NY STATEWIDE CLEAN HEAT CALCULATOR

HEAT RECOVERY CHILLERS (HRC)

Version 1.0

USER GUIDE

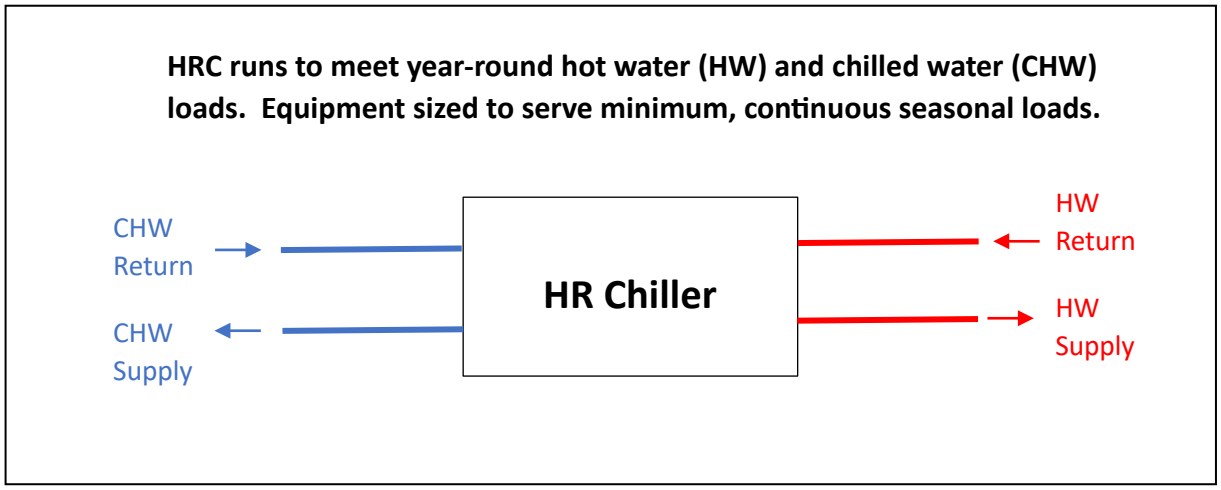
September 1, 2023

Contents

Summary

The Statewide Clean Heat Program Heat Recovery Chiller (HRC) Savings Calculator (Clean Heat HRC Calculator) is an excel based tool that is being developed to assist participating contractors applying to the New York State Clean Heat Program (Clean Heat Program) with calculating custom energy savings for the following heat recovery chiller technologies:

Heat Recovery Chiller (HRC) – chiller operating in mode where heat is moved between HW and CHW loops within the thermal envelope in buildings requiring simultaneous cooling and heating. Unit provides heating and cooling at the same time. Note: exempt from minimum annual heating thresholds applicable to each program.



This initial version enables users to quantify savings for specific HRC applications **ONLY** as indicated below. It also allows users to get a rough estimate of the savings for projects in the early stages to get a feasibility check on pursuing the project further.

When to Use this Calculator:

The Clean Heat HRC Calculator should be used as the default method to calculate energy savings for the technologies mentioned above if one or more of the following statements are true:

- The project involves installing water-source HRCs that meet or exceed the applicable minimum efficiency requirements in Table 6.8.1-16 of ASHRAE 90.1 – 2022.
- The Operating Mode for the HRC is: Simultaneous Heating and Cooling.
- The project building or facility operating conditions allows for a potential minimum of 6,000 equivalent full load hours (EFLH) of the HRC.
- For EFLH values lower than 8,760, the user has the option to enter the value manually.

In addition, the Version 1.0 Clean Heat HRC Calculator must be used for projects that have not yet received a **Preliminary Incentive Offer Letter** before September 1, 2023, superseding previously approved calculation results.

Revisions and Updates:

The following are the summary of updates from the last version of the Statewide Clean Heat HRC calculator:

Tab	Section	Summary of Revisions

Exceptions to Using Calculator:

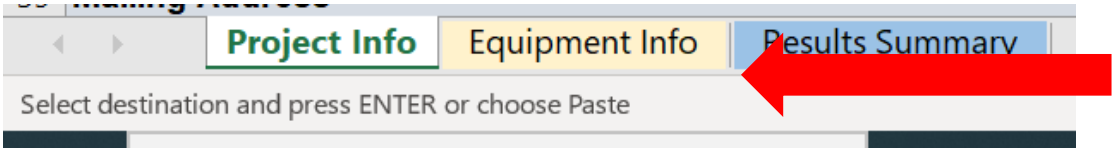
Under certain circumstances, applicants may bypass this calculator, opting instead to calculate savings using their own custom approach, even when one of the above statements is true. Justifiable reasons for doing so include, but are not limited to:

- The applicant has prepared a whole building energy model using one approved modeling software listed in the Clean Heat Program Guide.
- The project proposes installing an HRC/HPC technology that does not fall into one of the above applicable categories available in the clean heat calculator and no prescriptive TRM methodology is available for calculating savings.

All calculation approaches must use NYS ECC code minimum efficiencies and minimum efficiency requirements in Table 6.8.1-16 of ASHRAE 90.1 – 2022 for baseline HRC/HPC systems.

