ASHRAE Standard 205P

Public Review Draft

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

May 2020

(Complete Draft for Public Review)

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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

Mechanical equipment consumes fuel and emits carbon during facility operation. Simulation models allow prediction of these impacts given information about how the equipment performs under all conditions. The lack of detailed equipment performance data in readily-usable forms has hampered the application of building simulation models since their invention in the 1960s and 1970s. Data are often not available or published in inconsistent formats, forcing simulation users to resort to default information and/or time consuming (and error-prone) reformatting.

Standard 205 addresses this deficiency by defining common data models and serialization formats for facility equipment performance data, allowing automated exchange among data sources (manufacturers), simulation models, and other engineering applications. The formats and procedures specified by Standard 205 are developed under ASHRAE and ANSI consensus processes with participation of equipment manufacturers, *application software* developers, and engineering practitioners. The intent is that all *data publishers* write common-format data files and all *application software* will include suitable procedures to read files using that format.

Standard 205 defines the term *representation* to mean such a data file. Specifically, a *representation* is a Concise Binary Object Representation (CBOR) file conforming to a JSON schema defined by a *representation specification* – a human-readable (text) document that defines *data models* and formats for an equipment type. *Representation specifications* are included in Standard 205 appended as an open-ended set. Conceptually, a *representation specification* has three parts:

- ***Documentation*** provides narrative text, schematic(s), references, and other information that explain the equipment and how it is modeled. This material is aimed at human readers to support correct data generation and use. Additional documentation may be available at http://data.ashrae.org/standard205.
- ***Data model*** rigorously specifies the *data groups* and *data elements* that identify the performance of the equipment. The *ASHRAE 205 JSON schema* provides a machine-processable equivalent statement of the data model, allowing automated reading, writing, and validation of data files and is available on-line at http://data.ashrae.org/standard205/schema.html.
- ***Verification and application rules*** set forth logic for identifying data errors and/or using data as intended. Such rules are to be manually implemented in *application software*.

The main body of Standard 205 provides rules and definitions used for generating *representation specifications*. This includes *data groups* that are common to all *representation specifications*, requirements for the structure of a *representation specification*, common definitions such as abbreviations, and informative material. This portion of the main body can be viewed as a meta-standard in that it specifies how to produce a *representation specification*.

The structure of Standard 205 and how it is applied are shown in Figure 1.

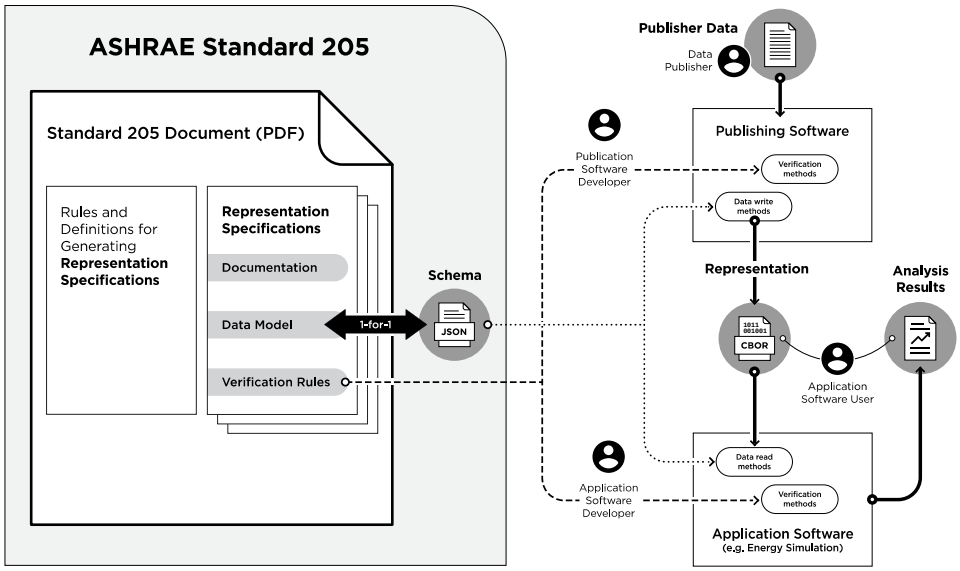

Figure 1. Standard 205 structure and application

Examples helpful for understanding the form and application of Standard 205 are found in Section 13 and on-line at http://data.ashrae.org/standard205/examples.html.

Standard 205 is intended to support the following use cases –

- **Data Publication**. *Data publishers* use *representation specifications* to guide implementation of data writing and testing software that produces correctly formed *representation* files.
- **Application Development**. *Application software developers* use *representation specifications* to guide implementation of software that correctly reads *representation* data. Such implementations may include verification tests, and developers may use *representation specification* example data for testing purposes.
- **Data Application**. *Application software 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.

Standard 205 requires use of SI units within *representations*, an exception to normal ASHRAE dual-units policy. In the context of automated data exchange, requiring or allowing more than one convention would introduce ambiguity and complicate implementation. Unit conversion can be done as needed for application or display.

Given that all *representations* have common structures and elements, many software components can be shared by *data publishers* and *application software developers*. To this end, an open source project is underway. See https://github.com/open205.

SPC 205 is developing *representation specifications* for additional equipment types. These will be published in future revisions of the standard.

1 PURPOSE

To facilitate automated sharing of equipment performance characteristics by defining data models and data serialization formats.

2 SCOPE

This standard applies to performance data for any HVAC&R or other facility system, equipment, or component.

3 DEFINITIONS

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

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

Application software user: The end user of *application software*.

ASHRAE 205 JSON schema: The JSON schema representing all *data models* defined by the collection of *representation specifications* in this standard. The official *ASHRAE 205 JSON schema* is located at http://data.ashrae.org/standard205/schema.html.

CBOR: Concise Binary Object Representation. See CBOR (2019).

Data element: A data item of a single-value, primitive data type (e.g., integer, numeric, boolean) or a single-object comprised of multiple data elements contained within a data group.

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

Data group: Multiple *data elements* grouped together under a single, named data structure.

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

Data publisher: A *facility equipment* manufacturer or other entity that generates *representations*.

Facility equipment: Equipment that impacts resource use or conditions related to an element of the built environment.

Grid cell: In a performance map, the parameter space defined by adjacent pairs of grid variable values in each dimension. For performance maps with one grid variable, the grid cell is the space between two adjacent points along a line; with two grid variables, the grid cell is a rectangle; with three grid variables, the grid cell is a cuboid; and with four or more grid variables the grid cell is a hyperrectangle of respective dimensionality.

Grid variable: A variable describing a single dimension of operating conditions (e.g., ambient drybulb temperature). *Grid variable* values are represented by an ordered array of discrete values. The collection of all *grid variable* values defines the overall operating range of the *facility equipment*. ***Informative note:*** *Grid variables* are often called "independent variables"; however, the dependence of *grid variables* and *lookup variables* can be application specific and thus the term "independent" is intentionally avoided.

JSON: JavaScript Object Notation. A lightweight text-based data-interchange format. See JSON (2019).

Lookup variable: A variable used for performance characteristics (e.g., capacity or input power). *Lookup variable* values are defined for each combination of *grid variables* values. ***Informative note:*** *Lookup variables* are often called "dependent variables", however, the dependence of *grid variables* and *lookup variables* can be application specific and thus the term "dependent" is intentionally avoided.

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*.

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

Power: Electrical power unless explicitly stated otherwise.

Representation: A *CBOR*-format file containing data conforming to a *representation specification*.

Representation specification: A definition of *facility equipment* performance-related *data models*, data verification tests, and descriptive information such as text descriptions and equipment schematics. The format of a *representation specification* is defined by this standard. *Representation specifications* are appended to the end of this standard.

Standard air conditions: Air weighing 0.075 lb/ft^3 (1.2 kg/m^3), which approximates dry air at a temperature of 70°F (21.1°C) and a barometric pressure of 29.92 in. Hg (101.3 kPa).

Verification rule: A set of one or more computable expressions used to verify consistency and physical reasonableness of a *representation*.

4 REPRESENTATION CONTENT

The *representation* shall be a file conforming to the *CBOR data serialization format* (CBOR 2019) that (1) is valid according to the *ASHRAE 205 JSON schema* and (2) passes all *verification rules* specified in the *representation specification.*

Representation files shall be named xxxx.a205.cbor, where xxxx is a suitable identifier chosen by the *data publisher* for the equipment whose performance is represented in the file.

Informative note: To be valid against the *ASHRAE 205 JSON schema*, the *representation* must be correctly formatted and pass all range checks.

5 DATA MODEL CONTENT

5.1 Data Element Attributes

Data elements shall be characterized in *data groups* by the attributes shown in Table 5-1.

Table 5-1. Data Element Attributes

Attribute	Description	Notes
Data Element Name	Public name of element	See Section 8.3
Description	Text description that defines the meaning of the element	
Data Type	Data type of element	See Section 5.3
Units	Units of element	See Section 9
Range	Range check validity tests for numerical elements	Range limits shall be expressed as numerical constants. Limitations implicit in the data type of *data elements* shall not be restated in the range.

Required (abbreviated as Req)	Indicates whether element is mandatory	Use checkmarks (✓) to indicate required elements.
Notes	Any supplementary information	

5.2 Data Group Composition

A *data group* is a collection of *data elements* as specified in this standard.

Informative note 1: Standard 205 *data groups* cannot be extended except via modification of the standard.

Informative note 2: *Representation* files containing *data elements* or *data groups* not defined in this standard will not validate against the *ASHRAE 205 JSON schema.*

Data groups and *data elements* are permitted to be designated as optional (not required). When optional items are included in *representations*, their properties shall conform to the associated *representation specification* requirements. That is, the inclusion of such items is optional, but all other requirements are fixed.

5.3 Data Type Definitions

Each *data element* shall have one of the data type attributes described in Sections 5.3.1.1 through 5.3.3.

5.3.1.1 Fundamental Data Type Definitions

Standard 205 adopts fundamental data type definitions from JSON Schema (2019).

Table 5-2. Fundamental Data Type Definitions

Data Type	Description	JSON Schema Type	Examples
Integer	A positive or negative whole number (i.e., a number that can be written without a fractional part).	integer	3, 19, -4
Numeric	A number that may include a fractional part with optional leading sign and optional exponent (engineering notation).	number	3.43, 0, 12.2, -4, 1.03e4, null
Boolean	True or false.	boolean	true, false
String	A sequence of characters of any length using any (specified) character set.	string	“Indirect evaporative cooler”

5.3.2 Specific String Data Type Definitions

The data types in Table 5-3 are defined for the purposes of this standard and are a pre-defined subset of the fundamental “string” data type defined in Table 5-2 conforming to the JSON Schema patterns provided.

Table 5-3. Specific String Data Type Definitions

Data Type	Description	JSON Schema Pattern	Examples
UUID	An effectively unique character string conforming to ITU-T	[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”

	Recommendation X.667 (ITU-T 2012).		
Date	A calendar date formatted per ISO 8601 (ISO 2004)	[0-9]{4}-[0-9]{2}-[0-9]{2}	"2015-04-29"
Timestamp	Date with UTC time formatted per ISO 8601 (ISO 2004)	[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.	(0|[1-9][0-9]*)\.(0|[1-9]][0-9]*)\.(0|[1-9]][0-9]*)(?:-((?:0|[1-9]][0-9]*|][0-9]*[a-zA-Z-][0-9a-zA-Z-]*)(?:\.(?:0|[1-9]][0-9]*|][0-9]*[a-zA-Z-][0-9a-zA-Z-]*))*))?(?:\+([0-9a-zA-Z-]+(?:\.[0-9a-zA-Z-]+)*))?	"1.1.3", "1.2.0-beta-92"
Pattern	A regular expression pattern as defined by ECMA-262 (ECMA 2019). Used for characterizing e.g. model numbers.	(Not applicable)	"CA225FB.[1-9]"

5.3.3 Derived and Composite Data Type Definitions

Some data types are derived explicitly for the purposes of this standard. These include specific enumerations, or "choice" data types, and composite data types comprising a collection of data elements of various data types.

5.3.3.1 Enumeration

An enumeration is a data type that takes one of a pre-defined set of string enumerator values. Each enumeration shall be given a unique data type name and shall define the set of string enumerators. *Data elements* representing enumerations shall be denoted in a *data group* by wrapping the name of the enumeration in angle brackets as the data type. Example: <RefrigerantType>.

Informative note: Enumerations are defined in JSON schema as "string" types with pre-defined "enum" values.

5.3.3.2 Data Group

Nested *data groups* shall be denoted by defining a *data element* whose data type is the name of a defined *data group* wrapped in curly brackets. Example: {PerformanceMapCooling}.

Informative note: Data groups are defined in JSON schema as "objects".

5.3.3.3 Array

Data elements representing an ordered collection of values of a specific data type (including enumerations, data groups, etc.), shall be denoted in a data group by wrapping the data type in square brackets. Examples: [Numeric] or [<RefrigerantType>].

Informative note: Arrays are defined in JSON schema as "array".

5.3.3.4 Alternative

A set of alternative data types where one, and only one corresponding value is provided. Alternatives shall be denoted in a data group by wrapping a comma separated list of alternative data types in round brackets. Examples: (Numeric, String) or ({RS0001}, {RS0002}).

