Report can be generated.

   - **Perform LEED (90.1 PRM) Rotations option.** This new option automatically makes three copies of the "Baseline 0 Degree" building and all of its systems, plants, spaces, chillers, cooling towers and boilers. In the three copies spaces are rotated 90 deg, 180 deg and 270 deg respectively. This provides a rapid way to generate the three rotations of the Baseline building. It also makes it efficient to place all Proposed and Baseline buildings in a single project so the Credit 1 Summary Report can be generated.

   - **Autosizing for DX and Plant Equipment.** This feature allows you to specify that equipment gross capacity be automatically determined as peak load plus a specified percent oversizing factor. For example peak cooling load + 15%.

   - **Input DX Equipment Performance as EER or COP.** This feature allows you to specify DX equipment as EER for cooling or COP for heating. The software then automatically decompiles the EER or COP to determine compressor kW for use in the simulation.

   - **All Terminal Units Use Same Settings.** When defining equipment performance for DX fan coils, WSHP, GWSHP or GSHP equipment, this new option allows you to specify one set of EER or COP performance values to apply to all zone terminal units in a system. This saves you from having to define compressor kW for each zone fan coil or heat pump separately.

   - **Baseline Fan kW Calculated per ASHRAE 90.1 Appendix G section G3.1.2.9.** When defining air systems for a Baseline building, you have the option of defining supply fan performance be

automatically calculated per the equation in section G3.1.2.9. This equation sets the total fan kW for the system.

- **Fan Performance Defined as W/CFM.** When specifying fan performance for fan powered mixing box terminals, performance can be input as W/CFM (W/L/s). The program will then automatically derive the fan watts from the design CFM for the box.

- **ASHRAE 90.1 Appendix G VAV Fan Part-Load Curve.** VAV fan part-load performance can be modeled using the VAV fan curve found in Appendix G Table G3.1.3.15.

- **Water Flow Rate Inputs as gpm/Ton or Delta-T.** New options allow water flow rates to be defined in terms of gpm/Ton (L/s/kW) or delta-T in addition to gpm.

- **Water Pump Performance as W/gpm or kW.** New options allow water pump performance to be defined in terms of W/gpm (W/L/s) or kW in addition to the existing specification of pump head.

2. **Theme 2 - Adding Features for Preliminary or Schematic Design.**   Throughout its history HAP has focused on system design and energy analysis tasks typically occurring in the detailed design phase of a project. These tasks involve detailed definition of the building envelope, layout and HVAC equipment, and require time consuming data entry to create a suitably detailed building model. When performing energy analysis in the preliminary or schematic design phase of a project, the objective is to quickly and roughly compare a large set of design alternatives to identify the most promising designs. This work typically does not require as detailed a definition of the building and its HVAC equipment. To make HAP more efficient for performing these types of analyses, new Wizard features have been added to allow users to rapidly generate input data for an analysis. This work builds on the Building Wizard feature offered in HAP v4.3. Specific enhancements include:

- **New Wizards Menu.** Provides options for running Building Wizard or Equipment Wizard alone, and for running an integrated session linking Building and Equipment Wizards together.

- **Building Wizard Option.** The Building Wizard option on the Wizards Menu can be used to rapidly generate space data for a building. The Building Wizard has been revised and upgraded for HAP v4.4.

- **Equipment Wizard Option.** The Equipment Wizard option on the Wizards Menu can be used to rapidly generate HVAC equipment for a building - specifically all of the air systems, plants, chillers, cooling towers, and boilers, as applicable.

- **Full Wizard Session Option.** The "Full Wizard Session" option on the Wizards Menu allows you to run the Building Wizard and Equipment Wizard in tandem. In a single Wizard session you can generate space data and data for multiple equipment designs. This essentially creates 95% of the input data for an energy cost study in minutes rather than hours or days. Only weather and utility rate data must be added before running calculations.

1. Full Summary List of Enhancements in v4.40

A complete summary list of enhancements in HAP v4.40 is provided below. More detailed explanations are found in subsequent sections.

1. **Main Window**
   - Wizards Menu
   - ASHRAE Standard 62.1-2007 option on View/Preferences window.

2. **Wizards**
   - Updated Building Wizard
   - New Equipment Wizard
   - New Full Wizard Session option.

3. **Weather**
   - Data for 10 new international cities added to simulation weather library.

4. **Spaces**
   - Define ventilation requirements based on space usage types in ASHRAE Standard 62.1-2007
   - Add Internal Heat Gains and Schedules to Spaces More Easily using the Global Replace Feature
   - Increased maximum spaces per project limit to 32000.

