ASHRAE Standard 205P

Public Review Draft

Standard Representation of Performance Simulation Data for HVAC&R and Other Facility Equipment

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(Complete Draft for Public Review)

This draft has been recommended for a public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website http://www.ashrae.org/public-review-drafts and access the online comment database.

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

Standard 205 defines the format of *representation specifications* that establish the descriptive and numerical information required to transmit equipment performance characteristics for use by simulation software. A *representation specification* is a human-readable document that provides the basis for implementation of automated data transfer schemes. In addition to the definition of performance-related data, a *representation specification* defines equipment identification data items, data validity tests, and descriptive information such as text descriptions and equipment schematics.

Standard 205 is intended to support the following use cases –

- **Data Publication**. *Data publishers* use *representation specifications* to guide implementation of data writing and validity testing software that produces correctly-formed *representation* files.
- **Application Development**. *Application developers* use *representation specifications* to guide implementation of software that correctly reads *representation* data. Such implementations may include validity tests, and developers may use *representation specification* example data for testing purposes.
- **Data Application**. *Application users* use *representation specifications* to understand and check *representation* data. Data exchange will generally be automated, but the availability of *representation specifications* facilitates additional data review when needed.

The Standard 205 purpose is broad – it does not restrict representation approaches used for sharing data. This initial version of the standard specifies *data models* using the *performance map* approach. Other schemes, such as *automation interfaces,* may be used when additional equipment types are added. Associated *data format* implementations are not formally part of this standard and are provided on an open source basis.

As stated in Section 4.10, Standard 205 requires use of SI units, an exception to normal ASHRAE dual-units policy. The standard addresses automated data transfer; requiring *data publishers* and *application developers* to support more than one convention is counter-productive. Conversion to any units can be done as needed for application or display.

1 PURPOSE

The purpose of Standard 205 is to facilitate sharing of equipment characteristics for performance simulation by defining standard representations such as data models, data formats, and automation interfaces.

2 SCOPE

This standard applies to data used in the performance simulation of any HVAC&R or other facility system, equipment, or component.

3 DEFINITIONS

Application. A software program that reads and uses *representation* data.

Application developer. A developer of software programs that read and use *representation* data.

Application user. The end user of application software.

Automation interface. A boundary across which two independent systems meet and act on or communicate with each other. In the context of Standard 205, an automation interface specification defines the methods of communication between an *application* and a data source.

Data element. A data item that is reasonably atomic, such as a single value (e.g., sensible capacity) or single object (e.g., polygon) that is contained within a *data group*.

Data format. A specification of an implementation for encoding a *data model* for storage or transmission. Many *data formats* are possible for a given *data model*.

Data group. A medium-level collection of related *data element*s.

Data model. A collection of *data groups* that represent *equipment* characteristics and performance.

Data publisher. An equipment manufacturer or other entity that generates *representations*.

Equipment. A device or system that provides heating, air conditioning, refrigeration, or related service to a facility.

Grid cell. In a *performance map*, hyperrectangle defined by adjacent pairs of *grid variable* values.

Grid variable. An ordered list of discrete values representing operating conditions (e.g., ambient drybulb temperature). The collection of all *grid variables* defines the overall operating range of the equipment.

Lookup variable. A variable used for performance characteristics (e.g., capacity or input power) defined for a combination of *grid variables*.

NULL. A conceptual representation of “no information provided” allowing omission of performance value(s). *NULL* will be transmitted in an implementation-specific manner in any given *representation implementation.*

Performance map. A *data group* consisting of a collection of *grid variables* and associated *lookup variables.*

Representation. A file or other electronic artifact that contains data conforming to a *representation specification*. In this standard, the term *representation* is used abstractly. See *representation implementation*.

Representation implementation. A *representation* implemented in a specific *data format*.

Representation specification. An unambiguous statement of a data format, data model, or interface that allows equipment performance data to be accessed by performance simulation applications. The format of *representation specifications* is defined by this standard.

Resolution. The required maximum increment of the last (least significant) digit in a number. For example, the number 23.04 complies with a resolution requirement of .01, while 23.1 does not.

Significant figures. The count of digits in a number that contribute to value determination. Also known as significant digits. Procedures for determining significant figures are found in AHRI Standard 551/591 (AHRI 2017). For example, 103.41 has 5 significant figures.

URI. Uniform Resource Identifier. A string of characters used to identify a resource. See RFC 3986 (2005).

4 GENERAL REQUIREMENTS

Each *representation specification* shall be complete. A *representation specification* and supporting material available at http://data.ashrae.org, along with Standard 205, shall provide sufficient information for *data publishers* to prepare conforming equipment performance *representations* and for *application developers* to implement interface code to access such information.

Unless explicitly stated in the *representation specification*, *representation* data shall not be used to estimate performance beyond the stated valid ranges.

4.1 Data Validity

4.1.1 Validity tests

Each *representation specification* shall define validity tests that identify erroneous data. Examples of such test include:

- Range checks. Specifications of valid ranges for values stated as fixed values or functions of other values.
- Physical limits. Physically-based tests allow detection of impossible values. For example, air-conditioner latent capacity must not imply that the leaving air has a negative humidity ratio.

The failure of any validity test shall indicate invalid data. The set of validity tests in a *representation specification* need not be sufficient to detect all invalid data.

4.1.2 Operational limits

A *representation specification* shall define operational limits that shall be enforced by any application utilizing representation data. All performance values derived from representation data shall be checked against applicable operational limits.

4.1.3 Responsibility for data quality

The *data publisher* shall be responsible for ensuring correctness of published data. Each published *representation* shall successfully pass all applicable data validity tests defined in the associated *representation specification*. The data publisher shall implement additional validation procedures as needed to minimize the likelihood of publication of erroneous data.

The *application developer* shall be responsible for implementing mechanisms for verifying that derived (e.g., interpolated) performance values do not violate any applicable operational limits.

4.2 Data Integrity

Informative: Standard 205 does not require or preclude use of schemes, such as digital signatures, that ensure correct data transmission. Such mechanisms are not in the scope of Standard 205.

4.3 Data Accuracy

Informative: Standard 205 includes no requirements that a *representation* should reproduce actual equipment performance with any specified accuracy. A *data publisher* may choose to characterize the accuracy of a *representation* based on the underlying accuracy of data sources such as physical measurements or engineering models.

4.4 Access Restrictions

Informative: *Data publisher*s may restrict access to *representation* data using schemes such as encryption or user-specific licensing. Such mechanisms are not in the scope of Standard 205.

4.5 Consistency with Ratings

Representation data need not be consistent with any published standard ratings unless such consistency is required by the associated *representation specification.* For example, it is not required that the COP derived from *representation* data at rating conditions match the rated COP.

Informative: *Representation* data conveys typical equipment performance at various operating conditions. Rating conditions and operating modes may or may not occur during installed operation. Standard 205 and ratings have different purposes; it is not possible to achieve consistency in all cases.

4.6 Versioning

4.6.1 Representation specification version

Each published *representation specification* shall include a version number that is incremented at each revision.

4.6.2 Representation version

Each *representation* shall include the *representation specification* version number, a *representation* version number that is incremented at each republication of revised data, and, in a form determined by the *data publisher,* an equipment revision identifier.

4.7 Optional Data

In *representation specifications*, *data groups* and *data elements* are permitted to be designated as optional. When optional items are included in *representations*, their properties shall conform to the associated *representation specification* definitions. That is, the inclusion of such items is optional, but all other requirements are fixed.

4.8 Custom Data

*Data publisher*s may provide *data groups* or *data elements* in addition to those defined in a *representation specification*. Such items shall be assigned names that begin with "custom" or "Custom", do not conflict with existing names used in the *representation specification*, and have negligible likelihood of conflicting with the names of custom items that could be provided by other *data publisher*s.

Representation-reading software may ignore *data group*s with names beginning with "Custom" and *data elements* with names beginning with "custom".

4.9 Names

The names of *data element*s and *data groups*, along with data definitions, form the basis of the data exchange contract defined by *representation specifications*. Names shall be assigned according to the following requirements. Additional guidance is found in Section 9.1.

All names shall be case-sensitive-unique within their scope: *data element* names shall be unique within their *data group,* and *data group* names shall be unique within their *representation specification*. All matching of names shall be done on a case-sensitive basis (that is, exact character-for-character match).

4.9.1 Allowed characters

All names shall contain only letters (as defined in the ASCII 7-bit character set, that is a-z, A-Z), digits (0-9), and underscore ('_'). Spaces and special characters other than underscore (such as punctuation) shall not be used. The first character of each name shall be a letter or an underscore.

4.9.2 Data group names

Each *data group* and component shall be assigned an "Upper Camel Case" (UCC) name. UCC naming results in the capitalization of the first letter of each word of a compound name, including capitalization of the initial letter of the name. Examples of UCC names are `DesignData` and `_LowSpeedRatings.`

4.9.3 Data element names

Each *data element* shall be assigned a "Lower Camel Case" (LCC) name. LCC naming results in the initial letter of a name being lower-case and the first letter of each subsequent word of a compound name capitalized. Examples of LCC names are `inletVanePosition` and `_airMassFlowRate.`

Exception: *Data element* names may begin with an upper-case abbreviation, for example `COPAtRatedCapacity.`

4.9.4 Reserved names

Names beginning with "Custom" or "custom" shall not be used in *representation specifications.*

4.9.5 Pre-existing names

Instead of inventing new names, names from existing relevant schemas and data dictionaries should be used when appropriate. Table 4-1 provides a non-exhaustive list of related schemas and data dictionaries. When pre-existing names are adapted for Standard 205 use, they shall be modified to conform to naming rules specified in this section.