Informative note: Alternatives are defined in JSON schema as "oneOf".

5.4 Common Enumerations

Common enumerations are used in more than one *representation specification*.

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

5.4.1 ASHRAE205Version

Table 5-4. Standard 205 Version Identifiers

Version	Title	Publication Date
PPR2	ASHRAE 205 – 2020 Publication Public Review 2	Unpublished

5.4.2 RS_ID

Each *representation specification* shall include an RS_ID (Representation Specification Identifier) enumerator as define in Table 5-5.

Table 5-5. Standard 205 Representation Specification Identifiers

RS_ID	Title
RS0001	Liquid-Cooled Chiller
RS0002	Unitary Cooling Air-Conditioning Equipment
RS0003	Fan Assembly
RS0004	Air-to-Air Direct Expansion Refrigerant Coil System
RS0005	Motor
RS0006	Electronic Motor Drive

5.4.3 RefrigerantType

Enumerators for refrigerants shall conform to refrigerant number designations listed in ANSI/ASHRAE Standard 34-2019 (ASHRAE 2019) latest revision using Technical Prefix of "R" (without hyphen). All characters shall be converted to uppercase.

Informative note: For example, "R410A" is an acceptable RefrigerantType; "R-410A" and "HCFC-22" are not.

5.4.4 CompressorType

Enumerator	Definition
RECIPROCATING	Reciprocating compressor
SCREW	Screw compressor
CENTRIFUGAL	Centrifugal compressor
ROTARY	Rotary compressor
SCROLL	Scroll compressor

5.4.5 CondenserType

Enumerator	Definition
AIR	Air-cooled condenser
WATER	Water-cooled condenser
EVAPORATIVE	Evaporative condenser

5.4.6 LiquidConstituent

Enumerator	Definition
WATER	Water
PROPYLENE_GLYCOL	Propylene glycol
ETHYLENE_GLYCOL	Ethylene glycol
SEA_WATER	Salt water from a sea

5.4.7 ConcentrationType

Enumerator	Definition
BY_VOLUME	Concentration is defined as a fraction of total liquid mixture volume
BY_MASS	Concentration is defined as a fraction of total liquid mixture mass

5.5 Common Data Groups

The following data groups shall be referenced in representation specifications where applicable to avoid independent implementations of similar data structures.

5.5.1 ASHRAE205

As described in Section 6.2.3, the ASHRAE205 *data group* is the root *data group* for all *representation specifications*. Each *representation* shall conform to this *data group*. The *representation* shall include all required data elements conforming to the *representation specification data group* corresponding to the type of *facility equipment* inserted into the "RS_instance" *data element*.

Table 5-6. Data Group ASHRAE205

Data Element Name	Description	Data Type	Units	Range	Req	Notes
standard_version	*ASHRAE 205 standard* version	<ASHRAE205Version>			✓	Identifies the version of the *ASHRAE 205 Standard* this *representation* complies with.
schema_version	*ASHRAE 205 schema* version	Version			✓	Identifies the version of the *ASHRAE 205 JSON schema* this *representation* complies with.
RS_ID	*Representation specification* identifier	Enumeration			✓	Identifies the *representation specification* used to generate this *representation*
description	Free-form description of equipment (suitable for display)	String			✓	
ID	Unique equipment identifier	UUID			✓	Assigned by *data publisher* to identify specific equipment. ID shall remain unchanged for revised *representations* for the same equipment.
data_timestamp	Date of publication	Timestamp			✓	Date/time of publication of this *representation*.
data_version	Integer version identifier for the data in the *representation*	Integer			✓	Used by data publisher to track revisions of the data for a specific *representation*. The value shall be incremented for each data revision.
data_source	Free-form identification of the source of this data	String				
disclaimer	Free-form characterization of accuracy, limitations, and applicability of this data	String				
notes	Additional information	String				

RS_instance	*Representation Specification* Data Group	({RSXXXX[1]})			✓	Data Group defined by specific *representation specification*. E.g., "RS0001".

5.5.2 Reusable Data Groups

The following data groups are defined here and shall be used in any representation specification where applicable to avoid independent implementations of similar data structures.

Informative note 1: These data groups may be used as many times as necessary, even within a single representation specification.

Informative note 2: Additional reusable data groups will be added as necessary when new representation specifications are defined.

5.5.2.1 LiquidMixture

Data Element Name	Description	Data Type	Units	Range	Req	Notes
liquid_components	An array of all liquid components within the liquid mixture	[{LiquidComponent}]			✓	Array may contain a single component.
concentration_type	Defines whether concentration is defined on a volume or mass basis	<ConcentrationType>			✓	

5.5.2.2 LiquidComponent

Informative note: The LiquidComponent is generally only used in the context of a LiquidMixture. References to LiquidMixtures in representation specifications implies that the representation specification also includes LiquidComponents.

Data Element Name	Description	Data Type	Units	Range	Req	Notes
liquid_constituent	Substance of this component of the mixture	<LiquidConstituent>			✓	
concentration	Concentration of this component of the mixture	Numeric	-	≥ 0, ≤ 1.0		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.

6 REPRESENTATION SPECIFICATION STRUCTURE

A *representation specification* shall consist of a single human-readable (e.g., PDF) document organized as specified in this section and appended to this standard. The ASHRAE 205 JSON schema file(s) associated with each *representation specification* are deemed equivalent to the data definitions in the *representation specification*, allowing automated validation and manipulation of representation data.

[1] Refer to list of all representation specification identifiers in Table 5-5.

A *representation specification* and normative supporting material available at http://data.ashrae.org/standard205, along with Standard 205, shall provide all required information for *data publishers* to prepare conforming *representations* and for *application software developers* to implement interface code to access and verify such information.

Informative note: Any number of informative supporting human- or machine- readable files may be provided for a *representation specification* at http://data.ashrae.org/standard205.

6.1 Documentation

The first section of the representation specification is the documentation section providing narrative text, schematic(s), references, and other information that explain the equipment and how it is modeled. This material is aimed at human readers to support correct data generation and use.

6.1.1 Identification and History

RS_ID. Representation Specification Identifier. A string code, assigned in Table 5-5, which uniquely identifies each *representation specification*. RS_IDs shall be of the form RSXXXX, where XXXX is 4 decimal digits.

Version history. A table with columns for "Schema Version", "Date", "Initial Approved Standard", and "Notes". Each time a revised *representation specification* is published, a new row shall be prepended to the top of the table. Entries for "Initial Approved Standard" shall include the year and any relevant addenda. "Notes" shall provide a high level description of relevant changes.

6.1.2 Scope and Description

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

6.1.2.1 Referencing Representation Specifications

If the *representation specification* is referenced in a *data element* as a child sub-component of any parent *representation specification,* the child *representation specification* shall include an informative list of all parent *representation specifications* where it is referenced.

6.2 Data Model

This section specifies of the *data groups*, *data elements*, and local enumerations that identify the performance of the equipment to be included in a *representation*.

6.2.1 Data Group Hierarchy

Each *representation specification* shall illustrate the hierarchy of *data groups* comprising a conforming *representation*. *Data groups* shall be nested within each other according to the following hierarchy, where bracketed numbers show the range of possible instances of each sub-data group (zero denotes that a data group is optional and N denotes no specific limit):

- ASHRAE205 [1]
    - RSXXXX [1]
        - Description [0 .. 1]
            - ProductInformation [0 .. 1]

- Rating [0 .. N]

- Performance [1]
  - PerformanceMap [0 .. N]
    - GridVariables [1]
    - LookUpVariables [1]

6.2.2 Local Enumerations

Any enumerations specific to the *representation specification* shall be defined prior to any *data group* definitions.

6.2.3 Data Group: ASHRAE205

The first data group in each *representation* shall be ASHRAE205, specified in Table 5-6. As a common *data group*, ASHRAE205 shall not be repeated in *representation specifications*.

6.2.4 Data Group: RSXXXX

Each *representation specification* shall define a single *data group* that contains nested *data groups* specific to the *facility equipment's* performance and description. This *data group* shall be nested under the root ASHRAE205 *data group* as the value of its "RS_instance" *data element*.

6.2.5 Data Group: RSXXX.Description

This *data group* contains descriptive information about the *facility equipment*. The contents of this *data group* shall not impact performance results derived using *representation* data.

6.2.6 Data Group: RSXXXX.Description.ProductInformation

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

6.2.7 Data Group(s): RSXXXX.Description.Rating

If appropriate, a *representation specification* shall define *data groups* that includes *data elements* that represent standard ratings.

6.2.8 Consistency with Ratings

Representation data need not be consistent with any published standard ratings unless such consistency is required by the associated *representation specification.*

If a *representation specification* includes a *data group* Rating, the *data group* shall contain a boolean *data element* that denotes whether the performance data included in the *representation* can be used to reproduce published standard rating data in the *data group* within the tolerance of the rating standard used to determine the rating.

Informative note: *Representation* data conveys typical 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.

6.2.9 Data Group: RSXXXX.Performance

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

Informative note: Where appropriate, *representation specifications* may use single *data elements* (or arrays) to capture equipment performance over a range of operating conditions using regression or curve-fit coefficients. This is generally preferred over the use of performance maps if there is a physical basis for the curve or regression form.

6.2.9.1 Operational limits

Representation specifications shall define operational limits (physical or practical) that define the range of conditions under which the equipment can operate, as applicable. Such limits shall be conveyed using any of the following approaches:

1. explicitly defined via individual data elements (e.g., `maximum_environmental_temperature`),
2. implicitly defined by the limits of the *grid variable* values in *performance maps* (unless the *representation specification* explicitly defines extrapolation procedures), or
3. explicitly defined through the use of *NULL lookup variable* values in *performance maps*.

Informative note: *Application software* utilizing the *representation* data should model the equipment as not operating if any operational limit is exceeded.

6.2.10 Data Group(s): RSXXXX.Performance.PerformanceMap

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 *data elements* representing *grid variables* and *lookup variables* that relate the performance of the equipment over a range of operating conditions.

Lookup variable values shall be provided in a rectilinear, but not necessarily uniform, grid (as illustrated in Figure 2 for 3 dimensions) defined by the *grid variable* values. The *lookup variable* values shall be provided at the vertex defined by the combination of the *grid variable* values. This implies that both the outer boundary and each *cell* are hyperrectangles (n-dimensional rectangles).

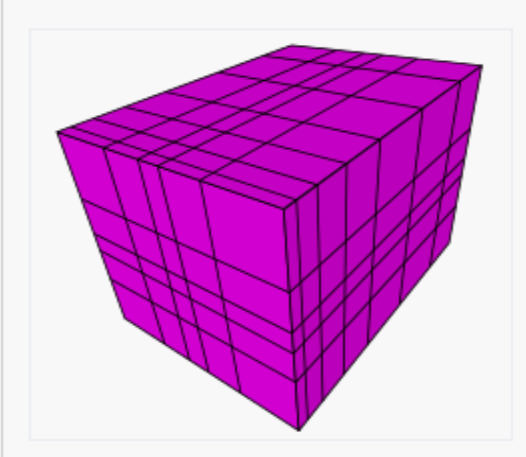

Figure 2. Rectilinear grid

Grid variable value combinations at which the equipment does not operate shall be represented with corresponding *lookup variable* values of *NULL*. Non-operation shall be assumed for any conditions falling within a *grid cell* having *NULL* data at any vertex.

Informative note: *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 note: A minimum of two 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 (unless otherwise noted for the specific *grid variable*).

6.2.11 Data Group RSXXXX.Performance.PerformanceMap.GridVariables

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

6.2.12 Data Group RSXXXX.Performance.PerformanceMap.LookupVariables

Lookup variables values shall be defined as an array corresponding to all combinations of *grid variable* values. *Lookup variables* shall appear as an array ordered according to the listed order of *grid variables* in the *data group* "GridVariables", with the value of last corresponding *grid variable* changing most rapidly. That is, the corresponding array for a *lookup variable* begins with the value corresponding to the first values of all *grid variables*, followed by the *lookup variable* value corresponding to the same *grid variable* values except using the second value of the last *grid variable* defined in the "GridVariables" *data group*. Consecutive *lookup variable* values correspond to cycling through the values of the last *grid variable*, followed by the second to last, and so on.

Informative note: See Section 13 for an example.

6.3 Verification and Application Rules

Representation specifications shall include description and documentation of computable rules used to verify minimal data validity and accuracy.

Basic data format rules are implicit in *data element* data types and are enforced via automated checking against the *ASHRAE 205 JSON schema*. Valid value ranges shall be included in the "Range" attribute of the *data element* definitions. Rules of this type shall not be restated in Verification Rules.

Additional rules shall be included in the "Verification Rules" section and will depend on the type of *facility equipment* and data being represented. Typical examples are logical relationships among values and physical constraints such as:

- Cross-element consistency checks.
- Physically-based tests that 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 verification test shall indicate invalid data.

A fully verified *representation* shall be both validated versus the *ASHRAE 205 JSON schema* and verified based on the Verification Rules.

Information note: The set of verification tests in a *representation specification* may not be sufficient to detect all invalid data.

6.3.1 Common Verification Rules

The following *verification rules* shall be performed on all *representations*. As common *verification rules*, the rules listed below shall not be repeated in *representation specifications*.