5. **Air Systems**
   - Autosize DX equipment gross cooling or heating capacity based on peak load plus a specified oversizing factor.
   - Define DX equipment performance as EER or COP. Program automatically derives the corresponding compressor input kW.
   - "All Terminal Units use Same Settings" option for DX Fan Coil, WSHP, GWSHP and GSHP equipment performance inputs.
   - New system types for Ground Water Source Heat Pump (GWSHP) and Ground Source Heat Pump (GSHP).
   - Define fan performance as W/CFM.
   - Define fan performance be automatically calculated per ASHRAE Std 90.1-2004 Appendix G section G3.1.2.9.
   - ASHRAE 90.1-2004 Appendix G VAV part-load fan curve.
   - Calculate ventilation requirements per ASHRAE Standard 62.1-2007.

6. **Plants**
   - Autosize plant capacity based on peak plant load plus a specified oversizing factor.
   - Automatically determine chiller capacity splits in a multiple-chiller plant.
   - Explicit LCHWT control options: Constant LCHWT, LCHWT Reset based on OADB Schedule, LCHWT Reset based on Return Water Temperature
   - Upgraded chiller plant simulation algorithm to model multiple cooling towers on a single piping loop, thereby allowing waterside economizer modeling for all cooling tower configurations.
   - Define water pump performance as W/gpm (W/L/s) or kW in addition to specifying pump head.

7. **Buildings**
   - New LEED NC 2.2 EA Credit 1 Summary Report
   - New "Duplicate Building (with Spaces and HVAC Eqpt)" option.
   - New "Perform LEED (90.1 PRM) Rotations" option.
   - Revised Misc. Energy Use tab to allow designation of energy use items as Process or Non-Process end uses.

8. **Chillers**
   - Autosize chiller capacity.
   - Define cooler and condenser flow rates as gpm/Ton (L/s/kW) or delta-T in addition to gpm.
   - Improved algorithm for modeling minimum load behavior for packaged chillers.
   - New feature for modeling non-integrated and integrated DX free cooling for air-cooled packaged chillers.
   - Updated default LCHWT correction factors for air-cooled packaged chillers.
   - Expanded certain input limits.

9. **Cooling Towers**
   - Define condenser flow rate as gpm/Ton (L/s/W) in addition to gpm.
   - Define condenser pump performance as W/gpm (W/L/s) or kW in addition to specifying pump head.
   - Update to VFD tower fan algorithm to cycle the fan below 25% airflow.

10. **Boilers**
   - Autosize boiler capacity.
   - Define hot water flow rate as delta-T or gpm/Ton (L/s/kW) in addition to specifying pump head.
   - Streamlined definition of full load performance.

11. Documentation
- Update help system and Quick Reference Guide to document new features.
- New overview and tutorials for Preliminary Design Energy Analysis using Wizards.

12. Bug Fixes
- Corrected a number of problems identified in HAP v4.34. A complete list is provided in section 1.2 of the program on-line help system,

2. New Wizard Features

1. Wizards Menu
- This new menu provides options for running the Building Wizard or Equipment Wizard alone, and for running a Full Wizard Session that integrates both Building and Equipment Wizards.

2. Updated Building Wizard
- Modified to support operating in SI Metric Units and with a wider range of numeric formatting conventions such as those used in Europe.
- Added option to set space ventilation requirements based on space usage types from ASHRAE Standards 62-2001, 62.1-2004 or 62.1-2007.
- To make the Building Wizard compatible with the Wizard Menu and the Full Wizard Session, the Building Wizard was modified to change it from a three-screen format to a two-screen format.

3. New Equipment Wizard
- This new wizard allows you to rapidly apply HVAC equipment to a building. With a few simple input screens you can use this Wizard to generate all of the air systems, plants, chillers, cooling towers and boilers for an energy analysis.

4. Full Wizard Session
- The "Full Wizard Session" option on the Wizards Menu allows you to run the Building Wizard and Equipment Wizard in tandem. In as single Wizard session you can generate space data and data for multiple equipment designs. This essentially creates 95% of the input data for an energy cost study in minutes rather than hours or days. Only weather and utility rate data must be added before running calculations.