General

Users shall review the 'Project Information, and 'Equipment Information' tabs and input project-specific details where needed. Cells requiring user input are highlighted in yellow. Cells in white will auto-populate based on the inputs the user enters. Red cells indicate there may be an issue with project or equipment eligibility. Users can fill in the costs and related data in the 'Results Summary Tab'



Yellow shaded cells indicate user input is required.

Inputs													Compliance Check and Savings					
System No.	Make / Model	Quantity*	Chiller Type	Equipment Type*	Heating Operation Type*	Entering / Leaving Heating Liquid Temperature*	Cooling Capacity (Tons)*	Heat Recovery Capacity (MBtu/h)*	Cooling kW/ton FL	Cooling kW/ton IPLV*	Heating COP*	Cooling and Heating COP*	Cooling Efficiency kW/ton - Baseline	Heating COP - Baseline*	EFLH	Annual Energy Savings (MMBTU)	ASHRAE Heating Compliance	ASHRAE Compliance Check
1	Multistack MSH070	2	Water-Cooled	Positive Displacement	Simultaneous Heating and Cooling	High 120°F/140°F	50.00	854.80		1.497	3.35	4	0.5263	0.80	8760	-	4.42	Not Compliant
																-		
																-		
																-		
																-		
																-		
Total		2					50.00	854.80								-		

When a row highlights in red, there may be an eligibility issue.

Tabs should be completed in the following order:

1. Project Information (Info) (highlighted cells only)
2. Equipment Information (highlighted cells only)
3. Results Summary (highlighted cells only)

Tab: Project Information

Yellow shaded cells indicate user input is required.

SECTION 1: Building Characteristics

Project Details	
Program Name	
Tool Generation Date	
Estimated Installation Date	
Utility Name*	Con Edison
Program Type*	Commercial and Industrial

- Program Name – Clean Heat Program
- Tool Generation Date – current date
- Estimated Installation Date – enter projected installation date
- Utility Name – chose from dropdown menu
- Program Type – Commercial & Industrial (default)

SECTION 2: Building Characteristics

Building Characteristics	
Building Type	Office - Large
Heating System Type	Steam Boiler
Cooling System Type	Electric Chiller
Heating Fuel Type	Gas
Distribution System Type	VAV with Economizer
Construction Type*	Existing Building - Retrofit
Year of Construction/ Renovation	1995
Gross Building Area Impacted by SOW (SF)	35,000
Billing Data: Annual Cooling Energy Use (kWh)	
Billing Data: Annual Heating Energy Use (MMBtu)*	20,000
Scope of Work*	Category 4 - Custom Full Load Space Heating Applications

- Building Type - Select the appropriate building type from the drop-down menu. Selection should correspond to the building type that the HRC will be serve. Building profiles have been derived from ASHRAE 90.1 Typical Occupancy Schedule and the New York State Technical Reference Manual Appendix A for several building types.
- Heating System Type – Select current heating system utilized from the drop-down menu.
- Cooling System Type - Select current cooling system utilized from the drop-down menu.
- Heating Fuel Type - Select current fuel type utilized from the drop-down menu.
- Distribution System Type – Not Applicable
- Construction Type – Select from the following drop-down options depending on the project facility application:

  1) New Construction (not applicable)

  2) Existing Building -Retrofit

  3) Gut Renovation[1]

  [1]Gut renovation is any renovation that removes material down to structural load-bearing beams.

- Year of Construction / Renovation

- Gross Building Area Impacted by SOW (SF) – area (square feet) impacted by measure
- Billing Data –
- Annual Cooling Energy Use (kWh)
- Billing Data - Annual Heating Energy Use (MMBtu)
- Scope of Work - chose the Clean Heat Program Incentive Category applicable to the project:

    - Category 4 — *Custom Full Load Space Heating Applications*
    - Category 4a — *Custom Full Load Space Heating Applications + Envelope*
    - Category 6 — *Custom Hot Water Heating Applications*
    - Category 10 — *C&I Custom Partial Load Space Heating Applications*

SECTION 3: System Characteristics

System Characteristics	
Facility Type (Applicable to Existing Only)	
BCL (MBtu/h)	
BHL (MBtu/h)	
Minimum CHW Demand (MBtu/h)*	1,258
Minimum Heating Demand (MBtu/h)*	6,824
Annual Baseline Heating or Domestic Hot Water (DHW) (MMBtu)	
Annual Baseline CHW (MMBtu)	
Annual Equivalent Full Load Hours (EFLH)*	8,760

- Facility Type (Applicable to Existing Only)
- BCL (MBtu/hr)
- BHL (MBtu/hr)
- Minimum CHW Demand (MBtu/hr) – enter minimum historic, calculated or modeled chilled water load required for the space being conditioned by the measure.
- Minimum Heating / DHW Demand (MBtu/hr) - enter minimum historic, calculated or modeled heating or domestic hot water loads required for the space being conditioned or serviced by the measure.
- Annual Baseline Heating / DHW (MMBtu) – enter the annual historic, calculated or modeled heating or domestic hot water consumption required for the space being conditioned or serviced by the measure.
- Annual Baseline CHW (MMBtu) - enter annual historic, calculated or modeled chilled water load required for the space being conditioned by the measure.
- Annual Equivalent Full Load Operating Hours (EFLH) – enter the calculated or proposed EFLH. If equipment capacity is less than minimum CHW and heating/DHW demand – 8,760 EFLH is the default.