6.3.1.1 RS_ID check

The "RS_ID" *data element* shall be consistent with the "RSXXXX" *data group* used in the "RS_instance" *data element.*

6.3.1.2 Nested Representations

Representation specifications that contain *data elements* referencing other *representation specifications* (e.g., ASHRAE205 *data groups*) shall state the RS_ID of the corresponding nested *representation specification* (e.g., ASHRAE205 (RS0003)). The nested *representation specification* shall be limited to *representations* of this RS_ID.

6.3.1.3 Schema version check

The "schema_version" *data element* in the ASHRAE205 *data group* shall be compatible with the version of the *ASHRAE 205 JSON schema* used to validate the *representation*. *Representations* with a major version number inconsistent with the schema major version number shall fail verification. When the major version numbers are identical, *representations* with minor version numbers greater than the schema minor version number shall fail verification. If both major and minor version numbers are identical, the *representation* shall pass verification regardless of the patch version number.

6.3.1.4 Lookup variable count check

For any *performance map*, the number of values in a *lookup variable* array shall be equal to the product of all the lengths of the corresponding *grid variable* arrays. For example, if a *performance map* has three *grid*

variables with 3, 3, and 2 values respectively, then every *lookup variable* array associated with this performance map shall have 18 (= 3 x 3 x 2) values.

6.4 References

References to external information sources that support this *representation specification.* For each Ratings data group, a reference to a corresponding ratings procedure document shall be provided.

6.5 Example(s)

Informative note: *Representation specifications* may provide one or more examples to illustrate implementation.

Supporting files shall be made available at http://data.ashrae.org/standard205

7 VERSIONING

The versioning of a representation is denoted by four individual data elements: standard_version, schema_version, ID, and data_version. The standard_version is incremented whenever there is a change to the standard and, within a *representation*, indicates which version of the standard was used to create a *representation*. The schema_version is incremented whenever there is a change to the schema and, within a *representation*, indicates which version of the schema was used to create a *representation*. The standard_version and schema_version are universal and apply to all *representation specifications*. The ID is used to identify the equipment covered by the *representation,* and the data_version is used to indicate the version of the data included in the *representation*.

A single ID can represent multiple pieces of equipment when the data in the *representation* is the same for all the pieces of equipment (e.g., a product line with identical performance but different model numbers). A *representation specification* shall include a *data element* for listing the pieces of equipment covered by a *representation* (e.g., model_number). An ID shall be assigned when the *representation* is first created. The ID shall not change as long as the pieces of equipment covered by the *representation* remains the same or additional pieces of equipment that have not been included in a different *representation* are added. A new ID shall be generated if pieces of equipment are added to the *representation* that have previously been included in a different *representation* or if pieces of equipment are removed from the *representation* and added to a different *representation*.

The data_version shall be incremented whenever any data in the *representation* is modified.

8 DATA MODEL NAMING CONVENTIONS

All names shall be case-sensitive-unique within their scope: *data element* names shall be unique within their *data group,* and *data group, and enumeration* 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).

Names shall be assigned according to the following requirements.

8.1 Allowed Characters

All *data element*, *data group*, enumeration, and enumerator 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.

8.2 Data Group Names

Each *data group* 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`.

8.2.1 Rating Data Groups

Rating data group names shall begin with the word “Rating” followed by the descriptive name of the corresponding rating standard (e.g., RatingAHRI210240).

8.2.2 PerformanceMap, GridVariables, and LookupVariables Data Groups

PerformanceMap data group names shall begin with the words “PerformanceMap” followed by the descriptive name of the mode of operation (e.g., PerformanceMapCooling, PerformanceMapHeating, PerformanceMapStandBy).

GridVariables and LookupVariables data group names shall be suffixed with the same descriptive name of the mode of operation used in the parent PerformanceMap (e.g., GridVariablesCooling and LookupVariablesCooling).

8.3 Data Element Names

Each *data element* shall be assigned a "Snake Case" name. **Snake case** (or **snake_case**) is the practice of writing compound words or phrases in which the elements are lower case and separated with one underscore character (‘_’) and no spaces. Examples of Snake Case names are `inlet_vane_position` and `air_mass_flow_rate`.

Exception: *Data element* names may use upper-case abbreviations, for example, `COP_at_rated_capacity`.

Enumeration *data elements* shall have names that match their enumeration type (e.g., “compressor_type” should be the name of a *data element* of the “CompressorType” enumeration) 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 liquids, *data elements* could be named condenser_liquid_type and evaporator_liquid_type.

Nested *representation data elements* shall have names suffixed with the word “representation” (e.g., “fan_representation”).

8.4 Enumeration Names

Each *enumeration* 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 `CompressorType` and `FanPosition`.

8.5 Enumerator Names

Enumerators names shall be strings of any length made up of uppercase letters, numbers, or ‘_’ and beginning with an uppercase letter. (That is, matching the regular expression pattern “[A-Z][A-Z,_,0-9]*”.)

Enumerator shall use the standard abbreviations specified in Section 8.6. Additional abbreviations used shall be clear and consistent with industry practice. A source of recognized abbreviations is found in ASHRAE (2017e).

8.6 Abbreviations

When appropriate, Table 8-1 abbreviations shall be used in names for all components of the data model. Abbreviations are replacements for groups of words and do not imply definitions of the associated phrases. Some phrases listed in Table 8-1 have multiple context-specific technical definitions. *Representation specifications* must provide unambiguous definitions for all terms (abbreviated or not).

Table 8-1. Abbreviation Definitions

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

8.7 Pre-existing names (Informative)

Instead of inventing new names, names from existing relevant schemas and data dictionaries should be used when appropriate. Table 8-2 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 8-2. 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_v8.9.0/InputOutputReference.pdf
ASHRAE Terminology		https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology
CEC SDD	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/
BEDES	Building Energy Data Exchange Specification	https://bedes.lbl.gov/

8.8 Naming Guidelines (Informative)

- **Readability is more important than length.** Although there is the potential that long names will increase the size of *representations*, accurate understanding and application of data is the overriding consideration. Thus, unambiguous and expressive names are preferred, for example, `evaporator_pressure_drop` rather than `evap_pres_drp`. It is also anticipated that messaging infrastructure will provide data compression for efficient transfer of *representations*.
- **Specify dimensions at end of name.** In general, use names such as `entering_temperature`, as opposed to `temperature_entering` (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 `air_CFM` or `pump_GPM`. Instead, consider names such as `air_volume_flow_rate` or `pump_volume_flow_rate`.
- **Do not include data types in names.** Use `AHRI_rated`, not `AHRI_rated_boolean`.
- **Avoid abbreviations and acronyms.** The list of exceptions is documented in Section 8.6 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 "`chiller_capacity`".
- **Consider "Type" at end of enumeration names.** Clear enumeration names often end in "Type". Examples are `CompressorType` and `RefrigerantType`.

9 UNITS

9.1 General requirement

Except as specified in Section 9.2, all numeric values shall be represented in SI units as specified in ASHRAE SI policy documents (ASHRAE 2013, ASHRAE 2017a, IEEE/ASTM 2011).

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

If a numeric *data element* does not have units, the hyphen (-) character shall be used for its units.

When combining base units into derived units, the following rules shall apply:

- For a symbol raised to a power use the symbol followed by the power (e. g. m2).
- For the product of two symbols use the hyphen (-) (e. g. N-m).
- For the quotient of two symbols use the solidus (/) (e. g. W/m2-K)
- Use only one solidus symbol per derived unit (e.g., m/s2, not m/s/s).
- Do not use parentheses (e.g., W/m2-K, not W/(m2-K)).
- Do not use negative exponents (e.g., W/m2-K, not W-m-2-K-1).

Any unit conversions needed for preparing or using *representation* data shall be done using conversion factors specified in ASHRAE SI policy. When no appropriate conversion factor is specified in ASHRAE SI policy, it shall be described in the data element descriptive text including conversion factors.

9.2 Non-SI Units

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* are permitted to be given in any units and the units used shall be stated.

10 PHYSICAL PROPERTIES

10.1 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 2017b).

10.2 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 2017c). Properties shall be assumed to be temperature dependent and pressure independent.

10.3 Refrigerant Properties

The properties of refrigerants shall be derived using data in the ASHRAE Handbook (ASHRAE 2017d) or techniques referenced there.

11 DATA QUALITY AND SECURITY

11.1 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 included in the *ASHRAE 205 JSON schema* and the *verification rules* defined in the associated *representation specification*.

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

11.1.1 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.

RFC 8152 (2017) describes how to create and process signatures, message authentication codes, and encryption using CBOR for serialization.

11.1.2 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.

11.1.3 Data Resolution (Informative)

The primary usage of Standard 205 is for the automated sharing of performance data, which will be accomplished in binary files using computer software. The data included in this exchange will be transmitted at the resolution of the variable types in the computer software. No other requirements for resolution of the data are included in the standard. *Data publishers* should be aware that the performance data will be used as included in the representation and should provide the data at an appropriate resolution to accurately convey the equipment performance.

11.1.4 Data 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.

12 REFERENCES

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RFC 8152. 2017. J. Schaad. CBOR Object Signing and Encryption (COSE). https://www.rfc-editor.org/info/rfc8152.

RFC 8259. 2017. T. Bray, Ed. The JavaScript Object Notation (JSON) Data Interchange Format. https://www.rfc-editor.org/info/rfc8259

Semver. 2016. Semantic Versioning 2.0.0. http://semver.org

13 EXAMPLE PERFORMANCE MAP REPRESENTATION (INFORMATIVE)

This example shows the *data model* for a single *performance map* and illustrates a *representation* conforming to this *data model*. This example does not reflect actual performance data of any specific device and is intended for illustrative purposes only.

Table 13-1. Example Performance Map Data Group

Data Element Name	Description	Data Type	Units	Range	Req	Notes

grid_variables	Data group defining the grid variables for performance	{GridVariables}			✓	
lookup_variables	Data group defining the lookup variables performance	{LookupVariables}			✓	

Table 13-2. Example Grid Variable Data Group

Data Element Name	Description	Data Type	Units	Range	Req	Notes
outdoor_temperature		[Numeric]	K	≥ 0	✓	For example purposes only.
indoor_temperature		[Numeric]	K	≥ 0	✓	For example purposes only.
air_volumetric_fow_rate		[Numeric]	m^3/s	≥ 0	✓	For example purposes only.

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

```
grid_variables:
  outdoor_temperature: [302.59, 308.15, 313.71]
  indoor_temperature: [295.37, 297.04, 298.71]
  air_volumetric_flow_rate: [0.26, 0.34]
```

Table 13-3. Example Lookup Variable Data Group

Data Element Name	Description	Data Type	Units	Range	Req	Notes
power		[Numeric]	W	≥ 0	✓	For example purposes only.
capacity		[Numeric]	W	≥ 0	✓	For example purposes only.

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

```
lookup_variables:
  power: [2192.5,2192.5,2192.5,2192.5,2192.5,2192.5,2370,2370,2370,2370,2370,2370,2615,2615,2615,2615,2615,2615]
  capacity: [8740,9100,8740,9100,8740,9100,8380,8720,8380,8720,8380,8720,8560,8910,8560,8910,8560,8910]
```

If the values of the *lookup variables* are expressed explicitly with their corresponding *grid variables* in table form, then an example representation of a *performance map data group* would be:

GridVariables			LookupVariables	
outdoor_temperature (K)	indoor_temperature (K)	air_volumetric_flow_rate (m3/s)	power (W)	capacity (W)
302.59	295.37	0.26	2192.5	8740.0
302.59	295.37	0.34	2192.5	9100.0
302.59	297.04	0.26	2192.5	8740.0
302.59	297.04	0.34	2192.5	9100.0
302.59	298.71	0.26	2192.5	8740.0
302.59	298.71	0.34	2192.5	9100.0
308.15	295.37	0.26	2370.0	8380.0

308.15	295.37	0.34	2370.0	8720.0
308.15	297.04	0.26	2370.0	8380.0
308.15	297.04	0.34	2370.0	8720.0
308.15	298.71	0.26	2370.0	8380.0
308.15	298.71	0.34	2370.0	8720.0
313.71	295.37	0.26	2615.0	8560.0
313.71	295.37	0.34	2615.0	8910.0
313.71	297.04	0.26	2615.0	8560.0
313.71	297.04	0.34	2615.0	8910.0
313.71	298.71	0.26	2615.0	8560.0
313.71	298.71	0.34	2615.0	8910.0

Notice the cycling of the corresponding *grid variable* values. In this case, the "air_volumetric_flow_rate" values are cycling on every row, the "indoor_temperature" cycles every two rows, and the "outdoor_temperature" cycles every six rows. In practice, this defined order allows *lookup variables* to be conveyed without repetition of *grid variable* values.

In JSON this example *performance map* would appear as:

```
{
  "performance_map":{
    "grid_variables":{
      "outdoor_temperature": [302.59, 308.15, 313.71],
      "indoor_temperature": [295.37, 297.04, 298.71],
      "air_volumetric_flow_rate": [0.26, 0.34]
    },
    "lookup_variables":{
      “power”: [2192.5,2192.5,2192.5,2192.5,2192.5,2192.5,2370,2370,2370,2370,2370,2370,2615,2615,2615,2615,2615,2615],
      “capacity”: [8740,9100,8740,9100,8740,9100,8380,8720,8380,8720,8380,8720,8560,8910,8560,8910,8560,8910]
    }
  }
}
```

RS0001 LIQUID-COOLED CHILLER

RS0001.1 Identification and History

RS_ID: RS0001

Schema Version	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0001.2 Scope and Description

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

The equipment covered by this representation specification is included as a subset of the liquid-chilling equipment defined by:

- ANSI/AHRI 551/591-2015, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”
- ANSI/AHRI 551/591-2015 With Addendum 1, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”
- ANSI/AHRI 551/591-2018 with Errata, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”

Representation Specification RS0001 does not cover steam turbine driven, combustion engine 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.