Table 4-1. Sources of Pre-Existing Names

Source	Description	URL
gbXML	Green Building XML	http://www.gbxml.org/
IFC	Industry Foundation Classes	http://www.buildingsmart.org/
DOE-2 BDL	DOE-2 Building Description Language	http://doe2.com/download/doe-21e/DOE-2BDLSummaryVersion21E.pdf http://www.doe2.com/Download/Docs/22_oview.pdf
EnergyPlus IDD	EnergyPlus Input Data Dictionary	https://energyplus.net/ https://energyplus.net/sites/all/ modules/custom/nrel_custom/pdfs/pdfs_v8.3.0/ InputOutputReference.pdf
ASHRAE Terminology		https://www.ashrae.org/resources--publications/ free-resources/ashrae-terminology
CEC	California Energy Commission Standards Data Dictionary	http://bees.archenergy.com/software.html
COBie	Construction Operations Building Information Exchange	http://www.wbdg.org/resources/cobie.php
COMNET	Commercial Energy Services Network	http://comnet.org/

4.9.6 Abbreviations

Except for cases defined in Section 8.1.6, no abbreviations shall be used in *data element* or *data group* names.

4.9.7 Namespaces

All *representation implementations* and related code that are intended for public use shall use namespace identifiers as follows:

- C++ and similar languages: ASHRAE205
- XML schemas: http://data.ashrae.org/ASHRAE205

Representation implementations shall use available mechanisms, if applicable, to reduce data payload size. For example, XML implementation should specify a default namespace http://data.ashrae.org/ASHRAE205 and use unqualified tags.

4.10 Units

4.10.1 General requirement

Except as specified in Section 4.10.2, all numeric values shall be represented in SI units as specified in ASHRAE SI policy documents (ASHRAE 2013a, ASHRAE 2013b, IEEE/ASTM 2011).

Units of all values in all *representation specifications* shall be documented using symbols defined in ASHRAE SI policy.

Any unit conversions needed for preparing or using *representation* data shall be done using conversion factors specified in ASHRAE SI policy.

4.10.2 Exceptions

Units other than SI are required or permitted in the following situations:

- Ratings. Standard rating values shall be published using the units specified in the rating definition. For example, SEER shall be published in Btu/Wh.
- Descriptive text. Values included in descriptive text or documentation *data elements* may be given in any units and the units used shall be stated.

4.11 Enumerated Types

An enumerated type is a data type that takes one of a pre-defined set of string enumerator values.

4.11.1 Enumerators

Enumerators are strings of any length made up of letters, numbers, or '_' and beginning with a letter or '_'. (That is, matching the POSIX regex "[a-z,A-Z,_][a-z,A-Z,_,0-9]*".)

Each enumerator shall be case-sensitive-unique within an enumerated type. Enumerators that differ only by case are not allowed (even though they are case-sensitive unique). All matching and validation of enumerators shall be performed on a case-sensitive basis (that is, exact character-for-character match).

Enumerator shall use the standard abbreviations specified in Section 8.1.6. Enumerators may use additional abbreviations if clear and consistent with industry practice. A source of recognized abbreviations is found in ASHRAE (2013f).

4.11.2 Common enumerated types

Section 8 lists enumerated types that have use in more than one *representation specification*. When such types are used, the associated *data element* shall be named per procedures set forth in Section 4.9, and enumerators shall be those specified in Section 8.

4.12 Numeric element precision

Numeric *data element* precision requirements (where applicable) shall be specified as *significant figures* or *resolution* or both. When both requirements are stated, *representation* values shall satisfy both.

4.13 Data Group Attributes

Table 4-2. Data Group Attributes

Attribute	Description	Notes
Data Group Name	Public name of group	See Section 4.9
Description	Text description that provides additional information about the group	

4.14 Data Element Attributes

Data elements shall be characterized in *representation specifications* by attributes shown in Table 4-3.

Table 4-3. Data Element Attributes

Attribute	Description	Notes
Data Element Name	Public name of element	See Section 4.9
Description	Text description that defines the meaning of the element	
Data Type	Data type of element	See Section 8.1
Units	Units of element	See Section 4.10
Validation	Text, algebraic, or pseudo-code definition of validity tests	
Significant figures (abbreviated as Sig figs)	Minimum significant figures numeric element	At least one of Sig figs and Res shall be specified.
Resolution (abbreviated as Res)	Maximum increment of least significant digit of numeric element	At least one of Sig digs and Res shall be specified.
Required (abbreviated as Req)	Indicates whether element is mandatory	Use checkmarks (✓) to indicate required elements.
Notes	Any supplementary information	

5 PHYSICAL DATA

5.1 Psychrometric Properties of Moist Air

Psychrometric properties of moist air shall be derived using ideal gas procedures found in the Fundamentals volume of the ASHRAE Handbook (ASHRAE 2013c).

5.2 Liquid Properties

Unless otherwise specified in a *representation specification*, the properties of water and other heat transfer liquids shall be derived using procedures found in the ASHRAE Handbook (ASHRAE 2013d). Properties shall be assumed to be temperature dependent and pressure independent.

5.3 Refrigerant Properties

The properties of refrigerants shall be derived using data in the ASHRAE Handbook (ASHRAE 2013e) or techniques referenced there.

6 REPRESENTATION SPECIFICATION STRUCTURE

A *representation specification* shall consist of

- The specification of a single human-readable (e.g., PDF) document organized as specified in this section;
- Any number of machine-readable files to support creation and consumption of *representation implementations;* and
- Any number of informative human- or machine- readable files providing background, test data, or other supporting information.

Supporting files are available at http://data.ashrae.org/standard205.

6.1 Identification and History

RSID. Representation Specification Identifier. A string code, assigned by ASHRAE which uniquely identifies each *representation specification*. RSIDs shall be of the form nnnn, where nnnn is 4 decimal digits.

RSTitle. Brief string title for the component to be represented.

RSVersion. *Representation specification* version number in the format defined by *data type* Version (see Table 8-1).

Version history. A table as follows

RSVersion	Date	Source	Notes

6.2 Scope and Description

A narrative section provides free-text information that defines the equipment covered by the *representation specification* and includes one or more schematic diagrams to aid correct generation and application of *representation* data.

6.3 Data Representation

This section provides the specifics of the *data groups* to be included in a *representation*. Data groups shall be nested within each other according to the following hierarchy:

- ASHRAE205 [1]
  - Description [0 .. 1]
    - ProductInformation [0 .. 1]
    - Rating [0 .. N]
    - CustomTable [0 .. N]
  - Performance [1]
    - PerformanceMap [0 .. N]
      - GridVariables [1]
      - LookUpVariables [1]

6.3.1 Data Group ASHRAE205

The first data group in each *representation* shall be ASHRAE205, specified in Table 6-1.

Table 6-1. Data Group ASHRAE205

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
RSID	*Representation specification* identifier	Enumeration	N/A		N/A		✓	Identifies the *representation specification* used to generate this *representation*
RSVersion	*Representation specification* version	Version	N/A		N/A		✓	Identifies the version of the *representation specification* used to generate this *representation*
RSTitle	Descriptive name of *representation specification*	String	N/A		N/A		✓	Copied from the title of the *representation specification* having the RSID and RSVersion.
ID	Unique equipment identifier	UUID	N/A		N/A		✓	Assigned by *data publisher* to identify specific equipment. ID shall remain unchanged for revised *representations* for the same equipment.
dataTimestamp	Date of publication	Timestamp	N/A		N/A		✓	Date/time of publication of this *representation*.
dataVersion	Free-form version identifier for this *representation*	String	N/A		N/A			

description	Free-form description of equipment (suitable for display)	String	N/A		N/A			
dataSource	Free-form identification of the source of this data instance	String	N/A		N/A			
notes	Additional information	String			N/A			
RSInstance	*Representation Specification* Data Group	RS	N/A		N/A		✓	Data Group defined by specific *representation specification*. E.g., “RS0001”.

6.3.2 Data Group RSXXXX

Each representation specification shall define a single, top-level data group that contains nested data groups specific to the equipment’s performance and description.

6.3.3 Data Group Performance

Performance shall contain any data elements that are needed to characterize the operational performance of the equipment. The performance data group contains (1) single data elements that represent equipment properties that are constant across all operating conditions, and (2) nested performance maps that represent equipment operation over a range of operating conditions.

6.3.4 Data Group PerformanceMap

Data groups with names beginning with “PerformanceMap” shall be used to describe the operational performance of the equipment over a range of operating conditions. Performance maps are required when the performance over the operational range of the equipment cannot be characterized by single data elements. One or more *performance maps* are included that convey equipment performance for a range of conditions and operating modes. Performance maps shall consist of two elements representing *grid variables* and *lookup variables* that relate the performance of the equipment over a range of operating conditions.

Lookup variables shall be provided in a rectilinear, but not necessarily uniform, grid (as illustrated in Figure 6-1 for 3 dimensions) defined by the *grid variable* values. This implies that both the outer boundary and each cell of the point set are hyperrectangles (n-dimensional rectangles).

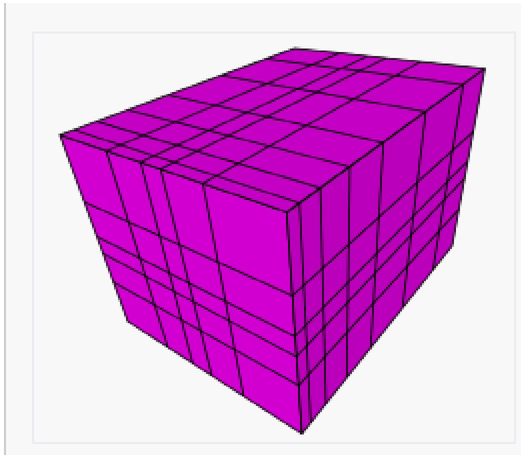

Figure 6-1. Rectilinear grid

Lookup variable data element values under *grid variable* conditions where the equipment does not operate shall be represented by *NULL*. Non-operation shall be assumed for any conditions falling within a *grid cell* having any NULL vertices. Application software may create temporary virtual operating points in regions of non-operation as a calculation convenience but shall not infer actual operation in non-operating regions.

