

# What is E20 II?

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Carrier's E20 II is a collection of software programs created specifically for the HVAC system designer. These programs are tailored to increase productivity and accuracy, improve analysis capabilities and job documentation, and add a level of "marketability" to a designer's estimates. Individual programs are available to assist in heating & cooling load estimating (Block Load, HAP), annual building operating cost estimating (HAP) and economic life cycle analysis (Engineering Economic Analysis). These programs are written by HVAC systems engineers for HVAC systems engineers, and are supported by more HVAC system engineers with years of field application experience.

## What Is HAP (Hourly Analysis Program) ?

Carrier's HAP is a dual function program – full-featured load estimating and system sizing for commercial

buildings plus versatile hour-by-hour energy and operating cost analysis. By combining both tools in one package significant time savings are achieved. Input data and results from system design calculations can be used directly in energy studies.

The core philosophy of HAP is that thermal loads of a building are calculated using the ASHRAE-endorsed Transfer Function load method. System components are then sized using the System-Based Design concept, which applies the ASHRAE-endorsed Heat Extraction Methodology to link system performance to building thermal loads. Energy analysis uses full 8760 hours-per-year analysis to evaluate the operation of a wide variety of air handling and plant equipment. Operating costs are computed based on energy use and demand charges. A wide range of tabular and graphical outputs is available which can be directly used as a submittal for the project.

In addition, HAP's 8760 hours energy analysis capabilities are very useful for green building design. For instance, HAP energy analysis results are accepted by the U.S. Green Building Council for its LEED® (Leadership in Energy and Environmental Design) Rating System. (Visit [www.usgbc.org](http://www.usgbc.org) for more LEED® info at the USGBC's website)

## Some Key Program Features

**gbXML Import** : gbXML is a neutral format for sharing building information between design tools such as CAD, Building Information Modeling (BIM), system design and system simulation programs. HAP allows to import data from a file containing data in gbXML format. For

## About the Author

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example, starting with a CAD floor plan drawing, building information can be extracted and saved in a gbXML file. HAP can then import the gbXML data to automatically generate spaces and other data. This transfer of electronic data replaces the traditional manual process of taking off data from drawings and entering it into HAP, thereby significantly increasing productivity & eliminating the human error possibilities.

**Building Wizard :** This feature is useful for quick and preliminary design and screening applications. Normally HAP uses a “bottom-up” approach to defining building characteristics. Schedules plus wall, roof and window characteristics are defined first. Spaces are then entered one-by-one. By contrast the Building Wizard uses a top down approach. The user first describes the overall size and shape of the building and the type of zoning used. Then the user selects the wall, roof and window constructions used, specifies internal loads and selects schedules for these loads. Finally the Wizard automatically generates data for all spaces in the building that were described. In this way spaces for an entire building can be rapidly generated.

**System Design Features :** HAP uses a system-based approach to design calculations, which tailors sizing procedures and reports to the specific type of system being designed. This offers productivity advantages over simple “load calculation” programs which require the engineer to apply calculation results to size system components.

Features are suitable for sizing systems involving central station air handlers, packaged rooftop units, self-contained units, split systems, DX fan coils, hydronic fan coils and water source heat pumps.

Sizing data is provided for central cooling and heating coils, preheat and precool coils, fans, humidifiers, terminal reheat coils, CAV and VAV air terminals, fan powered mixing boxes, perimeter baseboard units, fan coils and terminal heat pumps plus chillers and boilers.

HAP calculates required space, zone and system airflow rates. Calculations are tailored to the specific system type.

Airflow sizing calculations can be based on design values of supply temperature, cfm or cfm/sqft. Calculations also consider minimum flow specifications in cfm, cfm/sqft, cfm/person which are important for maintaining adequate ventilation and indoor air quality.

Space minimum ventilation airflow requirements can be set based on ASHRAE Standard 62-2001, ASHRAE Standard 62.1-2004 or user-defined values.

System minimum ventilation airflow requirements can be calculated using the ASHRAE Standard 62-2001 or ASHRAE Standard 62.1-2004 calculation procedures, or can be calculated as a simple sum of space ventilation

requirements.

The ASHRAE Transfer Function Method is used to calculate building heat flow.

Key sizing reports summarize data needed for equipment selection in two simple pages.