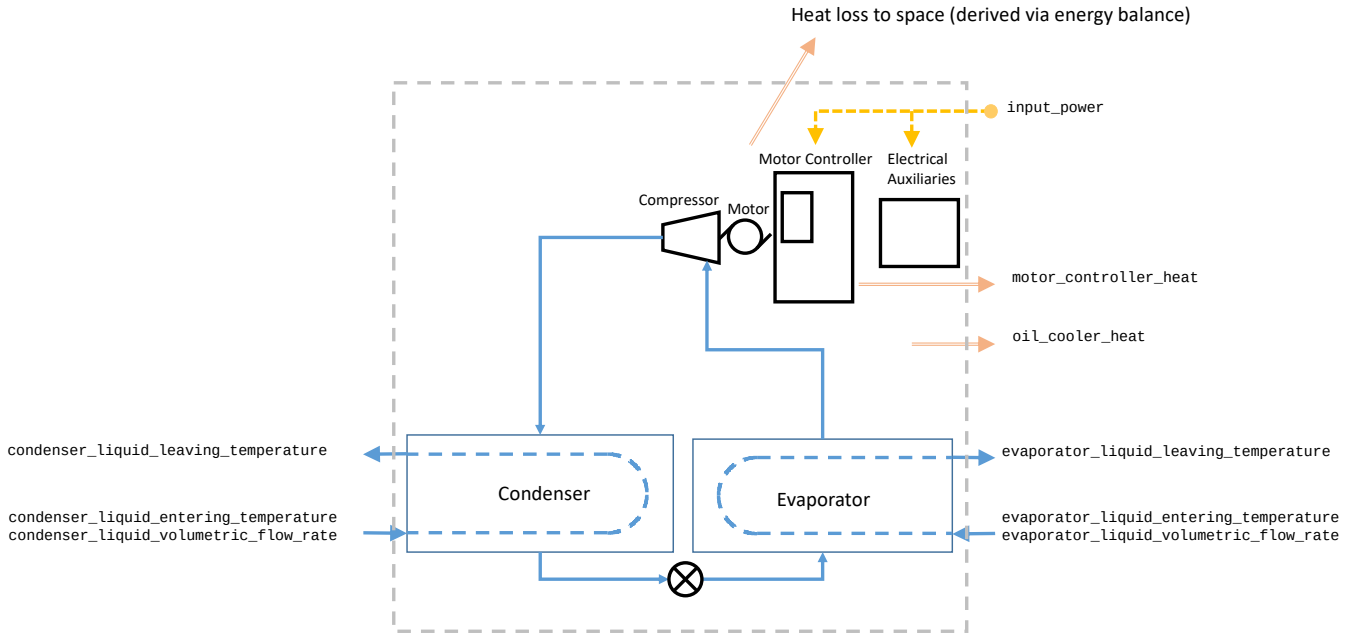

Figure RS0001-1. Liquid-cooled chiller

- 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 and is determined by applying the energy balance for the chiller as described in Section RS0001.4.1
- `motor_controller_heat` and `oil_cooler_heat` 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.

RS0001.3 Data Representation

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

- ASHRAE205 [1]
  - RS0001[1]
    - Description [0 .. 1]
      - ProductInformation [0 .. 1]
      - RatingAHRI550590 [0 .. 1]
      - RatingAHRI551591 [0 .. 1]
    - Performance [1]
      - PerformanceMapCooling [1]
        - GridVariablesCooling [1]
        - LookupVariablesCooling [1]
      - PerformanceMapStandby [1]
        - GridVariablesStandby [1]
        - LookupVariablesStandby [1]

Informative Note: When multiple chillers are designed to operate in concert, such as in a series counterflow arrangement, the performance of the chiller system can be represented in a single file. Other designs with multiple chillers operating independently should be represented with multiple files.

RS0001.3.1 Local Enumerations

The following local enumerations are defined:

RS0001.3.1.1 SpeedControlType

Enumerator	Definition	Notes
CONSTANT_SPEED	Compressor without speed control.	
VARIABLE_SPEED	Compressor with speed control.	

RS0001.3.1.2 StandardRatingVersion

Enumerator	Definition	Notes
AHRI_550_590_2015	Ratings and design points defined using IP unit version of the standard, 2015 edition.	Published 2015, effective 2016-Apr-01.
AHRI_551_591_2015	Ratings and design points defined using SI unit version of the standard, 2015 edition.	Published 2015, effective 2016-Apr-01.
AHRI_550_590_2015_ADDENDUM_1	Ratings and design points defined using IP unit version of the standard, 2015 edition with Addendum 1.	Published September 2017.
AHRI_551_591_2015_ADDENDUM_1	Ratings and design points defined using SI unit version of the standard, 2015 edition with Addendum 1.	Published September 2017.
AHRI_550_590_2018	Ratings and design points defined using IP unit version of the standard, 2018 edition.	Published 2018.
AHRI_551_591_2018	Ratings and design points defined using SI unit version of the standard, 2018 edition.	Published 2018.

RS0001.3.2 Data Groups

RS0001.3.2.1 RS0001

Data Element Name	Description	Data Type	Units	Range	Req	Notes
description	Data group describing product and rating information	{Description}				
performance	Data group containing performance information	{Performance}			✓	

RS0001.3.2.2 RS0001.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes
product_information	Data group describing product information	{ProductInformation}				
rating_AHRI_550_590	Data group containing information relevant to products rated under AHRI 550/590	{RatingAHRI550590}				
rating_AHRI_551_591	Data group containing information relevant to products rated under AHRI 551/591	{RatingAHRI551591}				

RS0001.3.2.3 RS0001.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
manufacturer	Name of the manufacturer	String			✓	
manufacturer_software_version	Version of the software used to generate the performance map	String				Example: “15.03” If the software version does not exist, input “NA”
model_number	Model number for this chiller	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*
nominal_voltage	Unit nominal voltage	Numeric	V	≥ 0		Example “460” If the unit can operate at multiple voltages, the lower of the two shall be stated
nominal_frequency	Unit nominal frequency	Numeric	Hz	≥ 0		Example “60” or “50” Power supply frequency for the intended region of installation
tolerance_standard	Name and version of the testing or certification standard under which the chiller is rated.	String				Example AHRI 550/590-2015, EN14511-2018, EN14825-2016, GB18430.1-2007
compressor_type	Type of compressor	<CompressorType>				See Standard 205 Common Enumerations
speed_control_type	Type of electrical motor drive	<SpeedControlType>				See RS0001.3.1 Local Enumerations
liquid_data_source	Source of the liquid properties data	String				Example: “ASHRAE Handbook Fundamentals 2013 chapter 31”
refrigerant_type	Refrigerant used in the chiller	<RefrigerantType>				See Standard 205 Common Enumerations

Data Element Name	Description	Data Type	Units	Range	Req	Notes
hotgas_bypass_installed	Indicates if a hot-gas bypass valve is installed on the chiller	Boolean				

RS0001.3.2.4 RS0001.Description.RatingAHRI550590

Data Element Name	Description	Data Type	Units	Range	Req	Notes
certification_reference_number	Certification reference number	String			✓	The certification number as stated on the certificate.
standard_rating_version	Version	<StandardRatingVersion>			✓	
net_refrigerating_capacity	Unit rated refrigeration capacity	Numeric	Btu/h	> 0	✓	The available cooling capacity of the evaporator to the thermal load calculated using only the sensible heat transfer at full load rating condition.
input_power	Total unit power at design point	Numeric	kW	≥ 0	✓	Total power input to the chiller package. See testing standard for details.
COP	Efficiency at design point as ratio of unit of cooling per unit of power consumed	Numeric	-	> 0	✓	
part_load_value	Rated part load efficiency over an integrated load profile	Numeric	-		✓	Represents the IPLV.IP or NPLV.IP based on the COP.
part_load_rating_points	The four measured data points used to calculate the part load rating value	[{PartLoadRatingPoint550 590}]				The measured data for all 4 points used to calculate the IPLV or NPLV rating point shall be given.
full_load_evaporator_liquid_volumetric_flow_rate	Chilled liquid flow at the full load design point rating condition	Numeric	gpm	> 0	✓	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.
full_load_evaporator_liquid_leaving_temperature	Leaving evaporator liquid temperature at the full load design point rating condition	Numeric	F	> 0	✓	Evaporator liquid temperature at the exit flange of the chiller's evaporator at full load rating condition. See testing standard for details.
full_load_evaporator_liquid_entering_temperature	Entering evaporator liquid temperature at the full load design point rating condition	Numeric	F	> 0	✓	Evaporator liquid temperature at the entry flange of the chiller's evaporator at full load rating condition.

full_load_evaporator_liquid_differential_pressure	Pressure drop across the evaporator at the full load design point rating condition	Numeric	ft of water	> 0	✓	Pressure drop is as defined in the applicable rating standard
full_load_evaporator_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer at the full load design point rating condition	Numeric	h-ft2-F/Btu	≥ 0	✓	Evaporator fouling factor at which the full rating condition was measured.
full_load_condenser_liquid_volumetric_flow_rate	Condenser liquid flow at the full load design point rating condition.	Numeric	gpm	> 0	✓	Condenser liquid volumetric flow rate at the full load rating condition. Density calculations shall be made at the inlet temperature of the heat exchanger.
full_load_condenser_liquid_entering_temperature	Entering condenser liquid temperature at the full load design point rating condition.	Numeric	F	> 0	✓	Condenser liquid temperature at the entry flange of the chiller's condenser at full load rating condition. See testing standard for details.
full_load_condenser_liquid_leaving_temperature	Leaving condenser liquid temperature at the full load design point rating condition.	Numeric	F	> 0	✓	Condenser liquid temperature at the exit flange of the chiller's condenser at full load rating condition.
full_load_condenser_liquid_dfferential_pressure	Pressure drop across the condenser at the full load design point rating condition.	Numeric	ft of water	> 0	✓	Pressure drop is as defined in the applicable rating standard
full_load_condenser_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer at the full load design point rating condition	Numeric	h-ft2-F/Btu	≥ 0	✓	Condenser fouling factor at which the full rating condition was measured.
rating_reproducible_from_performance_data	Whether this rating can be reproduced using the performance data in the representation	Boolean			✓	Mark this field as true if the rating values in this table can be reproduced using the performance data in the representation within the tolerance of the rating standard.

RS0001.3.2.5 RS0001.Description.PartLoadRatingPoint550590

Data Element Name	Description	Data Type	Units	Range	Req	Notes
percent_full_load_capacity	The percent full load cooling capacity for this data point	Numeric	%	≥ 0 and ≤ 100	✓	
cooling_capacity	The actual cooling capacity for the data point	Numeric	Btu/h	> 0	✓	
unit_power	The total unit power consumption for the data point	Numeric	kW	> 0	✓	

evaporator_liquid_entering_temperature	Entering evaporator liquid temperature for the data point	Numeric	F	> 0	✓	Evaporator liquid temperature at the entry flange of the chiller's evaporator for the part load data point
evaporator_liquid_leaving_temperature	Leaving evaporator liquid temperature for the data point	Numeric	F	> 0	✓	Evaporator liquid temperature at the exit flange of the chiller's evaporator for the pat load data point
evaporator_liquid_volumetric_flow_rate	Chilled liquid flow for the data point	Numeric	gpm	> 0	✓	Evaporator liquid volumetric flow rate for the part load data point. Density calculations shall be made at the inlet temperature of the heat exchanger.
evaporator_liquid_differential_pressure	Pressure drop across the evaporator for the data point	Numeric	ft of water	> 0	✓	Pressure drop is as defined in the applicable rating standard
evaporator_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer for the data point	Numeric	h-ft2-F/Btu	≥ 0	✓	Evaporator fouling factor at which the part load data was measured.
condenser_liquid_entering_temperature	Entering condenser liquid temperature for the data point.	Numeric	F	> 0	✓	Condenser liquid temperature at the entry flange of the chiller's condenser for the part load data point
condenser_liquid_leaving_temperature	Leaving condenser liquid temperature for the data point	Numeric	F	> 0	✓	Condenser liquid temperature at the exit flange of the chiller's condenser for the part load data point
condenser_liquid_volumetric_flow_rate	Condenser liquid flow for the data point.	Numeric	gpm	> 0	✓	Condenser liquid volumetric flow rate for the part load data point. Density calculations shall be made at the inlet temperature of the heat exchanger.
condenser_liquid_dfferential_pressure	Pressure drop across the condenser for the data point.	Numeric	ft of water	> 0	✓	Pressure drop is as defined in the applicable rating standard
condenser_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer for the data point	Numeric	h-ft2-F/Btu	≥ 0	✓	Condenser fouling factor at which the part load data was measured.