In cases where *representation specifications* define more than one *performance map,* rules shall be provided that determine which map is to be used. For example, a common case will be to use "PerformanceMapStandby" when other logic or NULL data indicates the equipment is not operating.

Lookup variable values shall be provided with sufficient *grid variable* spacing to capture non-linear performance characteristics (e.g., inflections).

Informative: A minimum of 2 values is required to indicate the operational range of the equipment for each *grid variable*. A single value for a *grid variable* indicates that operation is limited to that value.

6.3.5 Data Group GridVariables

Each *grid variable* within the GridVariable data group shall be described as an ordered list of values corresponding to points along an axis. Values shall be defined in ascending numerical order.

6.3.6 Data Group LookUpVariables

Lookup variables shall be defined as single values corresponding to a combination of *grid variable* values. When used within a *performance map data group*, *lookup variables* shall appear as a list ordered according to the listing of grid variables in the Data Group "GridVariables" such that the corresponding list of *lookup variables* varies most frequently with the last *grid variable* defined (See Section 10 for an example).

6.3.7 Data Group Description

This data group contains accessory information for the equipment that is not explicitly required to describe equipment performance.

6.3.8 Data Group ProductInformation

This section describes equipment identification information, for example: manufacturer name, model number(s), and general meta data characteristics (e.g., compressor type).

6.3.9 Data Group Rating

A *representation specification* may define *data groups* that includes *data elements* that represent standard ratings.

6.3.10 Data Group CustomTable

See definition in Section 4.8.

6.4 Validation Rules

Representation specifications shall include description and documentation of rules used to verify minimal data accuracy. The form of these rules will depend on the type of equipment and data being represented. Typical examples are valid ranges, logical relationships among values, and physical constraints. See Section 4.1.1.

Validation rules implicit in the data type of *data elements* shall not be restated in *representation specifications*. For example, a Boolean *data element* shall not include a validation rule of “T or F”.

6.5 References

References to external information sources that support this *representation specification.*

6.6 Example(s)

Representation specifications may provide one or more examples to illustrate implementation.
Supporting files shall be made available at http://data.ashrae.org/standard205

7 REFERENCES

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8 DEFINITIONS OF DATA TYPES, COMMON ENUMERATIONS, AND ABBREVIATIONS

The following information is presented as a stand-alone section to facilitate anticipated additions.

8.1 Data Type Definitions

Each *data element* included in a *representation specification* shall have one of the data type attributes listed in Table 8-1.

Table 8-1. Data Type Definitions

Data type	**Description**	**Examples**
Integer	A whole number (i.e., a number that can be written without a fractional part) with optional leading sign.	3, 19, -4, +212
Numeric	A number that may include a fractional part with optional leading sign and optional exponent (engineering notation).	3.43, 0, 12.2, -4, 1.03e4
Boolean	An enumerated type having two values: representing True and False.	True, False
Enumeration	Concise synonym for "enumerated type" -- a data type that takes one of a set of pre-defined named enumerators, see Section 4.11.	{air-conditioner, heat pump, furnace, boiler}
String	A sequence of characters of any length using any (specified) character set. (Informative: SPC 205 intends to later define methods that allow descriptive information to be provided in other languages in addition to English within the same representation.)	"Indirect evaporative cooler"
UUID	An effectively-unique character string conforming to ITU-T Recommendation X.667 (ITU-T 2012). *Informative:* POSIX regex: [0-9,a-f,A-F]{8}-[0-9,a-f,A-F]{4}-[0-9,a-f,A-F]{4}-[0-9,a-f,A-F]{4}-[0-9,a-f,A-F]{12}	123e4567-e89b-12d3-a456-426655440000
Date	A calendar date formatted per ISO 8601 (ISO 2004) *Informative:* POSIX regex: [0-9]{4}-[0-9]{2}-[0-9]{2}	2015-04-29

Timestamp	Date with UTC time formatted per ISO 8601 (ISO 2004) *Informative:* POSIX regex: [0-9]{4}-[0-9]{2}-[0-9]{2}T[0-9]{2}:[0-9]{2}Z	2016-06-29T14:35Z
Version	Version identifier in the form major.minor.patch as defined by Semver 2016. *Informative:* POSIX regex: [0-9]+\.[0-9]+\.[0-9]+	1.1.3
Data Group	A nested data group defined elsewhere in the standard.	Rating PerformanceMapCooling
< data type >	an ordered list of data type	<Integer> example = 1, 5, 23, 4

Common Enumerated Types

When a *representation specification* includes *data elements* of enumerated types listed in this section, the specified enumerators shall be used.

A specific use of an enumerated type may restrict or extend the set of allowed enumerators, but those that correspond to the specified common enumerators shall be retained exactly.

Enumerated type *data elements* shall have names that match their type except where more than one *data element* of the same enumerated type is used in the same *data group.* In that situation, distinguishing prefix(es) shall be added to the type name. For example, if a device uses two fluids, *data elements* could be named condenserLiquidType and evaporatorLiquidType.

8.1.1 RSID

Each *representation specification* shall include an RSID enumerator as define in Section 8.4.

8.1.2 RefrigerantType

Enumerators for refrigerants shall conform to refrigerant number designations listed in ANSI/ASHRAE Standard 34-2013 (ASHRAE 2013g) latest revision using Technical Prefix of "R".

For example, "R410a" is an acceptable refrigerantType; "HCFC-22" is not.

8.1.3 CompressorType

Enumerator	Definition	Notes
reciprocating	Reciprocating compressor	
screw	Screw compressor	
centrifugal	Centrifugal compressor	
rotary	Rotary compressor	
scroll	Scroll compressor	

8.1.4 CondenserType

Enumerator	Definition	Notes
air	Air-cooled condenser	
water	Water-cooled condenser	

evaporative	Evaporative condenser	

8.1.5 LiquidConstituent

Enumerator	Definition	Notes
water	Water	
propyleneGlycol	Propylene glycol	
ethyleneGlycol	Ethylene glycol	
seaWater	Salt water from a sea	

8.1.6 ConcentrationType

Enumerator	Definition	Notes
byVolume	Concentration is defined as a volume fraction	
byMass	Concentration is defined as a mass fraction	

8.2 Common Data Groups

8.2.1 LiquidMixture

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
liquidComponents	A list of all liquid components within the liquid mixture	<LiquidComponent>	N/A				✓	List may contain a single component.
concentrationType	Defines whether concentration is defined on a volume or mass basis	ConcentrationType	N/A				✓	

8.2.2 LiquidComponent

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
liquidConstituent	Substance of this component of the mixture	LiquidConstituent	N/A				✓	
concentration	Concentration of this component of the mixture	Numeric	-	$\geq 0, \leq 1.0$		0.01		If omitted, it is assumed to share equal portions with any other component with no defined concentration. e.g., can be left blank for the primary component.

8.3 Abbreviation Definitions

Except for abbreviations found in Table 8-2, abbreviations shall not be used in data names. Table 8-2 abbreviations shall be used in enumeration choices. Additional abbreviations may be used in enumeration choices, subject to the considerations in Section 4.11.1.

Abbreviations are replacements for groups of words and do not imply definitions of the associated phrases. Some phrases listed in Table 8-2 have multiple context-specific technical definitions. *Representation specifications* must provide unambiguous definitions for all terms (abbreviated or not).

Table 8-2. Abbreviation Definitions

Abbreviation	Meaning
COP	Coefficient of performance
PLR	Part load ratio
AHU	Air handling unit
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
RS	Representation specification
ID	Identifier
Max, max	Maximum
Min, min	Minimum
EER	Energy Efficiency Ratio
IEER	Integrated Energy Efficiency Ratio
SEER	Seasonal Energy Efficiency Ratio

8.4 Representation Specification List

Table 8-3 lists the *representation specifications* defined by this standard and shows their current status.

Table 8-3. Standard 205 Representation Specifications

RSID	Title	Status
RS0001	Liquid-Cooled Chiller	PPR
RS0002	Unitary Cooling Air-Conditioning Equipment	PPR
RS0003	Fan Assembly	PPR

9 REPRESENTATION SPECIFICATION STYLE GUIDE (INFORMATIVE)

9.1 Naming Guidelines

Informative: The naming convention guidelines listed below have been adapted from the ARTS XML (www.nrf-arts.org - formerly IXRetail) Technical Committee best practices (IBM, 2002) and MSDN Guidelines for Names (MSDN, 2012). The goal of these guidelines is to assist future development of standardized schemas from the *representation specifications* in this standard. Fundamental features include choosing names for descriptive value and continuity with prior industry standards, using local naming to keep message sizes reasonable, and planning for change.

- **Readability is more important than length.** Although there is the potential that long names will lengthen *representation implementation* documents, accurate understanding and application of data is the overriding consideration. Thus, unambiguous and expressive names are preferred, for example `evaporatorPressureDrop` rather than `evapPresDrp`. It is also anticipated that messaging infrastructure will provide data compression for efficient transfer of *representation implementation* documents.
- **Specify dimensions at end of name.** In general, use names such as `enteringTemperature`, as opposed to `temperatureEntering` (unless the latter form is available as a widely used pre-existing name).
- **Avoid names that include a defined unit of measurement.** For example, do not use names such as `airCFM` or `pumpGPM`. Instead, consider names such as `airVolumeFlowRate` or `pumpVolumeFlowRate`.
- **Do not include data types in names.** Use `AHRIRated`, not `AHRIRatedBoolean`.
- **Avoid abbreviations and acronyms.** The list of exceptions is documented in Section 8.1.6 of this standard.
- **Avoid using names that conflict with widely used programming languages.** For example, do not use `case, switch, default`, etc.
- **Avoid names that differ only in case.** Not all programming languages are case-sensitive, so it is best to avoid names differing only in case.
- **Names should not include a repetition of the names of containing structures or *data groups*.** The container provides adequate context; using its name in component names is redundant and needlessly lengthens component names. For example, the capacity of a chiller should be called simply "`capacity`" rather than "`chillerCapacity`".
- **Use text enumerators.** Enumerators based on a natural language can suggest meanings by appropriate selection of words, while numeric values do not. It is helpful to be consistent with names derived from common usage although words displayed to end users can be more expressive. For example, a `condenserType` enumeration might have enumerators "air" "water", and "evaporative".
- **Consider "Type" at end of enumeration names.** Clear enumeration names often end in "Type". Examples are `compressorType` and `refrigerantType`.