SECTION 4: Account Holder Information

Account Holder Information	
Account Name	
Account Number (15 Digits)	
Title	
Mailing Address	
Unit Number	
City	
Zip	
Contact Person	
Phone	
Email	

- Please complete all fields highlighted in yellow prior to submittal for review.

SECTION 5: Contractor Information

Contractor Information	
Installation Completed By	
Company Name	
Contact Name	
Title	
Tax ID	
Mailing Address	
Phone	
Email	

- Please complete all fields highlighted in yellow prior to submittal for review.

Tab: Equipment Information

This tab is utilized to enter equipment information, checks availability and displays the anticipated energy savings for the proposed project based on inputs entered by the user on this and previous tabs.

Section 1 – Inputs

System No.	Make / Model	Quantity*	Chiller Type	Equipment Type*	Heating Operation Type*
1	Multistack MSH070	2	Water-Cooled	Positive Displacement	Simultaneous Heating and Cooling
Total		**2**			

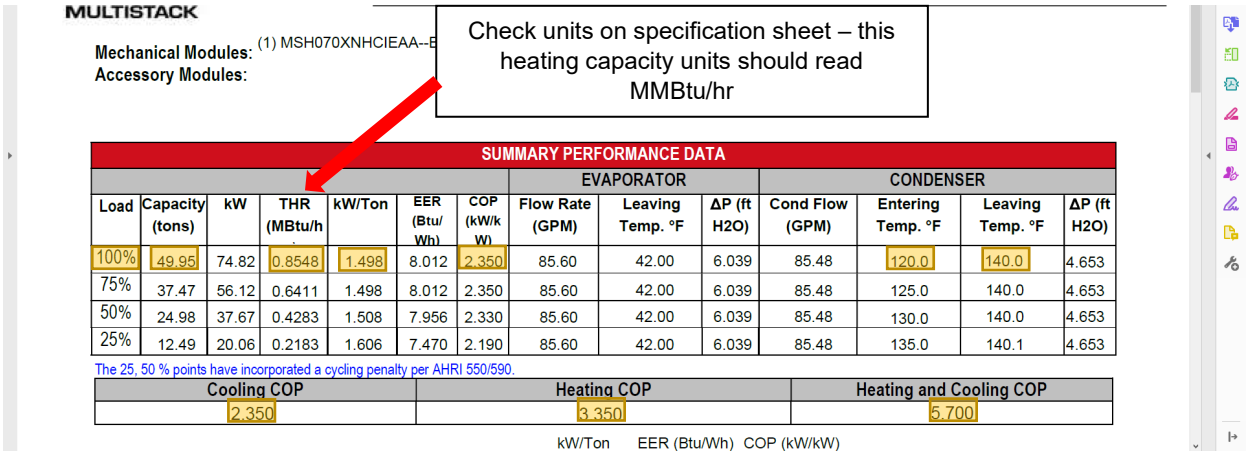
- System Number – enter each equipment / measure.
- Make / Model – enter full make and model number.
- Quantity – quantity of identical equipment to be installed.
- Chiller Type – drop-down menu: air/water cooled (only water-cooled is applicable for this calculator)
- Equipment Type – compressor type drop-down menu: Positive Displacement or Centrifugal
- Heating Operation Type – drop-down menu: Heat Pump Heating/**Simultaneous Cooling and Heating**/Heat Recovery Heating **(only Simultaneous Cooling and Heating operation is applicable to this version of the calculator).**

Entering / Leaving Heating Liquid Temperature*	Cooling Capacity (Tons)*	Heat Recovery Capacity (MBtu/h)*	Cooling kW/ton IPLV	Cooling kW/ton FL*	Heating COP*	Simultaneous Cooling and Heating COP*
High 120°F/140°F	50.00	854.80		1.497	3.35	5.7
	50.00	**854.80**				

When this value highlights in red, there may be an inconsistent cooling or heating COP value entered or the equipment is not eligible (not compliant with ASHRAE Standards).

- Entering / Leaving Heating Liquid Temperature – drop-down menu
  - Low (95F/105F)
  - Medium (105F/120F)
  - High (120F/140F)
  - Boost (120F/140F)
- Cooling Capacity (tons) – enter cooling capacity of each equipment unit.
- Heat Recovery Capacity (MBtu/hr or 1,000 Btu/hr) – enter hourly maximum heat output capacity.
- Cooling (kW/ton) – enter cooling efficiency at full load.
- Heating COP – enter heating COP at full load.
- Simultaneous Cooling and Heating COP – enter COP in specific heat recovery operating mode (only simultaneous cooling and heating operation mode is active in the current version of the calculator).

Please note sample manufacturer's specification sheet for values referenced in above calculator.