RS0001.3.2.6 RS0001.Description.RatingAHRI551591

Data Element Name	Description	Data Type	Units	Range	Req	Notes
certification_reference_number	Certification reference number	String			✓	The certification number as stated on the certificate.
standard_rating_version	Version	<StandardRatingVersion>			✓	
net_refrigerating_capacity	Unit rated refrigeration capacity	Numeric	kW	> 0	✓	The available cooling capacity of the evaporator to the thermal load calculated

						using only the sensible heat transfer at full load rating condition.
input_power	Total unit power at design point	Numeric	kW	≥ 0	✓	Total power input to the chiller package. See testing standard for details.
COP	Efficiency at design point as ratio of unit of cooling per unit of power consumed	Numeric	-	> 0	✓	COP kWc/kWin
part_load_value	Rated part load efficiency over an integrated load profile	Numeric	-		✓	Represents the IPLV.SI or NPLV.SI.
part_load_rating_points	The four measured data points used to calculate the part load rating value	[{PartLoadRatingPoint551 591}]	-			The measured data for all 4 points used to calculate the IPLV or NPLV rating point shall be given.
full_load_evaporator_liquid_volumetric_flow_rate	Chilled liquid flow at the full load design point rating condition	Numeric	l/s	> 0	✓	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.
full_load_evaporator_liquid_leaving_temperature	Leaving evaporator liquid temperature at the full load design point rating condition	Numeric	C	> 0	✓	Evaporator liquid temperature at the exit flange of the chiller's evaporator at full load rating condition. See testing standard for details.
full_load_evaporator_liquid_entering_temperature	Entering evaporator liquid temperature at the full load design point rating condition	Numeric	C	> 0	✓	Evaporator liquid temperature at the entry flange of the chiller's evaporator at full load rating condition.
full_load_evaporator_liquid_differential_pressure	Pressure drop across the evaporator at the full load design point rating condition	Numeric	kPa	> 0	✓	Pressure drop is as defined in the applicable rating standard
full_load_evaporator_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer at the full load design point rating condition	Numeric	m2-K/kW	≥ 0	✓	Evaporator fouling factor at which the full load rating condition was measured.
full_load_condenser_liquid_volumetric_flow_rate	Condenser liquid flow at the full load design point rating condition.	Numeric	l/s	> 0	✓	Condenser liquid volumetric flow rate at the full load rating condition. Density calculations shall be made at the inlet temperature of the heat exchanger.
full_load_condenser_liquid_entering_temperature	Entering condenser liquid temperature at the full load design point rating condition.	Numeric	C	> 0	✓	Condenser liquid temperature at the entry flange of the chiller's condenser at full load rating condition. See testing standard for details.

full_load_condenser_liquid_leaving_temperature	Leaving condenser liquid temperature at the full load design point rating condition.	Numeric	C	> 0	✓	Condenser liquid temperature at the exit flange of the chiller's condenser at full load rating condition.
full_load_condenser_liquid_dfferential_pressure	Pressure drop across the condenser at the full load design point rating condition.	Numeric	kPa	> 0	✓	Pressure drop is as defined in the applicable rating standard
full_load_condenser_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer at the full load design point rating condition	Numeric	m2-K/kW	≥ 0	✓	Condenser fouling factor at which the full load rating condition was measured.
rating_reproducible_from_performance_data	Whether this rating can be reproduced using the performance data in the representation	Boolean			✓	Mark this field as true if the rating values in this table can be reproduced using the performance data in the representation within the tolerance of the rating standard.

RS0001.3.2.7 RS0001.Description.PartLoadRatingPoint551591

Data Element Name	Description	Data Type	Units	Range	Req	Notes
percent_full_load_capacity	The percent full load cooling capacity for the data point	Numeric	%	≥ 0 and ≤ 100	✓	
cooling_capacity	The actual cooling capacity for the data point	Numeric	kW	> 0	✓	
unit_power	The total unit power consumption for the data point	Numeric	kW	> 0	✓	
evaporator_liquid_entering_temperature	Entering evaporator liquid temperature for the data point	Numeric	C	> 0	✓	Evaporator liquid temperature at the entry flange of the chiller's evaporator for the part load data point
evaporator_liquid_leaving_temperature	Leaving evaporator liquid temperature for the data point	Numeric	C	> 0	✓	Evaporator liquid temperature at the exit flange of the chiller's evaporator for the pat load data point
evaporator_liquid_volumetric_flow_rate	Chilled liquid flow for the data point	Numeric	l/s	> 0	✓	Evaporator liquid volumetric flow rate for the part load data point. Density calculations shall be made at the inlet temperature of the heat exchanger.
evaporator_liquid_differential_pressure	Pressure drop across the evaporator for the data point	Numeric	kPa	> 0	✓	Pressure drop is as defined in the applicable rating standard
evaporator_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer for the data point	Numeric	m2-K/kW	≥ 0	✓	Evaporator fouling factor at which the part load data was measured.

condenser_liquid_entering_temperature	Entering condenser liquid temperature for the data point.	Numeric	C	> 0	✓	Condenser liquid temperature at the entry flange of the chiller's condenser for the part load data point
condenser_liquid_leaving_temperature	Leaving condenser liquid temperature for the data point	Numeric	C	> 0	✓	Condenser liquid temperature at the exit flange of the chiller's condenser for the part load data point
condenser_liquid_volumetric_flow_rate	Condenser liquid flow for the data point.	Numeric	l/s	> 0	✓	Condenser liquid volumetric flow rate for the part load data point. Density calculations shall be made at the inlet temperature of the heat exchanger.
condenser_liquid_differential_pressure	Pressure drop across the condenser for the data point	Numeric	kPa	> 0	✓	Pressure drop is as defined in the applicable rating standard
condenser_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer for the data point	Numeric	m2-K/kW	≥ 0	✓	Condenser fouling factor at which the part load data was measured.

RS0001.3.2.8 RS0001.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes
evaporator_liquid_type	Type of liquid in evaporator	{LiquidMixture}			✓	LiquidMixture specifies liquid constituents and their concentrations, see Standard 205 Common Enumerations. Density shall be evaluated at the evaporator inlet liquid temperature.
condenser_liquid_type	Type of liquid in condenser	{LiquidMixture}			✓	LiquidMixture specifies liquid constituents and their concentrations, see Standard 205 Common Enumerations. Density shall be evaluated at the condenser inlet liquid temperature.
evaporator_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer	Numeric	m^2-K/W	≥ 0	✓	Evaporator fouling factor at which the performance map was created. This may be different from the certification data supplied.
condenser_fouling_factor	Factor of heat transfer inhibition due to heat exchanger fouling layer	Numeric	m^2-K/W	≥ 0	✓	Condenser fouling factor at which the performance map was created. This may be different from the certification data supplied.
unit_power_limit	Maximum unit power input	Numeric	W	> 0		Maximum power input the chiller can operate at reliably and continuously at any condition in the operating envelope.
cycling_degradation_coefficient	Cycling degradation coefficient (C_D) as described in AHRI 550/590 or AHRI 551/591	Numeric	-	≥ 0, ≤ 1.0	✓	Used for the lowest stage where the unit cycles to meet a setpoint.

Data Element Name	Description	Data Type	Units	Range	Req	Notes
performance_map_cooling	Data group describing cooling performance over a range of conditions	{PerformanceMapCooling}			✓	
performance_map_standby	Data group describing standby performance	{PerformanceMapStandby}			✓	

RS0001.3.2.9 RS0001.Performance.PerformanceMapCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes
grid_variables	Data group defining the grid variables for cooling performance	{GridVariablesCooling}			✓	
lookup_variables	Data group defining the lookup variables for cooling performance	{LookupVariablesCooling}			✓	

RS0001.3.2.10 RS0001.Performance.PerformanceMapCooling.GridVariablesCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes
evaporator_liquid_volumetric_flow_rate	Chilled liquid (evaporator) flow	[Numeric]	m^3/s	> 0	✓	
evaporator_liquid_leaving_temperature	Leaving evaporator liquid temperature	[Numeric]	K	> 0	✓	
condenser_liquid_volumetric_flow_rate	Condenser liquid flow	[Numeric]	m^3/s	> 0	✓	
condenser_liquid_entering_temperature	Entering condenser liquid temperature	[Numeric]	K	> 0	✓	
net_evaporator_capacity_fraction	Fraction of maximum net capacity at the same operating conditions.	[Numeric]		≥ 0 and ≤ 1	✓	Ratio of net_evaporator_capacity to the maximum evaporator capacity at the same operating conditions

RS0001.3.2.11 RS0001.Performance.PerformanceMapCooling.LookupVariablesCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes
input_power	Total power input to the packaged chiller.	[Numeric]	W	> 0	✓	All power consumed by the chiller, including controls, motors, variable speed drives, purge units, sump heaters, fans, etc.

net_evaporator_capacity	Unit refrigeration capacity	[Numeric]	W	≥ 0	✓	The available cooling capacity of the evaporator to the thermal load calculated using only the sensible heat transfer.
net_condenser_capacity	Condenser heat rejection	[Numeric]	W	≥ 0	✓	The capacity of the condenser transferred to the condenser cooling stream using only the sensible heat transfer.
evaporator_liquid_entering_temperature	Entering evaporator liquid temperature	[Numeric]	K	> 0	✓	
condenser_liquid_leaving_temperature	Leaving condenser liquid temperature	[Numeric]	K	> 0	✓	
evaporator_liquid_differential_pressure	Pressure drop across the evaporator	[Numeric]	Pa	> 0	✓	
condenser_liquid_differential_pressure	Pressure drop across the condenser	[Numeric]	Pa	> 0	✓	
oil_cooler_heat[1]	Heat rejected by the chiller oil cooler (if separate stream crossing the control volume boundary)	[Numeric]	W	≥ 0	✓	Heat transferred to another liquid crossing the control volume boundary from the chiller oil cooler. NULL if not present
motor_controller_heat[1]	Heat rejected by the motor control center cooling (if separate stream crossing the control volume boundary)	[Numeric]	W	≥ 0	✓	Heat transferred to another liquid crossing the control volume boundary from the chiller motor controller (inverter drive, starter, etc). NULL if not present

[1]**Informative note:** Values for oil_cooler_heat and motor_controller_heat should only be included when the oil cooler heat rejection and/or the motor controller heat rejection are met with a liquid stream other than the condenser. When these heat rejections are met by the condenser, the quantities should be included in the net_condenser_capacity and the values for oil_cooler_heat and/or motor_controller_heat should be NULL.

RS0001.3.2.12 RS0001.Performance.PerformanceMapStandby

The PerformanceMapStandby group defines the power consumed by the unit during standby operation.

The PerformanceMapStandby shall be used to determine the performance when one of the following is true:

(1) there is no call for cooling,

(2) a grid variable value is outside the range of the values for that grid variable in the GridVariablesCooling data group, or

(3) the value for any lookup variable in the LookupVariablesCooling data group at the combination of grid variable values is NULL.

Informative: 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	Range	Req	Notes
grid_variables	Data group defining the grid variables for standby performance	{GridVariablesStandby}			✓	
lookup_variables	Data group defining the lookup variables for standby performance	{LookupVariablesStandby}			✓	

RS0001.3.2.13 RS0001.Performance.PerformanceMapStandby.GridVariablesStandby

Data Element Name	Description	Data Type	Units	Range	Req	Notes
chiller_environment_dry_bulb_temperature	Dry bulb temperature of the air in the environment of the chiller	[Numeric]	K	> 0	✓	

RS0001.3.2.14 RS0001.Performance.PerformanceMapStandby.LookupVariablesStandby

Data Element Name	Description	Data Type	Units	Range	Req	Notes
input_power	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	✓	Power consumed by chiller during off cycle. An example is a VSD cooling fan or sump heater.

RS0001.4 Verification Rules

RS0001.4.1 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:

$$\sum Energy_{In} = \sum Energy_{Out} \quad \text{(RS0003-1)}$$

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

$$\dot{P}_{in} + \dot{Q}_{evap} = \dot{Q}_{cond} \quad \text{(RS0003-2)}$$

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

$$\dot{P}_{in} + \dot{Q}_{evap} = \dot{Q}_{cond} + \dot{Q}_{lossToSpace} + \dot{Q}_{oilCooler} + \dot{Q}_{motorController} \quad \text{(RS0003-3)}$$

All 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:

$$\dot{Q}_{lossToSpace} = (\dot{P}_{in} + \dot{Q}_{evap}) - (\dot{Q}_{cond} + \dot{Q}_{oilCooler} + \dot{Q}_{motorController}) \quad \text{(RS0003-4)}$$

The resulting loss to the space shall not be negative:

$$\dot{Q}_{lossToSpace} \geq 0 \quad \text{(RS0003-5)}$$

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.

RS0001.4.2 Nomenclature

Symbol	Data element	Description
$\dot{P}_{in}$	input_power	Power input to the refrigeration system, W
$\dot{Q}_{evap}$	net_evaporator_capacity	Heat addition rate from the chilled liquid stream to the refrigeration system at the evaporator, W
$\dot{Q}_{cond}$	net_condenser_capacity	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
$\dot{Q}_{oilCooler}$	oil_cooler_heat	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
$\dot{Q}_{motorController}$	motor_controller_heat	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

RS0001.5 References

AHRI. 2015. ANSI/AHRI 550/590-2015, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”.