9.2 Numeric Element Precision

When determining numeric element precision requirements, consideration should be given to uses of the associated values. Values that will be used in differences (such as entering and leaving temperatures) may necessitate high precision requirements.

10 EXAMPLE PERFORMANCE MAP REPRESENTATION (INFORMATIVE)

This example shows the representation specification for a single performance map and illustrates an instantiation of the performance map.

Table 10-1. Example Performance Map Data Group

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
gridVariables	Data group defining the grid variables for performance	GridVariables	N/A				✓	
lookupVariables	An ordered list of lookup variable data	<LookupVariables>	N/A				✓	

	groups representing performance							

Table 10-2. Example Grid Variable Data Group

Data Element Name	Description	Data Type	Units	Validation	Sig. figs	Res	Req	Notes
outdoorTemperature		<Numeric>	°C	≥ -273.15		0.01	✓	For example purposes only.
indoorTemperature		<Numeric>	°C	≥ -273.15		0.01	✓	For example purposes only.
airVolumetricFlowRate		<Numeric>	m^3/s	≥ 0	2		✓	For example purposes only.

An example instance of this *grid variable* data group would be:

```
gridVariables:
  outdoorTemperature: [29.44, 35.00, 40.56]
  indoorTemperature: [22.22, 23.89, 25.56]
  airVolumetricFlowRate: [0.26, 0.34]
```

Table 10-3. Example Lookup Variable Data Group

Data Element Name	Description	Data Type	Units	Validation	Sig. figs	Res	Req	Notes
power		Numeric	W	≥ 0	5		✓	For example purposes only.
capacity		Numeric	W	≥ 0	5		✓	For example purposes only.

An example instance of this *lookup variable* data group would be:

```
lookupVariables: [power: 2192.5, capacity: 8740.0]
```

If the values of the set of lookup variables are expressed explicitly as a set of the grid variables in table form, then an example instance of a performance map data group would be:

Grid Variables			Lookup Variables	
outdoorTemperature (C)	indoorTemperature (C)	airVolumetricFlowRate (m3/s)	power (W)	capacity (W)
29.44	22.22	0.26	2192.5	8740.0
29.44	22.22	0.34	2192.5	9100.0
29.44	23.89	0.26	2192.5	8740.0
29.44	23.89	0.34	2192.5	9100.0
29.44	25.56	0.26	2192.5	8740.0
29.44	25.56	0.34	2192.5	9100.0
35.00	22.22	0.26	2370.0	8380.0
35.00	22.22	0.34	2370.0	8720.0
35.00	23.89	0.26	2370.0	8380.0
35.00	23.89	0.34	2370.0	8720.0
35.00	25.56	0.26	2370.0	8380.0

35.00	25.56	0.34	2370.0	8720.0
40.56	22.22	0.26	2615.0	8560.0
40.56	22.22	0.34	2615.0	8910.0
40.56	23.89	0.26	2615.0	8560.0
40.56	23.89	0.34	2615.0	8910.0
40.56	25.56	0.26	2615.0	8560.0
40.56	25.56	0.34	2615.0	8910.0

Notice that the order of grid variable variation (and thus row order) is "last fastest". In this case, airVolumetricFlowrate varies with the highest frequency, indoorTemperature next, and outdoorTemperature lowest. In implementation practice, this defined order allows lookup variables to be conveyed without repetition of grid variable values.

RS0001: Liquid-Cooled Chiller

1 Identification and History

RSID: RS0001

RSTitle: Liquid-Cooled Chiller

RSVersion	Date	Source	Notes
0.1.0	22-Jan-2019	SPC-205 Chiller working group	Initial version

2 Scope and Description

Representation Specification RS0001 applies to electrically driven, factory-designed, and prefabricated vapor compression liquid-chilling packages, including one or more hermetic or open drive compressors (centrifugal, rotary screw, scroll, reciprocating, or other types), equipped with a liquid-cooled condenser.

The equipment covered by this representation specification is the same as the liquid-chilling equipment defined by:

- ANSI/AHRI 551/591-2015, "Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle"

Representation Specification RS0001 does not cover steam driven, gas driven, absorption liquid-chilling and liquid-heating packages, nor chillers with a separate heat recovery liquid stream.

Figure RS0001-1 shows a schematic of a vapor compression refrigeration liquid-chilling package with notes below.

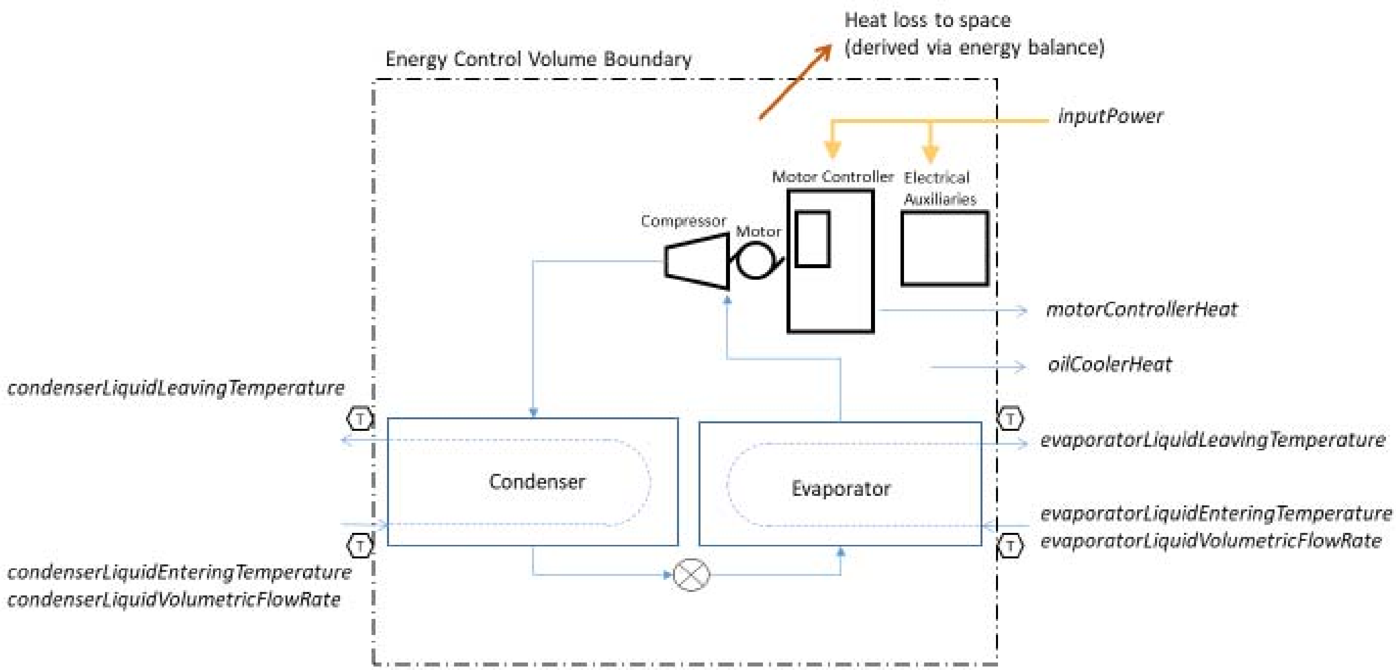

Figure RS0001-1. Liquid-cooled chiller

- All energy flows crossing the control volume boundary are to be accounted for unless separately reported in the performance data.
- Motor controller may be variable speed drive, solid state starter, or electro-mechanical starter, or not present
- Auxiliary power consumers are components such as control system power, block/compressor/crankcase/oil heaters, purge units, or other devices as defined in the applicable rating standard.

- *Heat loss to space* includes any heat that is dissipated to the air where the chiller is located.

- *motorControllerHeat* and *oilCoolerHeat* represent liquid cooled heat exchangers providing motor controller cooling and/or oil cooling not captured in evaporator or condenser rated values. If the heat loss is captured within the chiller and accounted for in the rating, then no additional heat flows need to be accounted for. These heat flows are represented as simply the required heat rejection and not the temperature and flow of the liquid streams providing the cooling.

3 Data Representation

A representation implementation conforming to this representation specification shall consist of the following *data groups*:

- ASHRAE205 [1]
    - Description [0 .. 1]
        - ProductInformation [0 .. 1]
        - RatingAHRI [0 .. 1]
        - CustomTable [0 .. N]
    - Performance [1]
        - PerformanceMapCooling [1]
            - GridVariablesCooling [1]
            - LookupVariablesCooling [1]
        - PerformanceMapStandby [1]
            - GridVariablesStandby [1]
            - LookupVariablesStandby [1]

Multiple chillers shall be represented in multiple representation files

3.1 Local Enumerations

The following local enumerations are defined:

3.1.1 SpeedControlType

Enumerator	Definition	Notes
ConstantSpeed	Compressor is driven by a constant speed motor.	
VariableSpeed	Compressor motor speed is controlled by a variable frequency drive.	

3.1.2 StandardRatingVersion

Enumerator	Definition	Notes
AHRI_550_590_2015	Ratings and design points defined using IP unit version of the standard.	
AHRI_551_591_2015	Ratings and design points defined using SI unit version of the standard.	