MULTISTACK

Mechanical Modules: (1) MSH070XNHCIEAA--E

Accessory Modules:

Check units on specification sheet – this heating capacity units should read MMBtu/hr

SUMMARY PERFORMANCE DATA

							EVAPORATOR			CONDENSER			
Load	Capacity (tons)	kW	THR (MBtu/h	kW/Ton	EER (Btu/Wh)	COP (kW/kW)	Flow Rate (GPM)	Leaving Temp. °F	ΔP (ft H2O)	Cond Flow (GPM)	Entering Temp. °F	Leaving Temp. °F	ΔP (ft H2O)
100%	49.95	74.82	0.8548	1.498	8.012	2.350	85.60	42.00	6.039	85.48	120.0	140.0	4.653
75%	37.47	56.12	0.6411	1.498	8.012	2.350	85.60	42.00	6.039	85.48	125.0	140.0	4.653
50%	24.98	37.67	0.4283	1.508	7.956	2.330	85.60	42.00	6.039	85.48	130.0	140.0	4.653
25%	12.49	20.06	0.2183	1.606	7.470	2.190	85.60	42.00	6.039	85.48	135.0	140.1	4.653

The 25, 50 % points have incorporated a cycling penalty per AHRI 550/590.

Cooling COP	Heating COP	Heating and Cooling COP
2.350	3.350	5.700

kW/Ton EER (Btu/Wh) COP (kW/kW)

Section 2 – Compliance Check and Savings

Compliance Check and Savings								
Cooling Efficiency kW/ton - Baseline	Heating COP - Baseline	EFLH	kWh Savings	kW Savings	Therm Savings	Annual Energy Savings (MMBTU)	ASHRAE Simultaneous Heating and Cooling Load Efficiency COP per AHRI 920	ASHRAE Compliance Check
0.5263	0.80	8760	(673,526.77)	(85.43)	168,481	14,549.94	4.42	Compliant
			-	-	-	-		
			-	-	-	-		
			-	-	-	-		
			-	-	-	-		
			-	-	-	-		
			(673,526.77)	**(85.43)**	**168,481**	**14,549.94**		

- Cooling Efficiency kW/ton – Baseline – automatically populates based on:
  - Equipment Type
  - Cooling Capacity
  - Path B – IPLV (from ASHRAE 90.1–2022–Attachment B)
- Heating COP – Baseline - automatically populates based on:
  - Equipment Type
  - Cooling Capacity
  - Heating Operation Type
  - Entering / Leaving Heating Liquid Temperature
- EFLH - automatically populates based on:
  - Equipment capacity
  - Minimum building/space heating and cooling loads
  - Manual Override Option Available
- kWh Savings - calculations described in Attachment C
- kW Savings - calculations described in Attachment C
- Therm Savings - calculations described in Attachment C
- Annual Energy Savings (MMBtu) - calculations described in Attachment C
- ASHRAE Cooling Compliance (IPLV) - from ASHRAE 90.1–2022–Attachment B
- ASHRAE Heating Compliance - from ASHRAE 90.1–2022–Attachment B
- ASHRAE Compliance Check - automatically populated based on eligibility criteria. If equipment is deemed “Not Compliant” – Annual Energy Savings are not calculated.

Tab: Results Summary

Technology	Material Cost	Labor Cost	Total Cost
Heat Recovery Chiller			$ -

- Enter Material and Labor Costs for each Measure.
- Total Cost = Material + Labor Costs

Net MMBtu Savings	Heating Electrification Savings (kWh)	Cooling Savings (kWh)	Net kWh savings	kW Savings	Therms Savings
14,549.9	-	(673,526.8)	(673,526.77)	(85.4)	168,481.1

- Net MMBtu Savings = Annual Energy Savings (MMBtu) - calculations described in Attachment C
- Heating Electrification Savings (kWh) = HRC Heating Energy = Zero (0) Free Heating - calculations described in Attachment C
- Cooling Savings (kWh) - calculations described in Attachment C
- kW Savings - calculations described in Attachment C
- Therm Savings - calculations described in Attachment C

Effective Useful Life (years)	Lifetime Net MMBtu Savings	Uncapped Incentive
15	218,249.1	$ 1,454,994.0

- Effective Useful Life (years) – Source NYS TRM Version 10 – Appendix P
- Lifetime Net MMBtu Savings – Net MMBtu Savings x Effective Useful Life
- Uncapped Incentive - Incentive Calculation automatically populates for each compliant measure based on calculated Net MMBtu Annual Savings, project information and location.

- **The Uncapped Incentive value should not be construed as a Preliminary Incentive Offer Letter (PIOL). A PIOL will be offered after the project is reviewed by the participating utility.**