Additional reports provide component loads, hourly load profiles, detailed hourly performance data and psychrometric charts.

The program is suitable for new construction and retrofit applications.

**Energy Analysis Features :** HAP performs a true hour-by-hour energy analysis, using measured weather data for all 8,760 hours of the year to calculate building heat transfer and loads, air system operation, and plant equipment operation.

Hourly energy consumption by HVAC components (e.g., compressors, fans, pumps, heating elements) and non-HVAC components (e.g., lighting, office equipment, machinery) is tabulated to determine the total building energy use profile as well as daily and monthly totals.

Energy consumption data and utility rate information is used to calculate the energy cost for each energy source or fuel type.

Because energy analysis reuses input data from the system design work, typically 50% to 75% of the input work needed for an energy analysis is complete once system design is finished.

**Climate Analysis Features :** It provides a database of design weather data for over 800 cities worldwide using TMY (Typical Metrological Year) and TRY (Typical Reference Year) type hourly weather data for energy simulations.

It also provides a library of simulation weather data for over 500 cities worldwide

**Load Calculation Features :** Load calculation feature uses ASHRAE Transfer Function cooling load calculation procedures, ASHRAE design heating load calculation procedures, ASHRAE design weather data, ASHRAE design solar calculation procedures.

*It calculates space and zone loads 24-hours a day for design days in each of the 12 months. In doing so it calculates heat flow for all room elements such as walls, windows, roofs, skylights, doors, lights, people, electrical equipment, non-electrical equipment, infiltration, floors and partitions considering time of day and time-of-year factors.*

*It then performs detailed simulation of air system operation to determine cooling coil loads and heating coil loads and other aspects of system performance 24-hours a day for design days in each of the 12 months.*

### **Analyzes Plenum Loads**

It considers any operating schedule for HVAC

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equipment from 1 hour to 24 hours in duration.

It also permits hourly and seasonal scheduling of occupancy, internal heat gains, and fan and thermostat operation.

**System Design Reports**

Detailed system design reports as mentioned below are generated and can be used for copy-and-paste from displayed reports into other documents, and for saving reports as RTF-format documents.

**Air System Sizing Summary:** Sizing data like coil load, CFM, ADP etc for central cooling and heating coils, supply and return fans.

**Zone Sizing Summary:** Peak loads and airflow rates for all spaces and zones served by the system.

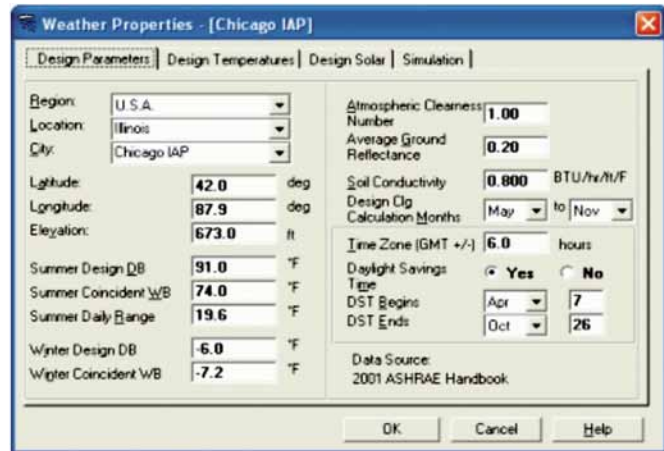
**Ventilation Sizing Summary:** Documents how minimum ventilation airflow rates are calculated. Report has different content depending on whether ASHRAE Std 62-2001, ASHRAE Std 62.1-2004 or Sum of Outdoor Airflows was chosen as the calculation method.

**Design Load Summaries:** Three separate reports providing itemized lists of component loads for systems, zones and spaces respectively. Reports can be generated for any hour of any design day during the year.

**Hourly Load Profiles:** Two separate reports providing 24-hour profiles of loads and performance, available in both tabular and graphical formats. The system report lists system airflow rates and coil loads. The zone report lists zone loads, airflow rates, air temperatures and relative humidity. The reports can be generated for any design day during the year.

**System Psychrometrics:** Tabular version of the report provides information about airflow rates, temperatures, humidities and heat flows for each point within the system. It is useful for understanding and troubleshooting system operation. Graphical version of the report plots state points on a psychrometric chart. It can also be generated for any hour of any design day.