3.2 Data Groups

3.2.1 Description

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Note
productInformation	Data group describing product information	ProductInformation	N/A		N/A	N/A		
ratingAHRI	Data group containing AHRI rating information	RatingAHRI	N/A		N/A	N/A		

3.2.2 ProductInformation

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Note
manufacturer	Name of the manufacturer	String	N/A		N/A	N/A	✓	Shall be the same as "unit manufacturer" when referring to AHRI 550/590 or AHRI 551/591
manufacturerSoftwareVersion	Version of the software used to generate the performance map	String	N/A		N/A	N/A	✓	Example: "15.03" If the software version does not exist, input "NA"
modelNumber	Model number for this chiller	String	N/A		N/A	N/A	✓	Complete model number string for the unit. May contain special characters.
nominalVoltage	Unit nominal voltage	Numeric	Volts	≥ 0	3	1.0	✓	Example "460" If the unit can operate at multiple voltages, the lower of the two shall be stated
nominalFrequency	Unit nominal frequency	Numeric	Hz	≥ 0	2	1.0	✓	Example "60" or "50" Power supply frequency for the intended region of installation
toleranceStandard	Name and version of the testing or certification standard under which the chiller is rated.	String	N/A		N/A	N/A		Example AHRI 550/590-2015, EN14511-2018, EN14825-2016, GB18430.1-2007
compressorType	Type of compressor	CompressorType	N/A		N/A	N/A	✓	See Standard 205 Global Enumerations (Table 8.2.3)
driveType	Type of electrical motor drive	SpeedControlType	N/A		N/A	N/A	✓	See 3.1 Local Enumerations

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Note
liquidDataSource	Source of the liquid properties data	String	N/A		N/A	N/A		Example: "ASHRAE Handbook Fundamentals 2013 chapter 31"
refrigerantType	Refrigerant used in the chiller	RefrigerantType	N/A		N/A	N/A	✓	See Standard 205 Table 8.2.2
hotgasBypassInstalled	Indicates if a hot-gas bypass valve is installed on the chiller	Boolean	N/A		N/A	N/A		

3.2.3 RatingAHRI

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Note
certificationReferenceNumber	Certification reference number	String	N/A		N/A	N/A	✓	The certification number as stated on the certificate.
standardRatingVersion	Version	StandardRatingVersion	N/A		N/A	N/A	✓	
designNetRefrigeratingCapacity	Unit rated refrigeration capacity	Numeric	W	>0	4	N/A	✓	The available cooling capacity of the evaporator to the thermal load calculated using only the sensible heat transfer at full load rating condition.
designInputPower	Total unit power	Numeric	W	≥ 0	4	1.0	✓	Total power input to the chiller package. See testing standard for details.
designCOP	Efficiency at design point as ratio of unit of cooling per unit of power consumed	Numeric	-	>0	4	N/A	✓	COP kWc/kWin
designPartLoadValue	Rated part load efficiency over an integrated load profile	Numeric	-		4	N/A	✓	Represents the IPLV.SI, IPLV.IP, NPLV.SI, NPLV.IP, or other part load metric as appropriate for the "standardRatingVersion" expressed as the dimensionless ratio of cooling per unit of power consumed.
designEvaporatorLiquidVolumetricFlowRate	Chilled liquid flow at the full load design point rating condition	Numeric	m^3/s	>0	4	N/A	✓	Evaporator liquid volumetric flow rate at the full load rating condition. Density calculations shall be made at the inlet temperature of the heat exchanger at full load rating condition.
designEvaporatorLiquidLeavingTemperature	Leaving evaporator	Numeric	°C	> -273.15	N/A	0.01	✓	Evaporator liquid temperature at the exit flange of the chiller's evaporator at full

	liquid temperature at the full load design point rating condition							load rating condition. See testing standard for details.
designEvaporatorLiquidEnteringTemperature	Entering evaporator liquid temperature at the full load design point rating condition	Numeric	°C	> -273.15	N/A	0.01	✓	Evaporator liquid temperature at the entry flange of the chiller's evaporator at full load rating condition.
designEvaporatorLiquidDifferentialPressure	Pressure drop across the evaporator at the full load rating condition.	Numeric	Pa	>0	3	1.0	✓	Pressure drop is as defined in the applicable rating standard
designCondenserLiquidVolumetricFlowRate	Condenser liquid flow at the full load design point rating condition.	Numeric	m^3/s	>0	4	N/A	✓	Condenser liquid volumetric flow rate at the full load rating condition. Density calculations shall be made at the inlet temperature of the heat exchanger.
designCondenserLiquidEnteringTemperature	Entering condenser liquid temperature at the full load design point rating condition.	Numeric	°C	> -273.15	N/A	0.01	✓	Condenser liquid temperature at the entry flange of the chiller's condenser at full load rating condition. See testing standard for details. Round to two decimal places
designCondenserLiquidLeavingTemperature	Leaving condenser liquid temperature at the full load design point rating condition.	Numeric	°C	> -273.15	N/A	0.01	✓	Condenser liquid temperature at the exit flange of the chiller's condenser at full load rating condition. Round to two decimal places
designCondenserLiquidDifferentialPressure	Pressure drop across the condenser at the full load design point	Numeric	Pa	> 0	3	1.0	✓	Pressure drop is as defined in the applicable rating standard

	rating condition.							

3.2.4 Performance

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Note
evaporatorLiquidType	Type of liquid in evaporator	LiquidMixture	N/A		N/A	N/A	✓	LiquidMixture specifies liquid constituents and their concentrations, see Standard 205 Global Enumerations (Table 8.2.5). Density shall be evaluated at the evaporator inlet liquid temperature.
condenserLiquidType	Type of liquid in condenser	LiquidMixture	N/A		N/A	N/A	✓	LiquidMixture specifies liquid constituents and their concentrations, see Standard 205 Global Enumerations (Table 8.2.5). Density shall be evaluated at the condenser inlet liquid temperature.
evaporatorFoulingFactor	Factor of heat transfer inhibition due to heat exchanger fouling layer	Numeric	m^2-K/W	> 0	3	N/A	✓	Evaporator fouling factor at which the performance matrix was created. This may be different from the certification data supplied
condenserFoulingFactor	Factor of heat transfer inhibition due to heat exchanger fouling layer	Numeric	m^2-K/W	> 0	3	N/A	✓	Condenser fouling factor at which the performance matrix was created. This may be different from the certification data supplied
unitPowerLimit	Maximum unit power input	Numeric	W	>0	4	1.0		Maximum power input the chiller can operate at reliably and continuously at any condition in the operating envelope
performanceMapCooling	Data group describing cooling performance over a range of conditions	PerformanceMapCooling	N/A		N/A	N/A	✓	
performanceMapStandby	Data group describing standby performance	PerformanceMapStandby	N/A		N/A	N/A	✓	

3.2.5 PerformanceMapCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
gridVariablesCooling	Data group defining the grid variables for cooling performance	GridVariablesCooling	N/A		N/A	N/A	✓	
lookupVariablesCooling	Data group defining the lookup variables for cooling performance	<LookupVariablesCooling>	N/A		N/A	N/A	✓	

3.2.6 GridVariablesCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
evaporatorLiquidVolumetricFlowRate	Chilled liquid (evaporator) flow	<Numeric>	m^3/s	> 0	4	N/A	✓	
evaporatorLiquidLeavingTemperature	Leaving evaporator liquid temperature	<Numeric>	°C	>-273.15	N/A	0.01	✓	
condenserLiquidVolumetricFlowRate	Condenser liquid flow	<Numeric>	m^3/s	> 0	4	N/A	✓	
condenserLiquidEnteringTemperature	Entering condenser liquid temperature	<Numeric>	°C	> -273.15	N/A	0.01	✓	
netEvaporatorCapacityFraction	Fraction of maximum net capacity at the same operating conditions.	<Numeric>	None	≥ 0 and ≤ 1	4	.01	✓	Ratio of netEvaporatorCapacity to the maximum evaporator capacity at the same operating conditions

3.2.7 LookupVariablesCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
inputPower	Total power input to the packaged chiller.	Numeric	W	> 0	3	1.0	✓	All power consumed by the chiller, including controls, motors, variable speed drives, purge units, sump heaters, fans, etc.
netEvaporatorCapacity	Unit refrigeration capacity	Numeric	W	≥ 0	4	1.0	✓	The available cooling capacity of the evaporator to the thermal load calculated using only the sensible heat transfer.
netCondenserCapacity	Condenser heat rejection	Numeric	W	≥ 0	4	1.0	✓	The capacity of the condenser transferred to the condenser cooling stream using only the sensible heat transfer.
evaporatorLiquidEnteringTemperature	Entering evaporator liquid temperature	Numeric	°C	> -273.15	N/A	0.01	✓	Round to two decimal places

condenserLiquidLeavingTemperature	Leaving condenser liquid temperature	Numeric	°C	> -273.15	N/A	0.01	✓	Round to two decimal places
evaporatorLiquidDifferentialPressure	Pressure drop across the evaporator	Numeric	Pa	> 0	3	1.0	✓	
condenserLiquidDifferentialPressure	Pressure drop across the condenser	Numeric	Pa	> 0	3	1.0	✓	
oilCoolerHeat	Heat rejected by the chiller oil cooler (if separate stream crossing the control volume boundary)	Numeric	W	≥ 0	4	1.0	✓	Heat transferred to another liquid crossing the control volume boundary from the chiller oil cooler. NULL if not present
motorControllerHeat	Heat rejected by the motor control center cooling (if separate stream crossing the control volume boundary)	Numeric	W	≥ 0	4	1.0	✓	Heat transferred to another liquid crossing the control volume boundary from the chiller motor controller (inverter drive, starter, etc). NULL if not present

3.2.8 PerformanceMapStandby

The PerformancyMapStandby group defines the power consumed by the unit during standby operation. The standby power input may be from devices that cycle on and off such as purge units and sump units or from devices that draw continuous power such as fans and controls. Standby power consumption shall be expressed as a time averaged power consumption since many standby components will cycle on/off during the standby period

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
gridVariablesStandby	Data group defining the grid variables for standby performance	GridVariablesStandby	N/A		N/A		✓	
lookupVariablesStandby	Data group defining the lookup variables for standby performance	<LookupVariablesStandby>	N/A		N/A		✓	

3.2.9 GridVariablesStandby

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
chillerEnvironmentDryBulbTemperature	Dry bulb temperature of the air in the environment of the chiller	<Numeric>	°C	≥ -273.15	N/A	0.01	✓	This may be rounded to 0 decimal places

3.2.10 LookupVariablesStandby

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
inputPower	Total power consumed by the chiller when not running. Value shall include all power sources and all auxiliary equipment provided with the chiller.	Numeric	W	≥ 0	3	1.0	✓	Power consumed by chiller during off cycle. An example is a VSD cooling fan or sump heater.