Appendices

A. Definitions

- **Air-Conditioning, Heating, and Refrigeration Institute (AHRI)**: A trade association representing manufacturers of heating, ventilation, air-conditioning, refrigeration, and water heating equipment. AHRI provides the database of equipment performance specifications, which is used in this program to determine the rebate amount.
- **Building Heating Load (BHL)**: Building heat loss in British Thermal Units per hour (Btu/h). For residential buildings, BHL shall be calculated using ACCA Manual J or another code-approved methodology. For commercial buildings, BHL shall be calculated following ANSI/ASHRAE/ACCA Standard 183-2007(RA2017), or other code-approved equivalent computational procedure. Calculation of the building's design heating load shall be at the 99% dry bulb heating design temperature for the most relevant ASHRAE 2017 location.
- **Building Cooling Load (BCL)**: Building total sensible and latent heat gain in British Thermal Units per hour (Btu/h). For residential buildings, BCL shall be calculated using ACCA Manual J or another code-approved methodology. For commercial buildings, BHL shall be calculated following ANSI/ASHRAE/ACCA Standard 183-2007 (RA2017), or other code-approved equivalent computational procedure. Calculation of the building's design cooling load shall be at the 1% dry bulb cooling design temperature for the most relevant ASHRAE 2017 location.
- **Coefficient of performance (COP)**: COP is the ratio of work or useful energy output of a system versus the work or energy input, measured in the same units. It is a measure of performance often used for electrically powered heating and cooling equipment, with the higher the system COP corresponding to the more efficient operation.
- **Energy Efficiency Ratio (EER)**: A measure of how efficiently a cooling system will operate when the outdoor temperature is 95 degrees Fahrenheit. It is calculated by dividing the rated cooling output at 95 degrees Fahrenheit by the watts used by the AC/HP system. A higher EER means the system is more efficient. It is an instantaneous measure of electrical efficiency, unlike SEER (Seasonal Energy Efficiency Rating), which is an averaged value of efficiency. This is a term applied to air conditioning equipment.
- **Full Load Heating System**: A system installed as a building's primary heating source, with a total system heating capacity that satisfies a minimum of 90% of building heating load (BHL).
- **Heat Pump Chiller (HPC)** – chiller operating in mode where heat sink or source is outside of the building (i.e., well field, air or chilled water loop as source of hot or cold water for the building). Unit provides either heating or cooling but not at the same time. This calculator does not currently have the capability to calculate savings for HPCs. Savings from HPC projects will be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.
- **Heat Recovery Chiller (HRC)** – chiller operating in mode where heat is moved between HW and CHW loops within the thermal envelope in buildings requiring simultaneous cooling and heating. Unit provides heating and cooling at the same time. Note: HRC are exempt from minimum annual baseline heating consumption displacement thresholds applicable to each program. This calculator may be utilized for HRC projects as described in the schematic below. The project would still retain the option to be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.
- **Heat Pump Chiller/ Heat Recovery Chiller (HPC+HRC)** – chiller that will operate in both of the above modes for a project. This calculator does not currently have the capability to calculate savings for HPC+HRC projects. Savings from HPC+HRC projects will be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.

B. Applicable ASHRAE 90.1 – 2022 Efficiency Requirements

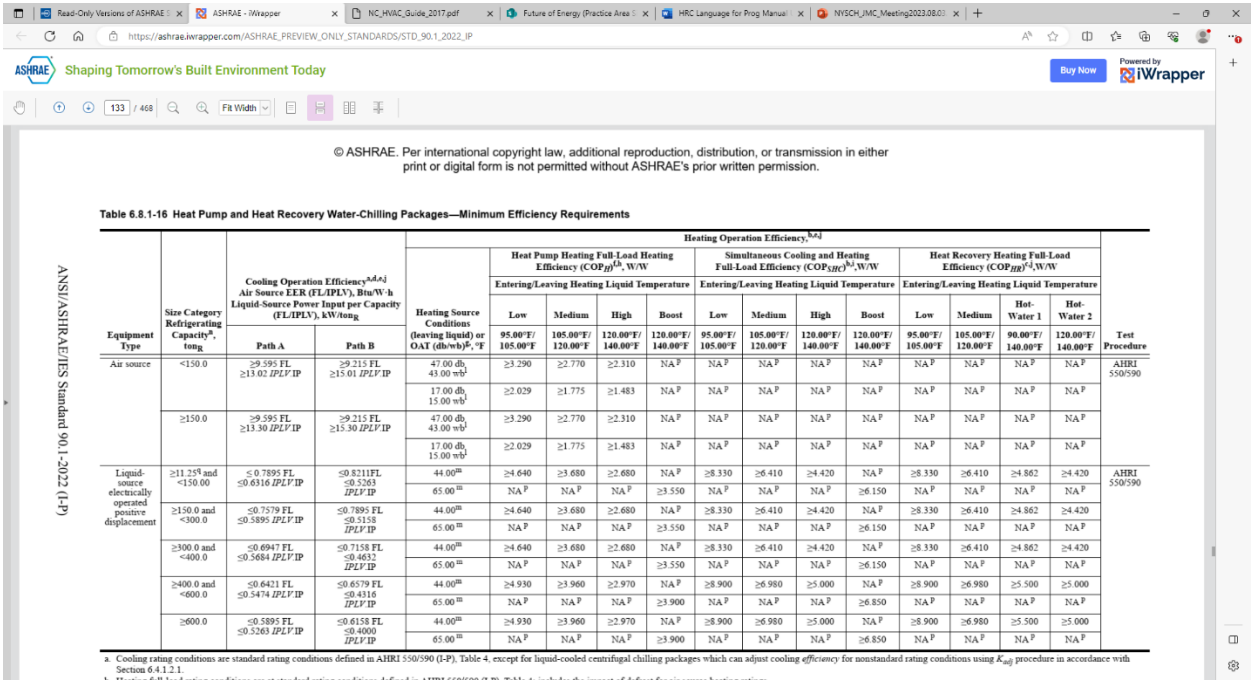


Table 6.8.1-16 Heat Pump and Heat Recovery Water-Chilling Packages—Minimum Efficiency Requirements