AHRI. 2015. ANSI/AHRI 551/591-2015, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”.

AHRI. 2017. ANSI/AHRI 550/590-2015 With Addendum 1, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”.

AHRI. 2017. ANSI/AHRI 551/591-2015 With Addendum 1, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”.

AHRI. 2018. ANSI/AHRI 550/590-2018 with Errata, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”.

AHRI. 2018. ANSI/AHRI 551/591-2018 with Errata, “Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle”

RS0001.6 Example (Informative)

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

RS0002 UNITARY COOLING AIR-CONDITIONING EQUIPMENT

RS0002.1 Identification and History

RS_ID: RS0002

Schema Version	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0002.2 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”.

The performance for the fan and direct expansion coil system is characterized through embedded representations (see RS0003 and RS0004, respectively).

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

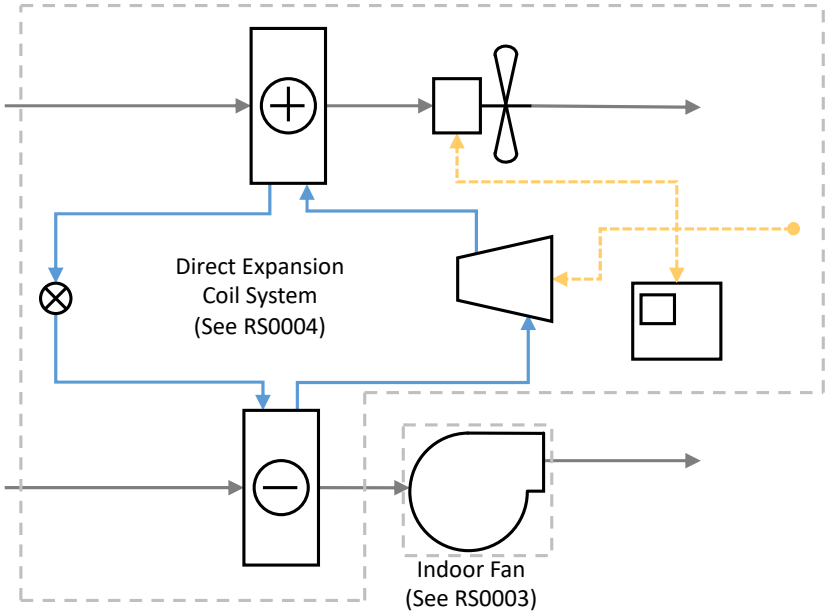

Figure RS0002-1. Unitary Air-Conditioning System

RS0002.3 Data Representation

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

- ASHRAE205 [1]
  - RS0002[1]
    - Description [0 .. 1]
      - ProductInformation [0 .. 1]
      - RatingAHRI210240 [0 .. 1][1]

[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.

- RatingAHRI340360 [0 .. 1][1]
- Performance [1]
  - ASHRAE205 (RS0003) [0 .. 1]
  - ASHRAE205 (RS0004) [0 .. 1]

RS0002.3.1 Local Enumerations

RS0002.3.1.1 FanPosition

Enumerator	Definition	Notes
BLOW_THROUGH	Fan is placed downstream of the indoor coil.	
DRAW_THROUGH	Fan is placed upstream of the indoor coil.	

RS0002.3.1.2 AHRI210240TestStandardYear

Enumerator	Definition	Notes
2008	Rating is based on AHRI Standard from 2008	
2017	Rating is based on AHRI Standard from 2017	

RS0002.3.1.3 AHRI340360TestStandardYear

Enumerator	Definition	Notes
2007	Rating is based on AHRI Standard from 2007	
2015	Rating is based on AHRI Standard from 2015	
IP_2019	Rating is based on IP AHRI Standard from 2019	

RS0002.3.2 Data Groups

RS0002.3.2.1 RS0002

Data Element Name	Description	Data Type	Units	Range	Req	Note
description	Data group describing product and rating information	{Description}				

Data Element Name	Description	Data Type	Units	Range	Req	Note
performance	Data group containing performance information	{Performance}			✓	

RS0002.3.2.2 RS0002.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes
product_information	Data group describing product information	{ProductInformation}				
rating_AHRI_210_240	Data group containing information relevant to products rated under AHRI 210/240	{RatingAHRI210240}				
rating_AHRI_340_360	Data group containing information relevant to products rated under AHRI 340/360	{RatingAHRI340360}				

RS0002.3.2.3 RS0002.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
manufacturer	Manufacturer name	String			✓	
model_number	Model number	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*

RS0002.3.2.4 RS0002.Description.RatingAHRI210240

Data Element Name	Description	Data Type	Units	Range	Req	Notes
certified_reference_number	AHRI Certified Reference Number	String			✓	
test_standard_year	Name and version of the AHRI test standard	<AHRI210240TestStandardYear>			✓	
manufacturer_data_source_version	Version of the software used to generate the AHRI rating and the performance maps	String			✓	
SEER	Seasonal Energy Efficiency Ratio as defined by AHRI 210/240	Numeric	Btu/W-h	> 0	✓	
EER	Energy Efficiency Ratio (A) as defined by AHRI 210/240	Numeric	Btu/W-h	> 0	✓	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	✓	The net capacity (accounting for fan motor heat) at the AHRI "A" operating conditions
rating_fan_power_per_flow	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		Used for verification of the rated SEER value (see SEER calculation procedures in AHRI 210/240)
rating_reproducible_from_performance_data	Whether this rating can be reproduced using the performance data in the representation	Boolean			✓	Mark this field as true if the rating values in this table can be reproduced using the performance data in the representation within the tolerance of the rating standard.

RS0002.3.2.5 RatingAHRI340360

Data Element Name	Description	Data Type	Units	Range	Req	Notes
certified_reference_number	AHRI Certified Reference Number	String			✓	
test_standard_year	Name and version of the AHRI test standard	<AHRI240360TestStandardYear>			✓	
manufacturer_data_source_version	Version of the software used to generate the AHRI rating and the performance maps	String			✓	
IEER	Integrated Energy Efficiency Ratio as defined by AHRI 340/360	Numeric	Btu/W-h	> 0	✓	
EER	Energy Efficiency Ratio as defined by AHRI 340/360	Numeric	Btu/W-h	> 0	✓	Net efficiency accounts for fan motor heat/power
capacity	Total cooling capacity as defined by AHRI 340/360	Numeric	Btu/h	> 0	✓	Net capacity accounts for fan motor heat
rating_fan_power_per_flow	Power per air flow rate of the indoor fan used in the AHRI 340/360 calculation of IEER and EER	Numeric	W/(m^3/s)	> 0		Used for verification of the rated IEER value (see IEER calculation procedures in AHRI 340/360)
rating_reproducible_from_performance_data	Whether this rating can be reproduced using the performance data in the representation	Boolean			✓	Mark this field as true if the rating values in this table can be reproduced using the performance data in the representation within the tolerance of the rating standard.

RS0002.3.2.6 RS0002.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes

standby_power	Continuous unit power draw regardless of whether the fan or DX system are operating.	Numeric	W	≥ 0	✓	Includes on-board controls and other power not otherwise included in the fan or dx system representations.
fan_representation	The corresponding Standard 205 enclosed fan assembly representation	ASHRAE205 (RS0003)				This is only required if the fan is packaged with the unitary equipment.
fan_position	Position of the fan relative to the indoor coil	<FanPosition>			✓	
DX_system_representation	The corresponding Standard 205 direct expansion coil system representation	ASHHRAE205 (RS0004)			✓	

RS0002.4 Verification Rules

No specific rules.

RS0002.5 References

AHRI Standard 210/240
AHRI Standard 340/360

RS0002.6 Example (Informative)

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

RS0003 FAN ASSEMBLY

RS0003.1 Identification and History

RS_ID: RS0003

	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0003.2 Scope and Description

Representation Specification RS0003 applies to fan assemblies. 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 including 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 does not include axial fans with variable blade pitch.

This *representation specification* considers fans that can operate continuously over a range of shaft speeds as well as fans with discrete speed settings dictated by a tap or dip switch. It also covers fans that are internally controlled to maintain discrete flow rates by varying rotational speed in response to changing static pressures. This *representation specification* does not cover fans using inlet guide vanes to modulate flow rate or axial fans with variable blade pitch.

The fan performance data can be presented in one of two ways: discrete or continuous. The discrete data is provided at a set of defined impeller speeds and is intended to be used at only those impeller speeds. The continuous data is provided at a range of impeller speeds, and the data can be interpolated across the range of impeller speeds.

The *representation specification* includes a *data element* that denotes how the fan assembly performs as installed and serves as an indicator to the *application software* how to utilize the data: fixed or continuous. A fixed fan assembly only operates at a single impeller speed once installed. A variable fan assembly operates over multiple impeller speeds based on the installed control system.

This *representation specification* allows for an embedded *representation* of an electric motor (see RS0005). For fans packaged without motors, no embedded motor *representation* shall be specified, and the input power into the fan shall represent the shaft power. In this case, any motor supplying the fan's shaft power shall be defined in an external motor *representation*.

For fans packaged with motors, this embedded motor *representation* shall be used to indicate to the *application software* whether:

1. the input power into the fan represents mechanical shaft power (where the conversion of electrical power to mechanical shaft power shall be provided in the motor *representation's* performance map), or
2. the input power into the fan represents electrical power into the motor (where the conversion of electrical power to mechanical shaft power shall be implicit in the fan assembly performance map; indicated by not providing a performance map in the motor *representation*).

The mechanical efficiency of any belt drive used to modify rotational speed between the motor and impeller shall be implicit in the representation data. That is, if a fan is belt driven, then its input power shall represent the power upstream of the belt drive.

Figure RS0003-1 illustrates an example of a fan assembly within the scope of this representation.

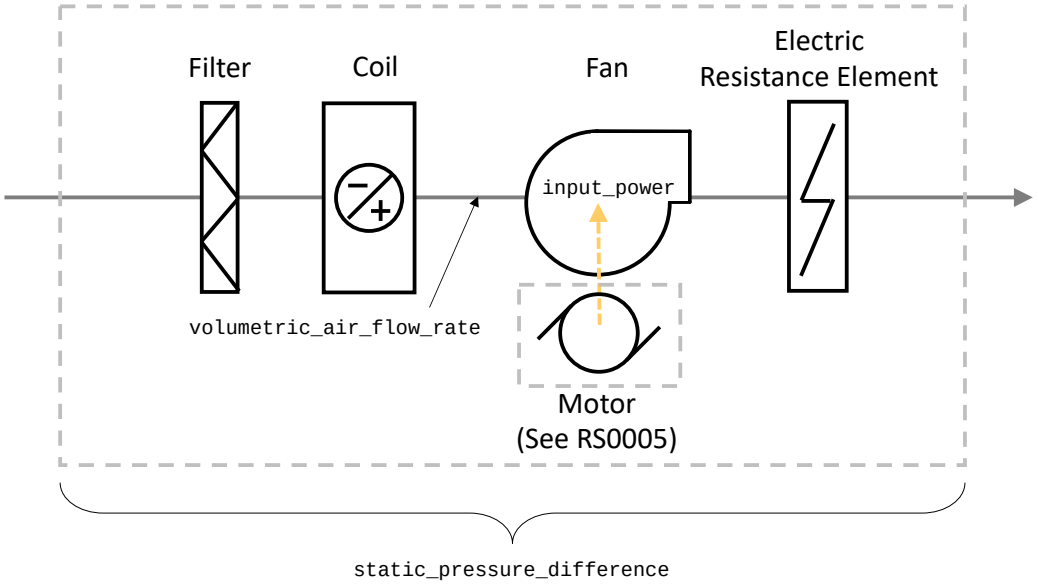

Figure RS0003-1. Example Fan Assembly for a Packaged System

RS0003.2.1 Referencing Representation Specifications (Informative)

- RS0002

RS0003.3 Data Representation

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

- ASHRAE205 [1]
  - RS0003[1]
    - Description[0 .. 1]
      - ProductInformation [0 .. 1]

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

RS0003.3.1 Local Enumerations

RS0003.3.1.1 PerformanceMapType

Enumerator	Definition	Notes
DISCRETE	Fan assemblies that can operate at one of a defined set of speeds	Data for this performance map type is provided at individual impeller speeds
CONTINUOUS	Fan assemblies that can operate at any point within a continuous range of speeds	Data for this performance map type is provided in a continuous range of impeller speeds

RS0003.3.1.2 SpeedControlType

This enumerator is used to define how the impeller speed control is installed for the fan and provides an indicator to the consumer of the data on how to use the data. Both SpeedControlTypes can be used with both PerformanceMapTypes. A DISCRETE PerformanceMapType with a FIXED SpeedControlType would be a map with one or more discrete impeller speeds, but the impeller will be set to run only at one speed. A DISCRETE PerformanceMapType with a VARIABLE SpeedControlType would be a map with two or more discrete impeller speeds, and the impeller speed can move between two or more of the impeller speeds based on the control of the fan assembly. A CONTINUOUS PerformanceMapType with a FIXED SpeedControlType would be a map with over a range of impeller speeds, but the impeller will be set to run only at one speed. A

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

CONTINUOUS PerformanceMapType with a VARIABLE SpeedControlType would be a map with over a range of impeller speeds and the impeller will be able to run over the range of impeller speeds based on the control of the fan assembly.