3.3 Validation Rules

3.3.1 Chiller Heat Balance

Heat balance of a system shall be used to verify conservation of energy. At the highest level, the heat balance is represented by the following equation:

$$\sum Energy_{In} = \sum Energy_{Out} \qquad \text{(RS0001-1)}$$

In the simplest chiller system, this can be represented as:

$$\dot{P}_{in} + \dot{Q}_{evap} = \dot{Q}_{cond} \qquad \text{(RS0001-2)}$$

Referring to Figure RS0001-1, this is expanded to:

$$\dot{P}_{in} + \dot{Q}_{evap} = \dot{Q}_{cond} + \dot{Q}_{lossToSpace} + \dot{Q}_{oilCooler} + \dot{Q}_{motorController} \qquad \text{(RS0001-3)}$$

All of these terms are provided in the performance tables except for the losses to the space, which can be calculated as the differences between the other energy flows:

$$\dot{Q}_{lossToSpace} = (\dot{P}_{in} + \dot{Q}_{evap}) - (\dot{Q}_{cond} + \dot{Q}_{oilCooler} + \dot{Q}_{motorController}) \qquad \text{(RS0001-4)}$$

The resulting loss to the space shall not be negative:

$$\dot{Q}_{lossToSpace} \geq 0 \qquad \text{(RS0001-5)}$$

Informative Note: There may be other losses in the system, such as the pressure effects on the physical state of the liquid flow under high pressure differentials, but for the intended use of the performance data provided in accordance with the standard, those losses have been considered negligible.

3.3.2 Nomenclature

Symbol	Data element	Description
$\dot{P}_{in}$	inputPower	Electrical power input to the refrigeration system, W
$\dot{Q}_{evap}$	netEvaporatorCapacity	Heat addition rate from the chilled liquid stream to the refrigeration system at the evaporator, W
$\dot{Q}_{cond}$	netCondenserCapacity	Heat rejection rate from the refrigeration system to the cooling liquid stream at the chiller, W
$\dot{Q}_{losstoSpace}$		Rate of thermal energy generated by the equipment that is lost to the surroundings (the portion of input power that is not transferred as useful work to the refrigeration system), W
$\dot{Q}_{oilCooler}$	oilCoolerHeat	Rate of thermal energy generated by the equipment that is lost through a liquid cooled oil cooler that exits the control volume through a separate liquid stream, W
$\dot{Q}_{motorController}$	motorControllerHeat	Rate of thermal energy generated by the equipment that is lost through a liquid cooled motor controller that exits the control volume through a separate liquid stream, W

4 References

AHRI Standard 550/590 - 2015

AHRI Standard 551/591 - 2015

5 Example

See http://data.ashrae.org/standard205

RS0002: Unitary Cooling Air-Conditioning Equipment

1 Identification and History

RSID: RS0002

RSTitle: Unitary Cooling Air-Conditioning Equipment

RSVersion	Date	Source	Notes
0.1.0	22-Jan-2019	SPC-205 unitary working group	Initial version

2 Scope and Description

Representation Specification RS0002 applies to factory-made; staged or variable speed compression; split-system, unitary or packaged; air-cooled; direct expansion; cooling air-conditioners.

The equipment covered by this representation specification is the same as the air-conditioning equipment defined in either:

- ANSI/AHRI 210/240, “Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment”, or
- ANSI/AHRI 340/360, “Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment”.

This definition does not include a fan for distributing conditioned air across the indoor coil. Fans for moving air across the outdoor coil are included.

Figure RS0002-1 illustrates the components of unitary air-conditioning systems within the scope of this appendix.

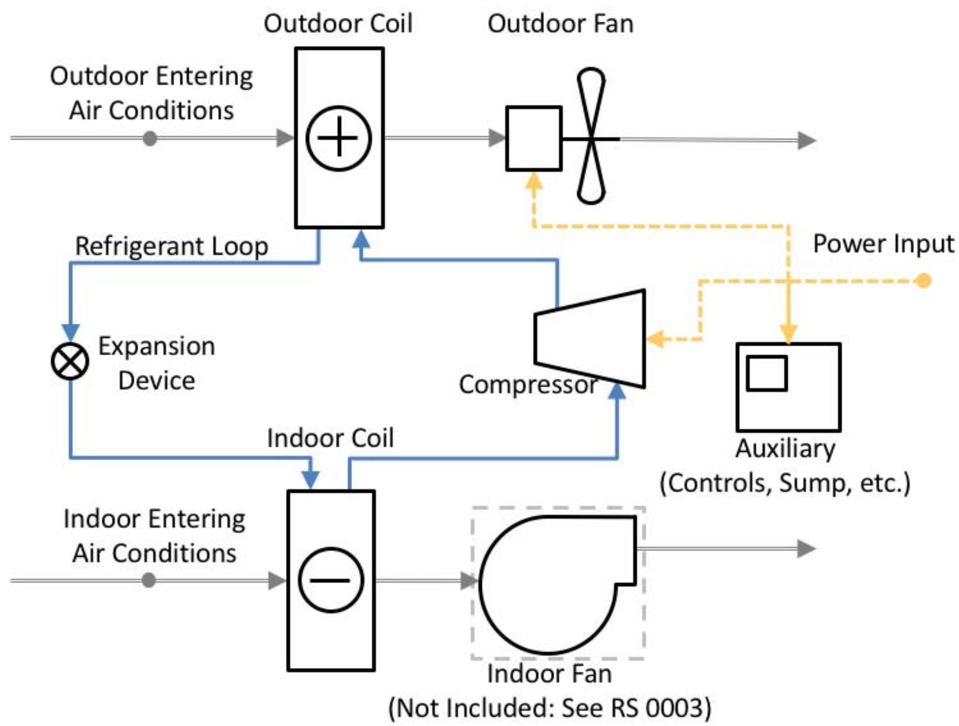

Figure RS0002-1. Unitary Air-Conditioning System

3 Data Representation

A representation implementation conforming to this representation specification shall consist of the following *data groups:*

- ASHRAE205 [1]
  - Description [0 .. 1]
    - ProductInformation [0 .. 1]
    - RatingAHRI210240 [0 .. 1][1]
    - RatingAHRI340360 [0 .. 1][1]
    - CustomTable [0 .. N]
  - Performance [1]
    - ASHRAE205 (RS0003) [0 .. 1]
    - PerformanceMapCooling [1]
      - GridVariablesCooling [1]
      - LookupVariablesCooling [1]
    - PerformanceMapStandby [1]
      - GridVariablesStandby [1]
      - LookupVariablesStandby [1]

3.1 Local Enumerations

3.1.1 CompressorControlMethod

Enumerator	Definition	Notes
Staged	Compressor loading is controlled by cycling between discrete stages.	
Dynamic	Compressor loading is controlled by continuously varying the speed of the compressor.	

[1] Any provided AHRI ratings shall be determined by the scope of the corresponding standard. Only one AHRI rating data group shall be defined per representation.

3.1.2 FanPosition

Enumerator	Definition	Notes
BlowThrough	Fan is placed downstream of the indoor coil.	
DrawThrough	Fan is placed upstream of the indoor coil.	

3.2 Data Groups

3.2.1 Description

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
productInformation	Data group describing product information	ProductInformation	N/A		N/A			
ratingAHRI210240	Data group containing information relevant to products rated under AHRI 210/240	RatingAHRI210240	N/A		N/A			
ratingAHRI340360	Data group containing information relevant to products rated under AHRI 340/360	RatingAHRI210240	N/A		N/A			

3.2.2 ProductInformation

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
outdoorUnitManufacturer	Name of the outdoor unit manufacturer	String	N/A		N/A		✓	
outdoorUnitModelNumber	Model number of the outdoor unit	String	N/A		N/A		✓	
indoorUnitManufacturer	Name of the indoor unit manufacturer	String	N/A		N/A			
indoorUnitModelNumber	Model number of the indoor unit	String	N/A		N/A			
refrigerantType	Type of refrigerant used	RefrigerantType	N/A		N/A			
compressorType	Type of compressor	CompressorType	N/A		N/A			

3.2.3 RatingAHRI210240

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
certifiedReferenceNumber	AHRI Certified Reference Number	String	N/A		N/A		✓	
testStandardYear	Name and version of the AHRI test standard	Integer	N/A	2008	N/A		✓	
manufacturerDataSourceVersion	Version of the software used to generate the AHRI rating and the performance maps	String	N/A		N/A		✓	
SEER	Seasonal Energy Efficiency Ratio as defined by AHRI 210/240	Numeric	Btu/W-h	> 0	3		✓	
EER	Energy Efficiency Ratio (A) as defined by AHRI 210/240	Numeric	Btu/W-h	> 0	3		✓	The net efficiency (accounting for fan motor heat/power) at the AHRI "A" operating conditions
capacity	Total cooling capacity (A) as defined by AHRI 210/240	Numeric	Btu/h	> 0	3		✓	The net capacity (accounting for fan motor heat) at the AHRI "A" operating conditions
ratingFanPowerPerFlow	Power per air flow rate of the fan used in the AHRI 210/240 calculation of SEER and EER	Numeric	W/(m^3/s)	> 0	3			Used for verification of the rated SEER value (see SEER calculation procedures in AHRI 210/240)