Equipment Type	Size Category Refrigerating Capacity[a], ton_R	Cooling Operation Efficiency[a,d,e,j] Air Source EER (FL/IPLV), Btu/W·h Liquid-Source Power Input per Capacity (FL/IPLV), kW/ton_R		Heating Operation Efficiency[b,e,j]														
					Heat Pump Heating Full-Load Heating Efficiency (COP_H)[f,h], W/W				Simultaneous Cooling and Heating Full-Load Efficiency (COP_{SHC})[h,i], W/W				Heat Recovery Heating Full-Load Efficiency (COP_{HR})[c,j], W/W				
					Entering/Leaving Heating Liquid Temperature				Entering/Leaving Heating Liquid Temperature				Entering/Leaving Heating Liquid Temperature				
		Path A	Path B	Heating Source Conditions (leaving liquid) or OAT (db/wb)[g], °F	Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot-Water 1	Hot-Water 2	Test Procedure
					95.00°F/ 105.00°F	105.00°F/ 120.00°F	120.00°F/ 140.00°F	120.00°F/ 140.00°F	95.00°F/ 105.00°F	105.00°F/ 120.00°F	120.00°F/ 140.00°F	120.00°F/ 140.00°F	95.00°F/ 105.00°F	105.00°F/ 120.00°F	90.00°F/ 140.00°F	120.00°F/ 140.00°F	
Air source	<150.0	≥9.595 FL ≥13.02 *IPLV*.IP	≥9.215 FL ≥15.01 *IPLV*.IP	47.00 db, 43.00 wb[l]	≥3.290	≥2.770	≥2.310	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	AHRI 550/590
				17.00 db, 15.00 wb[l]	≥2.029	≥1.775	≥1.483	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	
	≥150.0	≥9.595 FL ≥13.30 *IPLV*.IP	≥9.215 FL ≥15.30 *IPLV*.IP	47.00 db, 43.00 wb[l]	≥3.290	≥2.770	≥2.310	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	
				17.00 db, 15.00 wb[l]	≥2.029	≥1.775	≥1.483	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	NA[p]	
Liquid-source electrically operated positive displacement	≥11.25[q] and <150.00	≤ 0.7895 FL ≤0.6316 *IPLV*.IP	≤0.8211FL ≤0.5263 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	AHRI 550/590
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥150.0 and <300.0	≤0.7579 FL ≤0.5895 *IPLV*.IP	≤0.7895 FL ≤0.5158 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥300.0 and <400.0	≤0.6947 FL ≤0.5684 *IPLV*.IP	≤0.7158 FL ≤0.4632 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥400.0 and <600.0	≤0.6421 FL ≤0.5474 *IPLV*.IP	≤0.6579 FL ≤0.4316 *IPLV*.IP	44.00[m]	≥4.930	≥3.960	≥2.970	NA[p]	≥8.900	≥6.980	≥5.000	NA[p]	≥8.900	≥6.980	≥5.500	≥5.000	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.900	NA[p]	NA[p]	NA[p]	≥6.850	NA[p]	NA[p]	NA[p]	NA[p]	
	≥600.0	≤0.5895 FL ≤0.5263 *IPLV*.IP	≤0.6158 FL ≤0.4000 *IPLV*.IP	44.00[m]	≥4.930	≥3.960	≥2.970	NA[p]	≥8.900	≥6.980	≥5.000	NA[p]	≥8.900	≥6.980	≥5.500	≥5.000	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.900	NA[p]	NA[p]	NA[p]	≥6.850	NA[p]	NA[p]	NA[p]	NA[p]	

a. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 (I-P), Table 4, except for liquid-cooled centrifugal chilling packages which can adjust cooling *efficiency* for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1.