3. New Weather Features

1. Added 10 cities to the simulation weather library:
- Easter Island, Chile
- Semipalitinsk, Kazahkstan
- Lubljana, Slovenia
- Ekaterinburg, Russia
- Irkutsk, Russia
- Samara, Russia
- Kiev, Ukraine
- Odessa, Ukraine
- London-Gatwick, United Kingdom

4. New Space Features

1. Define Ventilation Requirements Based on Space Usage Types in ASHRAE Standard 62.1-2007
- The Preferences option on the View Menu provides a new option for basing project ventilation requirements on ASHRAE Standard 62.1-2007. This is in addition to the existing options for 62-2001 and 62.1-2004. When the 62.1-2007 preference is selected, you will have the ability to

choose from 62.1-2007 space usage types when entering spaces and have the space ventilation requirements defaulted based on that space usage type.

2. **Add Internal Heat Gains and Schedules to Spaces More Easily using the Global Replace Feature**
   - The global replace feature (accessed via the Replace option on the Edit Menu) has been streamlined to make adding internal heat gains and heat gain schedules easier. Previously if spaces did not contain data for a particular heat gain (task lighting for example), the Replace feature would not allow a schedule to be added. If you attempted to add a W/sqft or W heat gain value, the software would prompt you to specify a corresponding schedule for each space, thereby slowing the process. With the revision in HAP v4.4, you can add or modify heat gains or schedules without any preconditions or restrictions making the Replace process faster, easier and more versatile.

3. **Increased Maximum Spaces per Project Limit to 32000.**
   - This change was made to accommodate both larger projects and the increased storage requirements for holding a complete LEED Energy and Atmosphere Credit 1 analysis in a single project. In the latter case spaces for the 5 LEED EAc1 analysis buildings must be stored.

5. New Air System Features

1. **Autosize DX Equipment Gross Cooling or Heating Capacity**
   - When defining DX cooling equipment performance, you now have the option to specify that HAP automatically determine the gross cooling capacity based on peak coil load plus a specified oversizing factor. Example: Peak Load + 15%. This feature is primarily used for LEED EA Credit 1 analyses but is useful for preliminary or schematic design analyses as well.
   - When defining DX heat pump equipment performance, you now have the option to specify that HAP automatically determine the gross heating capacity based on peak coil load plus a specified oversizing factor. Example: Peak Load + 25%. This feature is primarily used for LEED EA Credit 1 analyses but is useful for preliminary or schematic design analyses as well.

2. **Define DX Equipment Performance as EER or COP**
   - When defining DX cooling equipment performance, you now have the option of entering the ARI or ISO/ARI performance rating value in EER. When this option is used, the program automatically decompiles the EER to determine compressor + OD fan kW for air-cooled equipment, or compressor kW for water-cooled equipment. This feature has applications for LEED EA Credit 1 analyses as well as standard energy analysis work.
   - When defining DX heat pump equipment performance, you now have the option of entering the ARI or ISO/ARI performance rating value in COP. When this option is used, the program automatically decompiles the COP to determine compressor + OD fan kW for air-cooled equipment, or compressor kW for water-cooled equipment. This feature has applications for LEED EA Credit 1 analyses as well as standard energy analysis work.

3. **"All Terminal Units use Same Settings" Option**
   - When entering equipment performance information for DX Fan Coil, WSHP, GWSHP or GSHP equipment, you now have the option to define one set of performance data to apply to all zone units instead of specifying separate values for each zone unit. For example, in a system with 100 WSHP units, you could apply one specification for cooling for autosizing to peak load + 15% and a particular ISO/ARI EER value to all 100 WSHP units instead of specifying separate capacity and EER or kW values to all 100 units. This is an important time saving feature which has application both for LEED EA Credit 1 analyses and standard energy analysis work.

4. **New System Types for GWSHP and GSHP**
   - New air system type options were added for Ground Water Source Heat Pump (GWSHP) and Ground Source Heat Pump (GSHP) equipment. These options are found in the system list when Equipment Type is "Terminal Units."

5. **Fan Performance as W/CFM**
   - Fan performance can be defined in terms of W/CFM (W/L/s). This feature has application in LEED EA Credit 1 analyses when modeling fan powered mixing box fans and may have wider use when running preliminary or schematic design analyses.

6. **Fan Performance Automatically Calculated per ASHRAE Std 90.1-2004 Appendix G**
   - A new fan performance option was added for supply fans to automatically calculate system fan kW per ASHRAE Standard 90.1-2004 Appendix G section G3.1.2.9. When this option is chosen, the program calculates system fan kW per Appendix G and then automatically overrides any fan performance specifications for return, relief and exhaust fans. This override is required because the Appendix G calculation defines the total allowable fan kW for a system, not just the fan kW for a single fan.