3.2.4 RatingAHRI340360

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
certifiedReferenceNumber	AHRI Certified Reference Number	String	N/A		N/A		✓	
testStandardYear	Name and version of the AHRI test standard	Integer	N/A	2008	N/A		✓	
manufacturerDataSourceVersion	Version of the software used to generate the AHRI rating and the performance maps	String	N/A		N/A		✓	
IEER	Integrated Energy Efficiency Ratio as defined by AHRI 340/360	Numeric	Btu/W-h	> 0	3		✓	
EER	Energy Efficiency Ratio as defined by AHRI 340/360	Numeric	Btu/W-h	> 0	3		✓	Net efficiency accounts for fan motor heat/power
capacity	Total cooling capacity as defined by AHRI 340/360	Numeric	Btu/h	> 0	3		✓	Net capacity accounts for fan motor heat
ratingFanPowerPerFlow	Power per air flow rate of the fan used in the AHRI 340/360 calculation of SEER and EER	Numeric	W/(m^3/s)	> 0	3			Used for verification of the rated SEER value (see SEER calculation procedures in AHRI 340/360)

3.2.5 Performance

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
compressorControlMethod	Method used to control different speeds of the compressor	CompresorControlMethod	N/A		N/A		✓	
fanRS	The corresponding Standard 205 enclosed fan assembly representation	ASHRAE205 (RS0003)	N/A		N/A			This is only required if the fan is packaged with the unitary equipment
fanPosition	Position of the fan relative to the indoor coil	FanPosition	N/A		N/A		✓	
nominalVolumetricAirFlowRate	Volumetric air flow rate leaving the indoor coil used to scale the flow ratios in the PerformanceMap	Numeric	m^3/s	≥ 0	3		✓	Generally, the volumetric air flow rate under full load conditions used in AHRI testing
cyclingDegradationCoefficient	Cycling degradation coefficient (C_D) as described in AHRI 210/240	Numeric	N/A	≥ 0 and < 1.0	2		✓	Used for the lowest stage where the unit cycles to meet a setpoint. *Informative note:* 340/360 specifies a fixed cycling degradation coefficient of approximately 0.12.
performanceMapCooling	Data group describing cooling performance over a range of conditions	PerformanceMapCooling	N/A		N/A		✓	
performanceMapStandby	Data group describing standby performance	PerformanceMapStandby	N/A		N/A		✓	

3.2.6 PerformanceMapCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
gridVariablesCooling	Data group defining the grid variables for cooling performance	GridVariablesCooling	N/A		N/A		✓	
lookupVariablesCooling	Data group defining the lookup variables for cooling performance	<LookupVariablesCooling>	N/A		N/A		✓	

3.2.7 GridVariablesCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes

outdoorCoilEnteringDryBulbTemperature	Dry bulb temperature of the air entering the outdoor coil	<Numeric>	°C	≥ -273.15	N/A	0.01	✓	
indoorCoilEnteringWetBulbTemperature[2]	Wet bulb temperature of the air entering the indoor coil	<Numeric>	°C	≥ -273.15	N/A	0.01	✓	As measured after any fan heat is added to the air stream
indoorCoilEnteringDryBulbTemperature[2]	Dry bulb temperature of the air entering the indoor coil	<Numeric>	°C	≥ -273.15	N/A	0.01	✓	As measured after any fan heat is added to the air stream
indoorCoilVolumetricFlowRatio	Ratio of the volumetric air flow rate over the indoor coil to the nominal volumetric air flow rate	<Numeric>	-	> 0	3		✓	Expressed as ratio of actual (not standard) flow rate
compressorSpeedRatio[3]	Fraction representing the stage or speed of compressor operation relative to full speed or operation	<Numeric>	N/A	≥ 0	2		✓	Expressed as a fraction of total compressor capacity/speed.
ambientAbsoluteAirPressure	Ambient absolute air pressure	<Numeric>	Pa		2		✓	

3.2.8 LookupVariablesCooling

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
grossTotalCoolingCapacity	Total heat removed by the indoor coil	Numeric	W	> 0	3		✓	Does not account for heat added by the fan
grossSensibleCoolingCapacity	Sensible heat removed by the indoor coil	Numeric	W	> 0	3		✓	Does not account for heat added by the fan
grossCoolingPower	Gross power draw (of the outdoor unit)	Numeric	W	> 0	3		✓	Does not include power drawn by the indoor fan. Includes compressor, outdoor fan, and any auxiliary power used by the unit's controls and any sump heater.

[2] Operation data points for combinations where the evaporator entering wet-bulb temperature is greater than the entering dry-bulb temperature shall not be reported.

[3] For equipment with multiple or variable speed operation, performance must be reported for compressor speed fractions representative of full speed (i.e., 1.0), minimum speed, and intermediate speeds. For compressors with staged operation, intermediate speed fractions represent each intermediate stage of the compressor(s). For compressors with dynamic operation (i.e., variable speed), performance shall be interpolated between intermediate speed fractions.

3.2.9 PerformanceMapStandby

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
gridVariablesStandby	Data group defining the grid variables for standby performance	GridVariablesStandby	N/A		N/A		✓	
lookupVariablesStandby	Data group defining the lookup variables for standby performance	<LookupVariablesStandby>	N/A		N/A		✓	

3.2.10 GridVariablesStandby

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
outdoorCoilEnvironmentDryBulbTemperature	Dry bulb temperature of the air in the environment of the outdoor coil	<Numeric>	°C	≥ -273.15	N/A	0.01	✓	

3.2.11 LookupVariablesStandby

Data Element Name	Description	Data Type	Units	Validation	Sig figs	Res	Req	Notes
grossPower	Gross power draw (of the outdoor unit)	Numeric	W	≥ 0	3		✓	Does not account for power drawn from the indoor fan. Includes compressor, outdoor fan, and any auxiliary power used by the unit's controls, and any sump heater.

4 Validation Rules

Performance data supplied must satisfy the following validation tests. The psychrometric functions used below shall follow the definitions provided by the ASHRAE Handbook of Fundamentals 2013, Chapter 1.

4.1 Saturation

The resulting condition of the air leaving the indoor coil shall not exceed 100% relative humidity:

$$\phi(T_{db,l}, T_{wb,l}, P) \leq 1.0 \quad \text{(RS0002-1)}$$

4.2 Apparatus Dew Point

An apparatus dew point for the indoor coil must be determinable from the given combination of entering air conditions, total cooling capacity, and sensible heat ratio. That is, a line drawn on a psychrometric chart between the inlet and outlet conditions must intersect the saturation curve when extended beyond the outlet conditions:

There exists $T_{db,ADP}$ and ω_{ADP} such that:

$$\frac{\omega_e - \omega_l}{T_{db,e} - T_{db,l}} = \frac{\omega_e - \omega_{ADP}}{T_{db,e} - T_{db,ADP}} \quad \text{(RS0002-2)}$$

and

$$\phi(T_{db,ADP}, \omega_{ADP}, P) = 1.0. \quad \text{(RS0002-3)}$$

4.3 Moisture Conservation

The resulting humidity ratio of the air leaving the indoor coil shall not exceed the humidity ratio of the air entering the indoor coil:

$$\omega_l \leq \omega_e \quad \text{(RS0002-4)}$$

4.4 Nomenclature

Symbol	Description
ϕ	Relative humidity
ω	Humidity ratio
T_{db}	Dry-bulb temperature, °C
T_{wb}	Wet-bulb temperature, °C
P	Absolute pressure, Pa
e	Subscript indicating entering coil conditions
l	Subscript indicating leaving coil conditions
ADP	Subscript indicating Apparatus Dew Point (ADP) conditions

5 References

AHRI Standard 210/240

AHRI Standard 340/360

ASHRAE Handbook of Fundamentals 2013, Chapter 1

6 Example

See http://data.ashrae.org/Standard205

RS0003: Fan Assembly

1 Identification and History

RSID: RS0003

RSTitle: Fan Assembly

RSVersion	Date	Source	Notes
0.1.0	22-Jan-2019	SPC-205 fan assembly working group	Initial version

2 Scope and Description

Representation Specification RS0003 applies to fans and fan-motor assemblies for forced-air HVAC systems. The assembly can be stand-alone (e.g., an air handling unit) or be an integrated part of a packaged system. The assembly can optionally be enclosed in a duct or a box and may include other components (e.g., filters, indoor coil, heat section, air-to-air heat exchanger). This representation does not include the heating and/or cooling performance of the individual components within the fan assembly. Only the performance impact on the static pressure difference across the assembly, volumetric air flow rate, fan power and fan speed (or speed number) are accounted for in this representation specification. The static pressure difference across the assembly (i.e., the external static) includes the impact of all the components contained within the assembly.

This representation specification considers fans that can operate continuously over a range of shaft speeds, such as on larger commercial systems. However, it does not cover applications using inlet guide vanes to modulate flow rate.

The representation also covers smaller residential fan systems that are setup to only operate at discrete rotational speeds that are dictated by a tap setting or dip switches. It also covers fans that are internally controlled to maintain discrete flow rates by varying rotational speed in response to changing static pressures.

Figure RS0003-1 illustrates the components of fan systems or assemblies within the scope of this representation. The fan assembly can be free-standing or it can be a sub-assembly as part of a single packaged unitary system.