**Plant Sizing Summaries:** Separate reports provide



sizing information for chilled water, hot water and steam plants serving one or more air systems.

**Chiller Load Profiles:** Lists 24-hour profiles of loads for a chiller plant serving one or more air systems. Can be generated for any design day and can be graphed.

**Energy Analysis Reports**

The energy analysis report summary generated are used for comparing energy use and energy cost of alternate building designs. In this, detailed reports provide annual, monthly, daily and hourly performance data and can be quickly understood.

**Comparative Building Reports:** These reports summarize annual component costs and energy use for buildings. Results for as many alternative building designs as desired can be compared side by side on these reports.

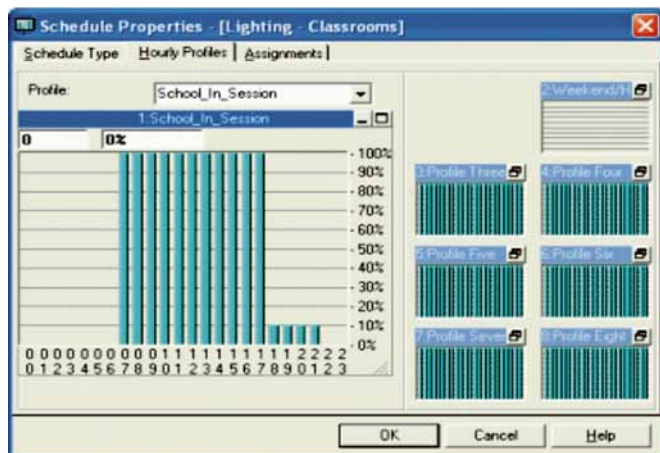
**Summary Building Reports:** These reports list annual component costs and energy use for individual buildings, combining graphics with tabular data. Includes energy budget reports.

**Detailed Building Reports:** These reports provide detailed month-by-month cost and energy use data for a building. Many combine graphics and tabular data in a single report. Includes a report documenting the calculation of each utility bill, showing monthly consumption, peak demand and time of peak demand data.

**Usage Profiles:** Presents hourly profiles of electric power or fuel use for any range of days (from 1 to 365) selected by the user. This report is available in both tabular and graphical formats. Useful for studying energy use patterns for the building.

**Monthly Simulation Results:** Provides monthly and annual totals of coil loads and energy consumption for individual air systems and plants. Available in tabular and graphical formats.

**Daily Simulation Results:** Provides daily totals of coil loads and energy consumption for individual air systems and plants. Available in tabular and graphical formats.