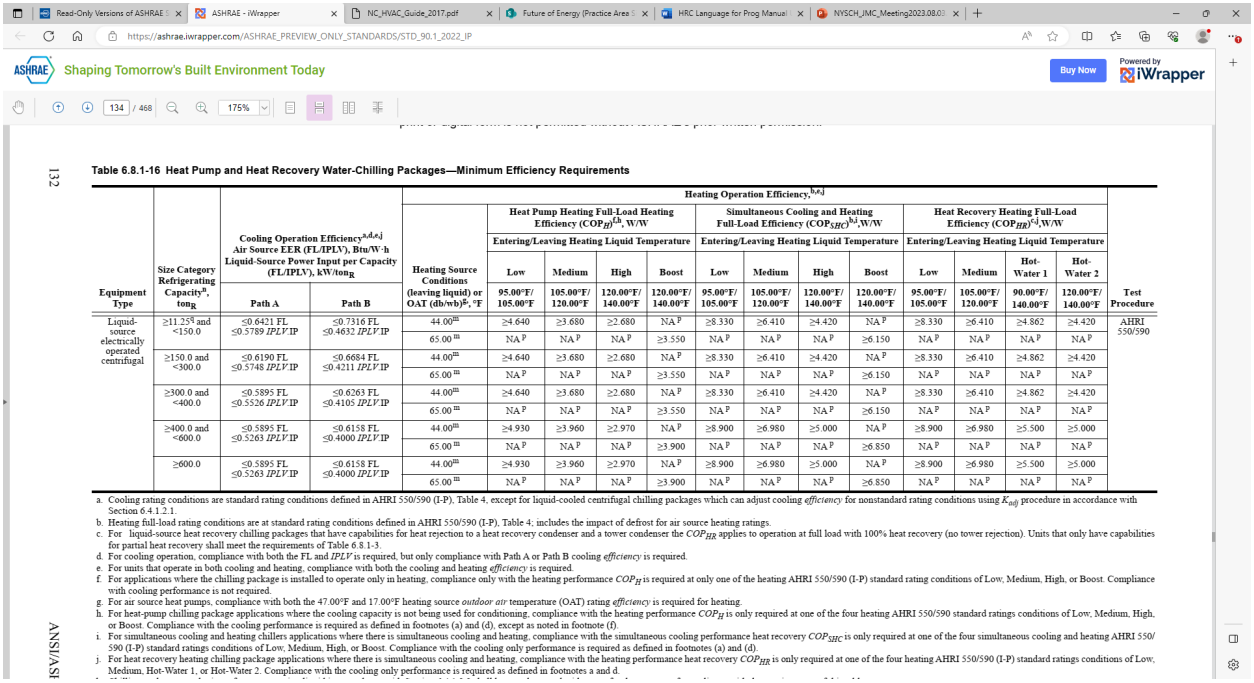


Table 6.8.1-16 Heat Pump and Heat Recovery Water-Chilling Packages—Minimum Efficiency Requirements

Equipment Type	Size Category Refrigerating Capacity[a], ton_R	Cooling Operation Efficiency[a,d,e,j] Air Source EER (FL/IPLV), Btu/W·h Liquid-Source Power Input per Capacity (FL/IPLV), kW/ton_R		Heating Operation Efficiency[b,e,j]														
					Heat Pump Heating Full-Load Heating Efficiency (COP_H)[f,h], W/W				Simultaneous Cooling and Heating Full-Load Efficiency (COP_{SHC})[h,i], W/W				Heat Recovery Heating Full-Load Efficiency (COP_{HR})[c,j], W/W				
					Entering/Leaving Heating Liquid Temperature				Entering/Leaving Heating Liquid Temperature				Entering/Leaving Heating Liquid Temperature				
		Path A	Path B	Heating Source Conditions (leaving liquid) or OAT (db/wb)[g], °F	Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot-Water 1	Hot-Water 2	Test Procedure
					95.00°F/ 105.00°F	105.00°F/ 120.00°F	120.00°F/ 140.00°F	120.00°F/ 140.00°F	95.00°F/ 105.00°F	105.00°F/ 120.00°F	120.00°F/ 140.00°F	120.00°F/ 140.00°F	95.00°F/ 105.00°F	105.00°F/ 120.00°F	90.00°F/ 140.00°F	120.00°F/ 140.00°F	
Liquid-source electrically operated centrifugal	≥11.25[q] and <150.0	≤0.6421 FL ≤0.5789 *IPLV*.IP	≤0.7316 FL ≤0.4632 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	AHRI 550/590
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥150.0 and <300.0	≤0.6190 FL ≤0.5748 *IPLV*.IP	≤0.6684 FL ≤0.4211 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥300.0 and <400.0	≤0.5895 FL ≤0.5526 *IPLV*.IP	≤0.6263 FL ≤0.4105 *IPLV*.IP	44.00[m]	≥4.640	≥3.680	≥2.680	NA[p]	≥8.330	≥6.410	≥4.420	NA[p]	≥8.330	≥6.410	≥4.862	≥4.420	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.550	NA[p]	NA[p]	NA[p]	≥6.150	NA[p]	NA[p]	NA[p]	NA[p]	
	≥400.0 and <600.0	≤0.5895 FL ≤0.5263 *IPLV*.IP	≤0.6158 FL ≤0.4000 *IPLV*.IP	44.00[m]	≥4.930	≥3.960	≥2.970	NA[p]	≥8.900	≥6.980	≥5.000	NA[p]	≥8.900	≥6.980	≥5.500	≥5.000	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.900	NA[p]	NA[p]	NA[p]	≥6.850	NA[p]	NA[p]	NA[p]	NA[p]	
	≥600.0	≤0.5895 FL ≤0.5263 *IPLV*.IP	≤0.6158 FL ≤0.4000 *IPLV*.IP	44.00[m]	≥4.930	≥3.960	≥2.970	NA[p]	≥8.900	≥6.980	≥5.000	NA[p]	≥8.900	≥6.980	≥5.500	≥5.000	
				65.00[m]	NA[p]	NA[p]	NA[p]	≥3.900	NA[p]	NA[p]	NA[p]	≥6.850	NA[p]	NA[p]	NA[p]	NA[p]	

a. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 (I-P), Table 4, except for liquid-cooled centrifugal chilling packages which can adjust cooling *efficiency* for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1.
b. Heating full-load rating conditions are at standard rating conditions defined in AHRI 550/590 (I-P), Table 4; includes the impact of defrost for air source heating ratings.
c. For liquid-source heat recovery chilling packages that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3.
d. For cooling operation, compliance with both the FL and *IPLV* is required, but only compliance with Path A or Path B cooling *efficiency* is required.
e. For units that operate in both cooling and heating, compliance with both the cooling and heating *efficiency* is required.
f. For applications where the chilling package is installed to operate only in heating, compliance only with the heating performance COP_H is required at only one of the heating AHRI 550/590 (I-P) standard rating conditions of Low, Medium, High, or Boost. Compliance with cooling performance is not required.
g. For air source heat pumps, compliance with both the 47.00°F and 17.00°F heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
h. For heat-pump chilling package applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is only required at one of the four heating AHRI 550/590 standard ratings conditions of Low, Medium, High, or Boost. Compliance with the cooling performance is required as defined in footnotes (a) and (d), except as noted in footnote (f).
i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} is only required at one of the four simultaneous cooling and heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, High, or Boost. Compliance with the cooling only performance is required as defined in footnotes (a) and (d).
j. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1, or Hot-Water 2. Compliance with the cooling only performance is required as defined in footnotes a and d.