7. **ASHRAE Std. 90.1-2004 Appendix G VAV Part-Load Fan Curve**
   - An option was added to model VAV fan part-load performance per the fan curve provided in ASHRAE Standard 90.1-2004 Appendix G, Table G.3.1.3.15. This is required when modeling air systems for the Baseline building in a LEED EA Credit 1 analysis.

8. **ASHRAE Std. 62.1-2007 Ventilation Calculations**
   - An option was added to calculate outdoor ventilation airflow requirements per the Ventilation Rate Procedure in ASHRAE Standard 62.1-2007.

6. New Plant Features

1. **Autosize Plant Capacity**
   - A plant can be designated to autosize capacity or to accept a user-defined capacity. When the autosize option is selected, HAP will automatically determine plant capacity based on peak plant load from the design calculations plus a specified oversizing factor. Example: Peak cooling plant load + 15%. When the user-defined capacity option is selected, the plant capacity will be determine from capacities of a boiler or individual chillers linked to the plant. The autosize option is useful for LEED EA Credit 1 analyses and for preliminary or schematic design analyses.

2. **Automatically Determine Chiller Capacity Splits**
   - When the autosize option is used for a chiller plant, the user specifies the number of chillers in the plant and the capacity split. The program automatically determines chiller full load capacity based on these specifications. For example, in a 2-chiller plant options such as "equally sized", "60%/40%, or "80%/20%" are offered for defining the capacity split.

3. **LCHWT Control Options**
   - A new option for LCHWT reset based on an outdoor air dry-bulb schedule was added.
   - The choice of LCHWT control is not explicit. A user selects from the options Constant LCHWT, LCHWT reset based on OADB schedule and LCHWT reset based on RWT (Load). Previously, the choice of LCHWT control was implied based on the design and maximum LCHWT values entered. When inputs implied reset, reset was based on holding a constant return water temperature.

4. **Upgraded Algorithm for Cooling Towers**
   - The chiller plant simulation algorithm was updated to model all cooling towers on a single water loop. For the "each chiller served by a separate cooling tower" configuration, individual cooling towers and condenser pumps were still paired with individual chillers in the plant, but the towers are on a single piping loop which allows waterside economizer to be used in this configuration. Previously waterside economizer was only offered for the "all chillers served by the same cooling tower" configuration.

5. **Water Pump Performance as W/gpm and Delta-T**
   - Water pump performance can now be defined as W/gpm (W/L/s) or kW in addition to the existing option of specifying pump head. This is useful both for LEED EA Credit 1 analyses and for preliminary or schematic design applications.

7. New Building Features

1. **LEED NC 2.2 EA Credit 1 Summary Report**
    *   This new report provides data found in sections 1.1 (General Information), 1.3 (Advisory Messages), 1.5 (Energy Type Summary), 1.8.1 (Baseline Performance), 1.8.1b (Baseline Energy Costs), 1.8.2 (Performance Rating Table) and 1.8.2b (Energy Cost and Consumption by Energy Type) of the LEED NC 2.2 EA Credit 1 on-line submittal template. The format of the report imitates the format used in these sections of the submittal template. The report contains energy simulation results from the Proposed Design and the Baseline 0 deg, Baseline 90 deg, Baseline 180 deg and Baseline 270 deg buildings; all five buildings must be in the same project to be combined on this report. This report eliminates the tedious work of assembling submittal template report data from multiple HAP reports.

2. **Duplicate Building (with Spaces and HVAC Eqpt) option**
    *   This new option automatically duplicates a HAP building and all the systems, plants, spaces, chillers, cooling towers and boilers it contains in one step. This option is useful in a LEED EA Credit 1 analysis when starting definition of the Baseline building based on a copy of data for the Proposed Building. More importantly it makes it easy to place Proposed and Baseline buildings in a single project so the Credit 1 Summary Report can be generated.

3. **Perform LEED (90.1 PRM) Rotations option.**
    *   This new option automatically makes three copies of the "Baseline 0 Degree" building and all of its systems, plants, spaces, chillers, cooling towers and boilers. In the three copies spaces are rotated 90 deg, 180 deg and 270 deg respectively. This provides a fast way to generate the three rotations of the Baseline building needed for a LEED EA Credit 1 analysis. It also makes it efficient to place all Proposed and Baseline buildings in a single project so the Credit 1 Summary Report can be generated.

4. **Updated Misc. Energy Use Tab**
    *   A new check box input was added to designate each energy use item as a Process or non-Process energy use. The designation of process energy use is needed for LEED EA Credit 1 analyses.
    *   Removed the check boxes used to turn rows in the energy use table on and off. Now all 10 rows in the table appear at all times. A row is only relevant if it specifies energy use data.