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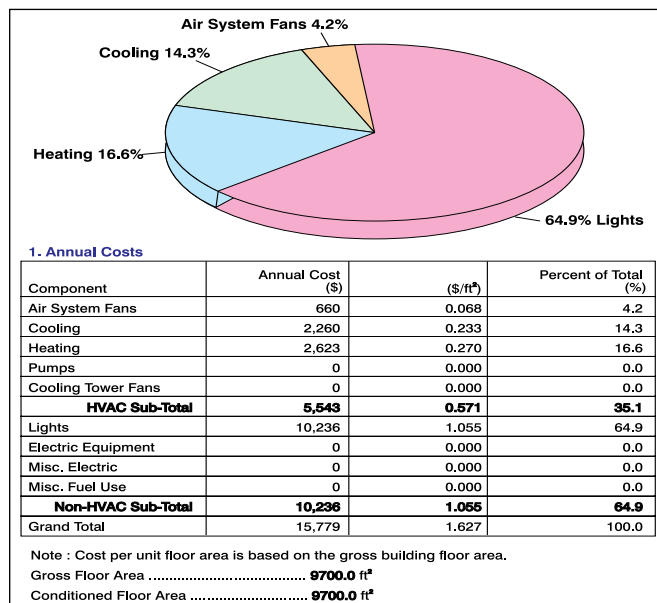
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<b>Air System Information</b>		Number of zones .....11
Air System Name .....Packaged Rooftop AHU	Floor Area ..... 9700.0	ft <sup>2</sup>
Equipment Class .....PKG ROOF	Location ..... Chicago IAP, Illinois	
Air System Type .....VAV		
<b>Sizing Calculation Information</b>		Calculation Months ..... May to Nov
<b>Zone and Space Sizing Method</b>		Sizing Date ..... Calculated
Zone CFM .....Peak zone sensible load		
Space CFM.....Individual leak space loads		
<b>Central Cooling Coil Sizing Data</b>		
Total coil load ..... 33.7	Tons	Load occurs at ..... Aug 1600
Total coil load ..... 404.6	MBH	OADB / WB ..... 91.0 / 74.0 °F
Sensible coil load ..... 279.6	MBH	Entering DB / WB ..... 87.2 / 69.8 °F
Coil CFM at Aug 1600 ..... 7777	CFM	Leaving DB / WB ..... 53.1 / 52.6 °F
Max block CFM at Aug 1700 ..... 8401	CFM	Coil ADP ..... 51.8 °F
Sum of peak zone CFM ..... 8589	CFM	Bypass Factor ..... 0.038
Sensible heat ratio ..... 0.691		Resulting RH ..... 47 %
ft <sup>2</sup> /Ton ..... 287.70		Design Supply Temp ..... 55.0 °F
BTU/(hr-ft <sup>2</sup> ) ..... 41.7		Zone T-stat Check .....11of11 OK
Water flow @ 10.0 °F rise ..... N/A		Max zone temperature deviation ..... 0.0 °F
<b>Preheat coil Sizing Date</b>		
Max coil load ..... 199.6	MBH	Load occurs at ..... Des Htg
Coil CFM at Des Htg ..... 3265	CFM	Ent DB / Lvg DB .....-6.0 / 52.0 °F
Max coil CFM ..... 8401	CFM	
Water flow @ 20.0 °F drop..... N/A		
<b>Supply Fan Sizing Data</b>		
Actual max CFM at Aug 1700 ..... 8401	CFM	Fan motor BHP ..... 7.34 BHP
Standard CFM ..... 8199	CFM	Fan motor kW ..... 5.48 kW
Actual max CFM/ft <sup>2</sup> ..... 0.87	CFM/ft <sup>2</sup>	Fan static ..... 3.00in wg
<b>Outdoor Ventilation Air Data</b>		
Design air flow CFM ..... 3848	CFM	CFM/person .....19.05 CFM/person
CFM/ft <sup>2</sup> ..... 0.40	CFM/ft <sup>2</sup>	

Air system sizing summary for packaged rooftop AHU.

Hourly Simulation Results: Provides hourly coil load and energy performance data for individual air systems and plants. Available in tabular and graphical formats. Users may specify duration from 1 to 365 days in length. Graphical version is especially useful for studying both long and short-term performance trends for equipment.

**Zone Temperatures:** Provides statistical data for air



Annual component cost – base case design.

temperature levels in zones served by an air system. Useful for examining comfort levels and also troubleshooting system operating problems.

**Unmet Loads:** Provides summary of hours when equipment capacity is sufficient or is not sufficient to meet loads. Separate reports provided for air systems and plants. Useful when troubleshooting equipment operating problems.

**HAP in Accordance with International Codes**

- HAP energy analysis meets or exceeds the minimum software requirements for the Energy Cost Budget compliance path for ASHRAE Standard 90.1-2001, 90.1-2004 and 90.1-2007.

- HAP energy analysis meets or exceeds the minimum software requirements the

Performance Rating Method in Appendix G of ASHRAE Standard 90.1-2004 and 90.1-2007.

- HAP energy analysis results are accepted by the U.S. Green Building Council for use in submissions for the LEED® (Leadership in Energy and Environmental Design) Rating System.

- HAP has been tested according to procedures in ASHRAE Standard 140-2001, Standard Method of Test of the Evaluation of Building Energy Analysis Computer Programs.

**Other Useful Features for Designers**

- Allows the user to efficiently rotate the building orientation.

- Analyzes external shading from reveals, overhangs, fins.

- 100 plants, 250 systems and 2500 spaces, plus unlimited numbers of walls, roofs, windows, doors and schedules.

- Up to 100 zones per air system, up to 50 different spaces per zone, with multipliers allowed.

- Up to 8 wall constructions, 16 window constructions, 8 door constructions and 16 shade geometries per space.

For further information on E20 II and to order in India, please contact Carrier Airconditioning & Refrigeration Ltd, Gurgaon at email : bssindia@carrier.utc.com