Enumerator	Definition	Notes
FIXED	Fan speed cannot change after installation	
VARIABLE	Fan speed can change depending on operation after installation	

RS0003.3.1.3 ImpellerType

Enumerator	Definition	Notes
CENTRIFUGAL_FORWARD_CURVED	Forward curved fan impeller	Consistent with ASHRAE standard terminology
CENTRIFUGAL_BACKWARD_CURVED	Backward curved or inclined fan impeller	
CENTRIFUGAL_AIR_FOIL	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	

RS0003.3.1.4 ComponentType

Enumerator	Definition	Notes
COIL	Finned coil in cross-flow arrangement	

FURNACE	Fuel-fired heating section	
FILTER	Air filters	
HEAT_EXCHANGER	Additional heat exchanger	e.g., an air-to-air heat exchanger
ELECTRIC_RESISTANCE_ELEMENT	Electric resistance heater elements	
OTHER	Additional components in air stream	

RS0003.3.2 Data Groups

RS0003.3.2.1 RS0003

Data Element Name	Description	Data Type	Units	Range	Req	Notes
description	Data group describing product and rating information	{Description}				
performance	Data group containing performance information	{Performance}			✓	

RS0003.3.2.2 RS0003.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes
product_information	Data group describing product information	{ProductInformation}				
assembly_components	An array of components included in the fan assembly air stream	[{AssemblyComponent}]				

RS0003.3.2.3 RS0003.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
manufacturer	Name of the assembly/unit manufacturer	String			✓	
model_number	Model number of the assembly / unit	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*
is_enclosed	Fan assembly is enclosed	Boolean			✓	If true, the performance data reflects the static pressure difference across the enclosure

impeller_type	Type of impeller in fan assembly	<ImpellerType>				
has_belt_drive	The fan impeller is driven by a belt and pulley system	Boolean				
number_of_impellers	Number of impellers included in the fan assembly	Numeric				

RS0003.3.2.4 RS0003.Description.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 shall only be specified if "is_enclosed" is true.

Data Element Name	Description	Data Type	Units	Range	Req	Notes
component_type	Type of component	<ComponentType>			✓	
component_description	Informative description of the component	String				
component_ID	Identifier of the corresponding Standard 205 representation	UUID				Optionally provided if the component has a Standard 205 representation.

RS0003.3.2.5 RS0003.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes
nominal_volumetric_air_flow_rate	Nominal air flow rate for fan assembly	Numeric	m^3/s	≥ 0	✓	Nominal or rated air flow rate at *standard air conditions*. Used for calculating wet coil pressure drop.
wet_coil_pressure_drop	Additional static pressure drop if cooling coil component is collecting condensate	Numeric	Pa	≥ 0	✓	Corresponds to pressure drop at nominal_volumetric_air_flow_rate. If unknown, a value of 75 Pa shall be used.
heat_loss_fraction	Fraction of efficiency losses added as heat transferred into the air stream	Numeric		$\geq 0, \leq 1$	✓	Used to determine amount of heat from the motor added to the air stream.
maximum_impeller_speed	Maximum impeller rotational speed	Numeric	rev/s	≥ 0	✓	

minimum_impeller_speed	Minimum impeller rotational speed	Numeric	rev/s	≥ 0	✓	If no minimum, use zero.
stability_curve	A description of the stability area for system selection	{SystemCurve}				
performance_map_type	Type of performance map (discrete or continuous)	<PerformanceMapType>			✓	
speed_control_type	Type of fan impeller speed control installed with the fan assembly	<SpeedControlType>			✓	
motor_representation	The corresponding Standard 205 motor representation	ASHRAE205 (RS0005)				Included if the fan is packaged with a motor. If this is not provided, the fan input power shall represent mechanical shaft power. If this is provided, the input power shall represent either mechanical shaft power or electrical power depending on the data provided by the motor representation.
performance_map	Data group describing fan performance when operating	({PerformanceMapContinuous}, {PerformanceMapDiscrete})			✓	The performance map data group should reflect the type and operation of the fan. PerformanceMapContinuous describes fan performance in terms of air flow, static pressure, impeller speed, and fan electrical or shaft power. PerformanceMapDiscrete describes fan performance in terms of speed setting, static pressure, air flow, and power.

RS0003.3.2.6 RS0003.Performance.SystemCurve

Data Element Name	Description	Data Type	Units	Range	Req	Notes
volumetric_air_flow_rate	Volumetric air flow rate through an air distribution system	[Numeric]	m^3/s	≥ 0	✓	
static_pressure_difference	Static pressure drop of an air distribution system	[Numeric]	Pa	≥ 0	✓	

RS0003.3.2.7 RS0003.Performance.PerformanceMapContinuous

The continuous performance map option is associated with fan assemblies that operate over a continuous range of impeller speeds. 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 air conditions* can be modified according to the fan laws at different temperatures and atmospheric pressures by using density correction factors.

Electrical power estimations from shaft power for untested fan duty points shall be done per AMCA standard 207 to account for electrical and mechanical fan drive losses.

Electrical power interpolations between wire-to-air tested points shall be done per AMCA 211.

Data Element Name	Description	Data Type	Units	Range	Req	Notes
grid_variables	Data group describing grid variables for continuous fan performance	{GridVariablesContinuous}			✓	
lookup_variables	Data group describing lookup variables for continuous fan performance	{LookupVariablesContinuous}			✓	

RS0003.3.2.8 RS0003.Performance.PerformanceMapContinuous.GridVariablesContinuous

Data Element Name	Description	Data Type	Units	Range	Req	Notes
volumetric_air_flow_rate	Volumetric air flow rate through fan assembly	[Numeric]	m^3/s	≥ 0	✓	At *standard air conditions*.
static_pressure_difference[2]	Static pressure across fan assembly at dry coil conditions	[Numeric]	Pa	≥ 0	✓	Or external static

[2]Any static pressure deduction (or addition) for wet coil is specified by "wet_coil_pressure_drop" in "Performance" data group

RS0003.3.2.9 RS0003.Performance.PerformanceMapContinuous.LookupVariablesContinuous

Data Element Name	Description	Data Type	Units	Range	Req	Notes
impeller_speed	Rotational speed of fan impeller	[Numeric]	rev/s	≥ 0	✓	

input_power	Power input to fan assembly	[Numeric]	W	≥ 0	✓	Mechanical shaft power or electrical power depending on the data provided by the motor representation.

RS0003.3.2.10 RS0003.Performance.PerformanceMapDiscrete

The discrete performance map applies to fan assemblies that operate at a defined set of impeller speeds. Data must be provided for all allowable discrete speeds or settings. Air flow, fan power, and static pressure values are at *standard air 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	Range	Req	Notes
grid_variables	Data group describing grid variables for discrete fan performance	{GridVariablesDiscrete}			✓	
lookup_variables	Data group describing lookup variables for discrete fan performance	{LookupVariablesDiscrete}			✓	

RS0003.3.2.11 RS0003.Performance.PerformanceMapDiscrete.GridVariablesDiscrete

Data Element Name	Description	Data Type	Units	Range	Req	Notes
speed_number	Number indicating discrete speed of fan impeller	[Integer]	-	≥ 0	✓	In rank order
static_pressure_difference[3]	Static pressure across fan assembly at dry coil conditions	[Numeric]	Pa	≥ 0	✓	Or external static

[3]Any static pressure deduction (or addition) for wet coil is specified by "wet_coil_pressure_drop" in "Performance" data group

RS0003.3.2.12 RS0003.Performance.PerformanceMapDiscrete.LookupVariablesDiscrete

Data Element Name	Description	Data Type	Units	Range	Req	Notes
volumetric_air_flow_rate	Volumetric air flow rate through fan assembly	[Numeric]	m^3/s	≥ 0	✓	At *standard air conditions*.
input_power	Power input to fan assembly	[Numeric]	W	≥ 0	✓	Mechanical shaft power or electrical power depending on the data provided by the motor representation.

RS0003.4 Verification Rules

Performance data supplied must satisfy the following verification tests.

RS0003.4.1 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.

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

Informative note: All losses are assumed to be added to the air stream and/or the surroundings depending on the value of heat_loss_fraction.

RS0003.4.2 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, -

RS0003.5 References

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

AMCA 211. Certified Ratings Program Product Rating Manual for Fan Air Performance

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

ANSI/AMCA Standard 207-17. Fan System Efficiency and Fan System Input Power

RS0003.6 Example (Informative)

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

RS0004 AIR-TO-AIR DIRECT EXPANSION COIL SYSTEM

RS0004.1 Identification and History

RS_ID: RS0004

Schema Version	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0004.2 Scope and Description

Representation Specification RS0004 applies to direct expansion vapor compression refrigerant coil systems with two coils (one evaporator and one condenser) both exchanging heat with air streams. This includes systems with reversing capability to provide either cooling or heating.

Figure RS0004-1 illustrates the components of the refrigerant systems within the scope of this appendix.

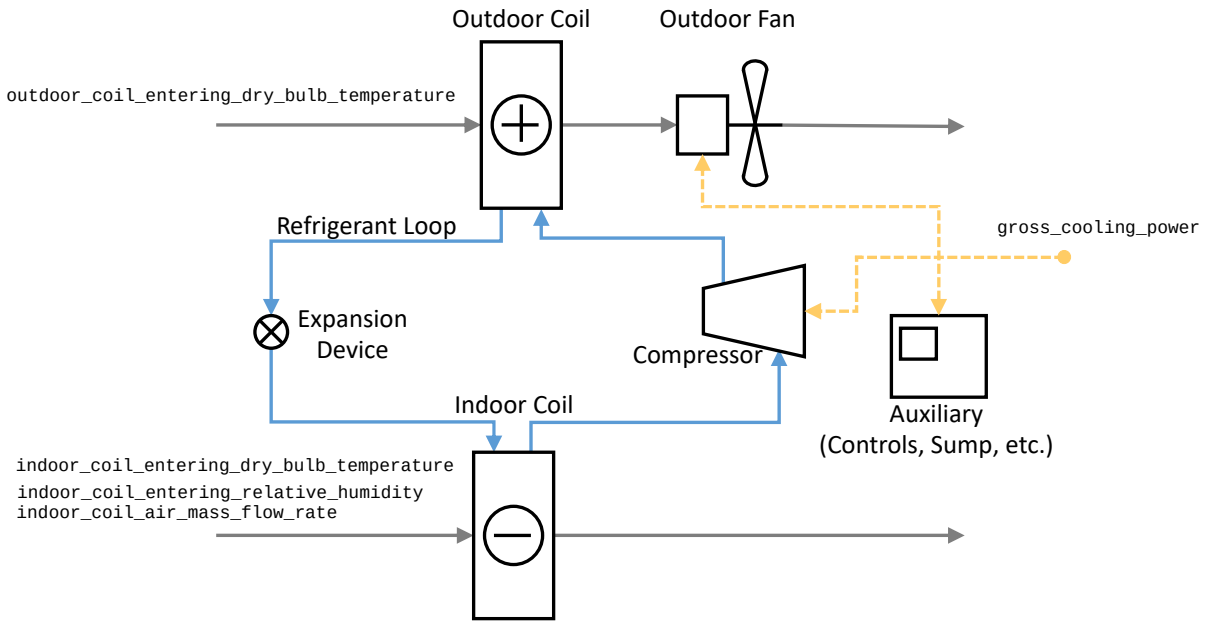

Figure RS0004-1. Direct Expansion Refrigerant Coil System

RS0004.2.1 Referencing Representation Specifications (Informative)

- RS0002

RS0004.3 Data Representation

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

- ASHRAE205 [1]
  - RS0004[1]
    - Description [0 .. 1]

- ProductInformation [0 .. 1]
- Performance [1]
  - PerformanceMapCooling [1]
    - GridVariablesCooling [1]
    - LookupVariablesCooling [1]
  - PerformanceMapStandby [1]
    - GridVariablesStandby [1]
    - LookupVariablesStandby [1]

RS0004.3.1 Local Enumerations

RS0004.3.1.1 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.	