C. Sample Calculations and Formulas

Calculations for Annual Energy Use for the Proposed HRC

Inputs:

- **Condenser Leaving Water Temperature**
- **Simultaneous Cooling & Heating COP**
- **COPcooling (kW/ton Full Load & IPLV)**
- **Heating COP - COPheating**
- **Max. HRC Capacity -Tons (@ Max. Operating Conditions)**
- **Heat Recovery Capacity/ Heating Output (MBtu/hr)**
- **EFLH (hours) –** defaults to 8,760 but user should enter actual calculated EFLH if available

Outputs:

- **Cooling Output MMBtu/hr** = Max Tons x 12,000 Btu/Ton / 1,000,000 Btu / MMBtu
- **Cooling Input MMBtu/hr** = Output / $COP_{cooling}$
- **Heating Input MMBtu = 0 (Free)**
- **Energy Use MMBtu/yr** = (Cooling Input + Heating Input) * EFLH

Simultaneous Cooling & Heating COP Check:

Cooling Output + Heating Output) / Cooling Input = Heating and Cooling COP (mfg. specs.)

Calculations for Annual Energy Use for Baseline System @ Code Efficiency

Inputs:

- **Simultaneous Cooling & Heating COP**
- **COPcooling (kW/ton) – Path B IPLV**
- **COPheating = code compliant baseline heating system efficiency**

Outputs:

- **Cooling Output MMBtu/hr** = HRC Max Tons x 12,000 / 1,000,000
- **Cooling Input MMBtu/hr** = Output / COP @ Code

- **Heating Output MMBtu/hr** = HRC Heating Capacity (BTU/hr) / 1,000,000
- **Heating Input MMBtu/hr** = Heating Output / COP @ Code

Assumptions and Standards:

- Boiler HW Pump Input = HW Loop Pump Input (assumed negligible - not included)
- Chilled Water Pump Baseline = HRC CHW Pump Input (assumed negligible - not included)

- **Cooling Tower Energy Standard = 38.2 gpm/hp (ASHRAE 90.1-2022 – Appendix G)**
- Note: Cooling Tower Ton = 15,000 Btu Chiller Ton = 12,000 Btu
- Cooling tower GPM = 15,000 Btu / 500 x 10 delta T = 3 gpm/ton
- **Cooling Tower Energy (kW/ton) =** 1/38.2 gpm/hp x 3 gpm/ton x 0.7457 kW/hp) = **.059 kW/ton**

- **Condenser Water Pump Energy Standard = 19 W/gpm (ASHRAE 90.1-2022 – Appendix G)**
- **Condenser Water Energy (kW/ton)** = (19 W/gpm x 3 gpm/ton) / 1000 watts/kW = **0.057 kW/ton**

- **Baseline Energy MMBtu/yr** = (Cooling Input + Heating Input + Cooling Tower Input + Condenser Water Pump Input) * EFLH

Results Summary Calculations:

Net MMBtu Savings	Heating Electrification Savings (kWh)	Cooling Savings (kWh)	Net kWh savings	kW Savings	Therms Savings	Effective Useful Life (years)	Lifetime Net MMBtu Savings
14,549.9	-	(673,526.8)	(673,526.77)	(85.4)	168,481.1	20	290,998.8

Net MMBtu Savings (Annual Energy Savings) = (Baseline Energy - Proposed Energy) x Safety Factor (0.9)

Heating Electrification Savings (kWh) = Zero (Free Heating)

Cooling Savings (kWh) = [Cooling Input Energy @ Code (Path B IPLV) (kW/ton) + Cooling Tower Energy (kW/ton) + Condenser Water Energy (kW/ton) - HRC Cooling Energy (kW/ton @ Full Load)] x Capacity (ton) x (# of units) x EFLH x Safety Factor (0.9)

Net kWh Savings = Heating Electrification Savings + Cooling Savings

kW Savings = [Cooling Input Energy @ Code (Path B IPLV) (kW/ton) + Cooling Tower Energy (kW/ton) + Condenser Water Energy (kW/ton) - HRC Cooling Energy (kW/ton @ Full Load)] x Capacity (ton) x (# of units)

Therms Savings = [(Heat Recovery Capacity (MBtu/hr) / 1,000 MBtu/MMBtu / Heating COP @Code * 10 Therms/MMBtu] x EFLH x Safety Factor (0.9)

Effective Useful Life (years) – Source NYS TRM Version 10 – Appendix P – 20 Years for Air- or Water-Cooled Chillers

Lifetime Net MMBtu Savings = Net MMBtu Savings x Effective Useful Life