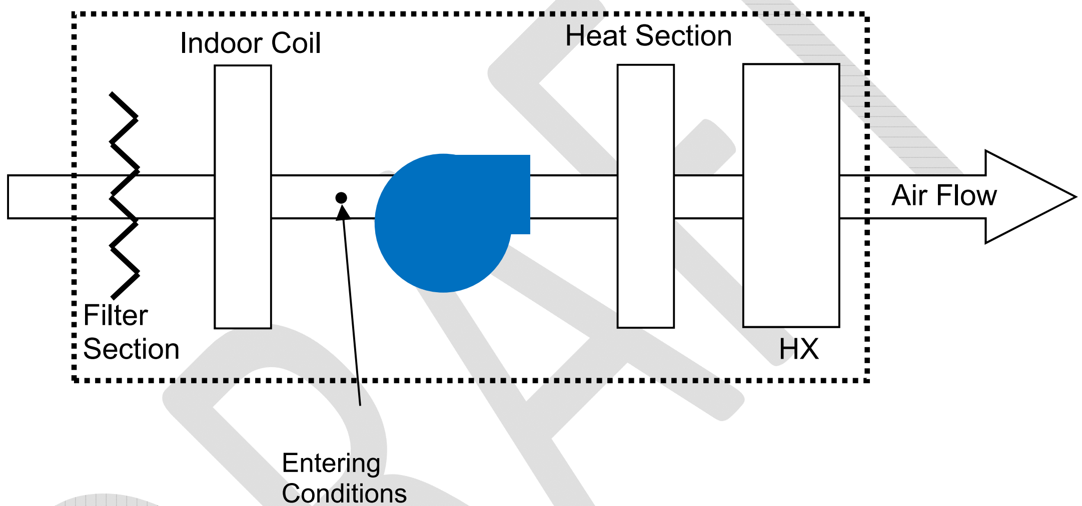

Figure RS0003-1. Example Fan Assembly (with all possible components shown)

3 Data Representation

A representation implementation conforming to this representation specification shall consist of the following *data groups*

- ASHRAE205 [1]

- Description[0 .. 1]
  - ProductInformation [0 .. 1]
  - AssemblyComponent [0 .. N]
  - CustomTable [0 .. N]
- Performance [1]
  - PerformanceMapContinuous [0 .. 1][1]
    - GridVariablesContinuous [1]
    - LookupVariablesContinuous [1]
  - PerformanceMapDiscrete [0 .. 1][1]
    - GridVariablesDiscrete [1]
    - LookupVariablesDiscrete [1]

3.1 Local Enumerations

3.1.1 ImpellerType

Enumerator	Definition	Notes
CentrifugalForwardCurved	Forward curved fan impeller	Consistent with ASHRAE standard terminology
CentrifugalBackwardCurved	Backward curved or inclined fan impeller	
CentrifugalAirFoil	Air foil impeller with shaped blades	
Axial	Fan impeller with shaft parallel to air flow stream for high static applications	
Propeller	Fan impeller with shaft parallel to air flow stream for low static pressure applications	

[1] At least one PerformanceMap data group must be defined, depending on the type of fan operation (i.e., Continuous or Discrete)

3.1.2 ComponentType

Enumerator	Definition	Notes
Coil	Finned coil in cross-flow arrangement	
Furnace	Fuel-fired heating section	
Filter	Air filters	
HeatExchanger	Additional heat exchanger	e.g., an air-to-air heat exchanger
ElectricResistanceElement	Electric resistance heater elements	
Other	Additional components in air stream	

3.2 Data Groups

3.2.1 Description

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
productInformation	Data group describing product information	ProductInformation			N/A			
assemblyComponent	Data group explicitly identifying enumerated components included in the fan assembly air stream	AssemblyComponent			N/A			

3.2.2 ProductInformation

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
manufacturer	Name of the assembly/unit manufacturer	String			N/A		✓	
modelNumber	Model number of the assembly / unit	String			N/A		✓	
hasMotor	Assembly includes a motor	Boolean			N/A		✓	True indicates input power is electrical power. False implies input power is shaft power driven externally.

enclosed	Fan assembly is enclosed	Boolean			N/A		✓	If true, the performance data reflects the static pressure difference across the enclosure
impellerType	Type of impeller in fan assembly	ImpellerType			N/A			
directDriveImpeller	Motor and impeller are directly coupled	Boolean			N/A			False if impeller is belt driven or if assembly does not include a motor.

3.2.3 AssemblyComponent

The fan assembly represents a system composed of the fan, and optionally, its enclosure with any coils, furnace sections, heat exchangers, filters, etc., that are included in the reported fan assembly performance. This data group informs the context of the performance map and can be used to ensure that the representation is not used out of context. This data group is repeated for each enumerated component within the assembly air flow path. Components should only be specified if “enclosed” is true.

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
componentType	Type of component	ComponentType			N/A		✓	
componentDescription	Informative description of the component	String			N/A			
componentID	Identification number of the corresponding Standard 205 representation	UUID			N/A			If the component has a Standard 205 representation, otherwise NULL

3.2.4 Performance

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
nominalVolumetricAirFlowRate	Nominal air flow rate for fan assembly	Numeric	m^3/s	≥ 0	3		✓	Nominal or rated air flow rate
wetSurfacePressureDrop	Additional static pressure drop if cooling coil component is collecting condensate	Numeric	Pa	≥ 0	3		✓	Corresponds to pressure drop at nominalVolumetricAirFlowRate
motorHeatFraction	Fraction of motor heat into the air stream	Numeric		≥ 0, ≤ 1	2		✓	Used to determine amount of heat from motor (and drive)

powerStandby	Assembly power draw when fan is not operating	Numeric	W	≥ 0	3		✓	
performanceMapContinuous	Data group describing fan performance in terms of air flow, static pressure, shaft speed, and power	PerformanceMapContinuous			N/A		✓ Note 1	Applies for commercial fans
performanceMapDiscrete	Data group describing fan performance in terms of speed setting, static pressure, air flow, and power	PerformanceMapDiscrete			N/A		✓ Note 1	Residential fans, either with or without flow control feature

Note 1: Exactly 1 of performanceMapContinuous or performanceMapDiscrete is required (not both)

3.2.5 PerformanceMapContinuous

The continuous performance map option is usually associated with larger commercial or industrial fan assemblies. Corrections to different operating conditions can use fan laws from the ASHRAE SI Handbook of HVAC Systems and Equipment (2012), Chapter 21, based on the assumption that the fan assembly is a constant volume device. For instance, the fan power and static pressure values at standard conditions can be modified according to the fan laws at different temperatures and atmospheric pressures by using density correction factors.

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
gridVariablesContinuous	Data group describing grid variables for continuous fan performance	GridVariablesContinuous			N/A		✓	
lookupVariablesContinuous	Data group describing lookup variables for continuous fan performance	LookupVariablesContinuous			N/A		✓	

3.2.6 GridVariablesContinuous

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
volumetricAirFlowRate	Volumetric air flow rate through fan assembly	Numeric	m^3/s	≥ 0	3		✓	
staticPressureDifference[1]	Static pressure across fan assembly at dry coil conditions	Numeric	Pa	≥ 0	3		✓	Or external static

[1]Any static pressure deduction (or addition) for wet coil is specified by “wetCoilPressureDrop” in “Performance” data group

3.2.7 LookupVariablesContinuous

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
impellerSpeed	Rotational speed of fan impeller	Numeric	rev/s	≥ 0	3		✓	
inputPower	Power input to fan assembly	Numeric	W	≥ 0	3		✓	Shaft or electric power depending on “hasMotor”

3.2.8 PerformanceMapDiscrete

The discrete performance map option normally applies to residential fan assemblies where speed taps or dip switches are used to select the desired air flow rate. Data must be provided for all allowable discrete speeds or settings. Air flow, fan power, and static pressure values are at standard conditions but can be modified according to the fan laws at different temperatures and atmospheric pressures by using density correction factors. If data are only available for one static pressure condition, specify a single nominal (or arbitrary) value.

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
gridVariablesDiscrete	Data group describing grid variables for discrete fan performance	GridVariablesDiscrete	N/A		N/A		✓	
lookupVariablesDiscrete	Data group describing lookup variables for discrete fan performance	LookupVariablesDiscrete	N/A		N/A		✓	

3.2.9 GridVariablesDiscrete

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
speedNumber	Number indicating discrete speed of fan impeller	Integer	-	≥ 0	N/A		✓	Should be in rank order
staticPressureDifference[1]	Static pressure across fan assembly at dry coil conditions	Numeric	Pa	≥ 0	2		✓	Or external static

[1]Any static pressure deduction (or addition) for wet coil is specified by “wetCoilPressureDrop” in “Performance” data group

3.2.10 LookupVariablesDiscrete

Data Element Name	Description	Data Type	Units	Validation	Sig Figs	Res	Req	Notes
volumetricAirFlowRate	Volumetric air flow rate through fan assembly	Numeric	m^3/s	≥ 0	3		✓	
inputPower	Power input to fan assembly	Numeric	W	≥ 0	3		✓	

4 Validation Rules

Performance data supplied must satisfy the following validation tests.

4.1 Fan Efficiency

The resulting energy content of the air flow, which is a product of unit static pressure (ΔP) and flow rate ($\dot{V}$), must be less than the fan assembly power input ($\dot{P}_f$). That is, the fan efficiency (ε_f) must be less than unity.

$$\varepsilon_f = \frac{\dot{V} \cdot \Delta P}{\dot{P}_f} < 1 \qquad \text{(RS0003-1)}$$

4.2 Nomenclature

Symbol	Description
$\dot{V}$	Volumetric flow rate, m3/s
ΔP	Static pressure difference across assembly, Pa
$\dot{P}_f$	Input power to fan assembly, W
ε_f	Fan efficiency, -

5 References

AHRI 210/240. Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

ANSI/AHRI 340/360. Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

6 Example

See http://data.ashrae.org/Standard205.