8. New Chiller Features

1. **Autosize Chiller Capacity**
    *   The autosize option is used in conjunction with the autosize capacity option in the chiller plant. When a chiller plant uses the autosize capacity option, only individual chillers also specifying autosize capacity can be linked to the plant. When the autosize option is selected for a chiller the chiller full load capacity does not need to be entered.

2. **Cooler and Condenser Flow Rates as gpm/Ton or Delta-T**
    *   Cooler and condenser flow rates can now be entered as gpm/Ton (L/s/kW) or delta-T in addition to gpm.

3. **Cooler and Condenser Pressure Drop Inputs Removed**
    *   The Cooler Pressure Drop and Condenser Pressure Drop inputs were removed. These inputs were only reference values and were not used in any calculations.

4. **Minimum Load Modeling for Packaged Chillers**
    *   For packaged chillers whose performance map data is defined in terms of compressor stages instead of % load, the Minimum Load input does not appear. Instead, the minimum load is determined during the simulation directly from the performance map data. It varies as a function of the entering condenser temperature. Note that performance map data is currently only defined in terms of compressor stages when data for a Carrier air-cooled packaged chiller is imported from the ECAT Packaged Chiller Builder program.

5. **DX Free Cooling for Air-Cooled Packaged Chillers**
   - Added capabilities for modeling DX free cooling in air-cooled packaged chillers. With the DX free cooling feature, at low outdoor air temperature conditions the chiller may be able to turn off the compressor and use a small pump to circulate refrigerant between the evaporator and condenser to serve the load, thereby significantly reducing energy consumption. Both non-integrated and integrated types of DX free cooling can be modeled via an input on the Design Inputs tab. When DX free cooling is specified, an extra tables appears on the Performance Map tab to define DX free cooling performance. With non-integrated DX free cooling the chiller operates in 100% mechanical cooling or 100% DX free cooling modes. With integrated DX free cooling, the chiller can operate in these two modes and a mixed mode where one compressor circuit uses DX free cooling and one circuit uses mechanical cooling. This mode expands the number of operating hours per year during which DX free cooling can be used.
   - Updated the Chiller Import feature to accept DX Free Cooling performance data from the ECAT Packaged Chiller Builder program.

6. **Updated LCHWT Correction Factors for Air-Cooled Packaged Chillers**
   - LCHWT correction factors for the performance map (used when calculating performance at off-design LCHWT conditions) were upgraded for air-cooled packaged chillers based on a new study of equipment performance.

7. **Changes to Certain Input Limits**
   - Expanded the maximum size of the performance map from 6 to 8 rows.
   - Increased the input range for the Full Load LCHWT input from 34-70 F (1.1-21.1 C) to 10-75 F (-12.2-23.9 C)
   - Reduced the minimum limit for Full Load ECWT, Full Load EACWT and Full Load OAT inputs from 70 F (21.1 C) to 60 F (15.6 C).

9. New Cooling Tower Features

1. **Condenser Flow as gpm/Ton or Delta-T**
   - Condenser flow rate can now be entered as gpm/Ton (L/s/kW) or delta-T in addition to gpm.

2. **Condenser Pump Performance as W/gpm or kW**
   - Condenser pump performance can now be entered as W/gpm (W/L/s) or kW in addition to specifying pump head. This is useful for LEED EA Credit 1 analyses and preliminary or schematic design analysis.

3. **VFD Tower Fan Algorithm**
   - The simulation algorithm for VFD tower fan operation was modified to model VFD operation down to 25% of design airflow and then fan cycling below 25% airflow. Previously VFD operation was modeled for all part-load airflow levels, but resulted in inefficient operation at airflows below 25%.

10. New Boiler Features

1. **Autosize Boiler Capacity**
   - The autosize option is used in conjunction with the autosize capacity option in the boiler plant. When a boiler plant uses the autosize capacity option, only a boiler also specifying autosize capacity can be linked to the plant. When the autosize option is selected for a boiler, the boiler gross output does not need to be entered.

2. **Hot Water Flow Rate as Delta-T and gpm/Ton**
   - Hot water flow rate can now be entered as delta-T or gpm/Ton (L/s/kW) in addition to gpm. The gpm/Ton option is only used for WSHP loop applications.

3. **Streamlined Definition of Full Load Performance**
   - The Boiler input window was streamlined to only ask for Boiler Gross Output and Full Load Efficiency. Previously the window also contained an input for Boiler Input. This change was made for compatibility with the autosize feature.

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