RS0004.3.2 Data Groups

RS0004.3.2.1 RS0004

Data Element Name	Description	Data Type	Units	Range	Req	Note
description	Data group describing product and rating information	{Description}				
performance	Data group containing performance information	{Performance}			✓	

RS0004.3.2.2 RS0004.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes

product_information	Data group describing product information	{ProductInformation}				

RS0004.3.2.3 RS0004.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
outdoor_unit_manufacturer	Name of the outdoor unit manufacturer	String			✓	
outdoor_unit_model_number	Model number of the outdoor unit	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*
indoor_unit_manufacturer	Name of the indoor unit manufacturer	String				
indoor_unit_model_number	Model number of the indoor unit	Pattern				Pattern shall match all model numbers that can be represented by the *representation*
refrigerant_type	Type of refrigerant used	<RefrigerantType>				
compressor_type	Type of compressor	<CompressorType>				

RS0004.3.2.4 RS0004.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes
compressor_control_method	Method used to control different speeds of the compressor	<CompressorControlMethod>			✓	
cycling_degradation_coefficient	Cycling degradation coefficient (C_D) as described in AHRI 210/240	Numeric		$\geq 0, \leq 1.0$	✓	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.
performance_map_cooling	Data group describing cooling performance over a range of conditions	{PerformanceMapCooling}			✓	
performance_map_standby	Data group describing standby performance	{PerformanceMapStandby}			✓	

RS0004.3.2.5 RS0004.Performance.PerformanceMapCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes

grid_variables	Data group defining the grid variables for cooling performance	{GridVariablesCooling}			✓	
lookup_variables	Data group defining the lookup variables for cooling performance	{LookupVariablesCooling}			✓	

RS0004.3.2.6 RS0004.Performance.PerformanceMapCooling.GridVariablesCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes
outdoor_coil_entering_dry_bulb_temperature	Dry bulb temperature of the air entering the outdoor coil	[Numeric]	K	≥ 0	✓	
indoor_coil_entering_relative_humidity	Relative humidity of the air entering the indoor coil	[Numeric]	-	≥ 0, ≤ 1.0	✓	As measured immediately before entering the coil (i.e., after the fan in a blow-through configuration).
indoor_coil_entering_dry_bulb_temperature	Dry bulb temperature of the air entering the indoor coil	[Numeric]	K	≥ 0	✓	As measured immediately before entering the coil (i.e., after the fan in a blow-through configuration).
indoor_coil_air_mass_flow_rate	Mass flow rate of air entering the indoor coil	[Numeric]	kg/s	> 0	✓	
compressor_sequence_number[1]	Index indicating the relative order of the compressor speed/stage	[Numeric]		≥ 0	✓	Expressed in order from initial stage/speed to final stage/speed
ambient_absolute_air_pressure	Ambient absolute air pressure	[Numeric]	Pa		✓	

RS0004.3.2.7 RS0004.Performance.PerformanceMapCooling.LookupVariablesCooling

Data Element Name	Description	Data Type	Units	Range	Req	Notes
gross_total_cooling_capacity	Total heat removed by the indoor coil	[Numeric]	W	> 0	✓	Does not account for heat added by the fan
gross_sensible_cooling_capacity	Sensible heat removed by the indoor coil	[Numeric]	W	> 0	✓	Does not account for heat added by the fan

[1] For equipment with multiple or variable speed operation, performance must be reported for operational compressor stages/speeds. For compressors with staged operation, sequence numbers represent each intermediate stage of the compressor(s). For compressors with dynamic operation (i.e., variable speed), performance shall be interpolated between sequence numbers.

gross_cooling_power	Gross power draw (of the outdoor unit)	[Numeric]	W	> 0	✓	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.

RS0004.3.2.8 RS0004.Performance.PerformanceMapStandby

The PerformanceMapStandby group defines the power consumed by the unit during standby operation.

The PerformanceMapStandby shall be used to determine the performance when one of the following is true:

(1) there is no call for cooling,

(2) a grid variable value is outside the range of the values for that grid variable in the GridVariablesCooling data group, or

(3) the value for any lookup variable in the LookupVariablesCooling data group at the combination of grid variable values is NULL.

Data Element Name	Description	Data Type	Units	Range	Req	Notes
grid_variables	Data group defining the grid variables for standby performance	{GridVariablesStandby}			✓	
lookup_variables	Data group defining the lookup variables for standby performance	{LookupVariablesStandby}			✓	

RS0004.3.2.9 RS0004.Performance.PerformanceMapStandby.GridVariablesStandby

Data Element Name	Description	Data Type	Units	Range	Req	Notes
outdoor_coil_environment_dry_bulb_temperature	Dry bulb temperature of the air in the environment of the outdoor coil	[Numeric]	K	≥ 0	✓	

RS0004.3.2.10 RS0004.Performance.PerformanceMapStandby.LookupVariablesStandby

Data Element Name	Description	Data Type	Units	Range	Req	Notes
gross_power	Gross power draw (of the outdoor unit)	[Numeric]	W	≥ 0	✓	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.

RS0004.4 Verification Rules

Performance data supplied must satisfy the following verification tests. The psychrometric functions used below shall follow the definitions provided by the ASHRAE Handbook of Fundamentals 2017, Chapter 1.

RS0004.4.1 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:

$$\frac{\omega_e - \omega_l}{T_{db,e} - T_{db,l}} = \frac{\omega_e - \omega_{ADP}}{T_{db,e} - T_{db,ADP}} \quad \text{(RS0004-1)}$$

and

$$\phi\left(T_{db,ADP}, \omega_{ADP}, P\right) = 1.0. \quad \text{(RS0004-2)}$$

RS0004.4.2 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:

$$\omega_l \leq \omega_e \quad \text{(RS0004-3)}$$

RS0004.4.3 Nomenclature

Symbol	Description

ϕ	Relative humidity
ω	Humidity ratio, kg_{water} / $kg_{dry\ air}$
T_{db}	Dry-bulb temperature, K
P	Absolute pressure, Pa
e	Subscript indicating entering coil conditions
l	Subscript indicating leaving coil conditions
ADP	Subscript indicating Apparatus Dew Point (ADP) conditions

RS0004.5 References

ASHRAE Handbook of Fundamentals 2017, Chapter 1

RS0004.6 Example (Informative)

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

RS0005 MOTOR

RS0005.1 Identification and History

RS_ID: RS0005

	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0005.2 Scope and Description

Representation Specification RS0005 applies to electric motors.

Figure RS0005-1illustrates an example of a motor within the scope of this representation.

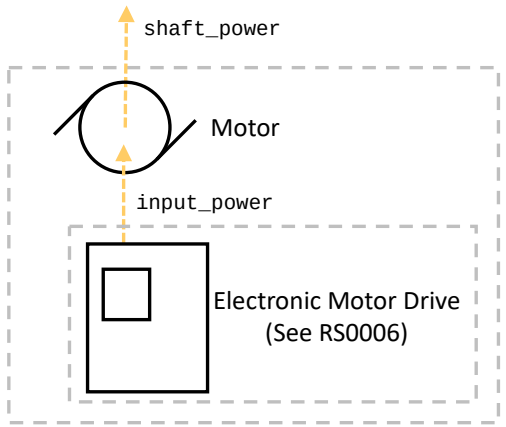

Figure RS0005-1. Motor

RS0005.2.1 Referencing Representation Specifications (Informative)

- RS0003

Some referencing *representations* of motor-driven equipment may incorporate motor efficiency implicitly in their data (input power represents electrical power and not shaft power). In such cases, the referenced motor *representation* may omit the motor's *performance map* to imply that the input power of the referencing *representation* serves as electrical input power (instead of mechanical shaft power). Referencing *representations* shall also indicate what fraction of motor efficiency losses are added as heat to a fluid stream if the motor is used to move fluids.

RS0005.3 Data Representation

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

- ASHRAE205 [1]
  - RS0005[1]
    - Description [0 .. 1]
      - ProductInformation [0 .. 1]
    - Performance [1]
      - PerformanceMap [1]
        - GridVariables [1]
        - LookupVariables [1]

RS0005.3.1 Local Enumerations

None.

RS0005.3.2 Data Groups

RS0005.3.2.1 RS0005

Data Element Name	Description	Data Type	Units	Range	Req	Notes
description	Data group describing product and rating information	{Description}				
performance	Data group containing performance information	{Performance}			✓	

RS0005.3.2.2 RS0005.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes
product_information	Data group describing product information	{ProductInformation}				

RS0005.3.2.3 RS0005.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
manufacturer	Name of the manufacturer	String			✓	
model_number	Model number	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*
input_voltage	Input voltage	Numeric	V	≥ 0	✓	
input_frequency	Input frequency	Numeric	Hz	≥ 0	✓	
number_of_poles	Number of poles	Integer				

RS0005.3.2.4 RS0005.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes
maximum_power	Maximum operational input power to the motor	Numeric	W	≥ 0	✓	This is the operational limit set to prevent overheating or overcurrent. This is not the rated name plate power.
standby_power	Power draw when motor is not operating	Numeric	W	≥ 0	✓	
drive_representation	The corresponding Standard 205 drive representation	ASHRAE205 (RS0006)				
performance_map	Data group describing motor performance when operating	{PerformanceMap})				If no performance map is defined, the motor shall be assumed to transfer all electric power directly to the shaft. ***Informative note:*** This field may be omitted for motor-driven equipment where motor efficiencies are

						incorporated into their performance data.

RS0005.3.2.5 RS0005.Performance.PerformanceMap

Data Element Name	Description	Data Type	Units	Range	Req	Notes
grid_variables	Data group describing grid variables for motor performance	{GridVariables}			✓	
lookup_variables	Data group describing lookup variables for motor performance	{LookupVariables}			✓	

RS0005.3.2.6 RS0005.Performance.PerformanceMap.GridVariables

Data Element Name	Description	Data Type	Units	Range	Req	Notes
shaft_power	Delivered rotational shaft power	[Numeric]	W	≥ 0	✓	

RS0005.3.2.7 RS0005.Performance.PerformanceMap.LookupVariables

Data Element Name	Description	Data Type	Units	Range	Req	Notes
efficiency	Efficiency of motor	[Numeric]	-	≥ 0, ≤ 1.0	✓	Defined as the ratio of mechanical shaft power to electrical input power of the motor.
power_factor	Power factor of the motor	[Numeric]	-	≥ 0, ≤ 1.0	✓	

RS0005.4 Verification Rules

Performance data supplied must satisfy the following verification tests.

RS0005.4.1 Motor Efficiency

The resulting shaft power ($\dot{P}_s$) must be less than or equal to the electrical input power to the motor ($\dot{P}_m$). That is, the motor efficiency (ε_m) must be less than or equal to unity.

$$\varepsilon_m = \frac{\dot{P}_s}{\dot{P}_m} \leq 1 \qquad \text{(RS0005-1)}$$

Informative note: All losses are assumed to be added as heat to the surroundings or to a fluid stream as indicated by a referencing *representation*.

RS0005.4.2 Nomenclature

Symbol	Description
$\dot{P}_s$	Shaft power, W
$\dot{P}_m$	Input power to motor, W
ε_m	Motor efficiency, -

RS0005.5 References

None.

RS0005.6 Example (Informative)

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

RS0006 ELECTRONIC MOTOR DRIVE

RS0006.1 Identification and History

RS_ID: RS0006

	Date	Initial Approved Standard	Notes
0.1.0	22-Jan-2019	2020	Initial version

RS0006.2 Scope and Description

Representation Specification RS0006 applies to electronic motor drives.

Figure RS0006-1illustrates an example of a motor within the scope of this representation.

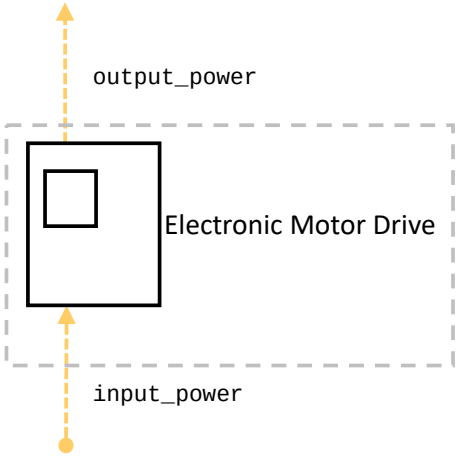

Figure RS0006-1. Electronic Motor Drive

RS0006.2.1 Referencing Representation Specifications (Informative)

- RS0005

RS0006.3 Data Representation

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

- ASHRAE205 [1]
  - RS0006[1]
    - Description[0 .. 1]
      - ProductInformation [0 .. 1]
    - Performance [1]
      - PerformanceMap [1]
        - GridVariables [1]
        - LookupVariables [1]

RS0006.3.1 Local Enumerations

RS0006.3.1.1 CoolingMethod

Enumerator	Definition	Notes
PASSIVE_COOLED	Drive is cooled using natural air convection within the surrounding environment	All drive efficiency losses are assumed to be added as heat to the surrounding environment
ACTIVE_AIR_COOLED	Drive is cooled using forced air convection within the surrounding environment	Electrical power required for the active cooling system shall be included in the efficiency of the drive. All drive efficiency losses are assumed to be added as heat to the surrounding environment.
ACTIVE_LIQUID_COOLED	Drive is cooled using forced liquid convection, transferring heat to the liquid	Any liquid pumping power shall be modeled external to the drive by the *application software*. All drive efficiency losses are assumed to be added as heat to the liquid stream.

RS0006.3.2 Data Groups

RS0006.3.2.1 RS0006

Data Element Name	Description	Data Type	Units	Range	Req	Notes
description	Data group describing product and rating information	{Description}				
performance	Data group containing performance information	{Performance}			✓	

RS0006.3.2.2 RS0006.Description

Data Element Name	Description	Data Type	Units	Range	Req	Notes
product_information	Data group describing product information	{ProductInformation}				

RS0006.3.2.3 RS0006.Description.ProductInformation

Data Element Name	Description	Data Type	Units	Range	Req	Notes
manufacturer	Name of the manufacturer	String			✓	
model_number	Model number	Pattern			✓	Pattern shall match all model numbers that can be represented by the *representation*

RS0006.3.2.4 RS0006.Performance

Data Element Name	Description	Data Type	Units	Range	Req	Notes
maximum_power	Maximum power draw of the drive	Numeric	W	≥ 0	✓	
standby_power	Power draw when the motor is not operating	Numeric	W	≥ 0	✓	
cooling_method	Method used to cool the electronic drive.	<CoolingMethod>			✓	
performance_map	Data group describing drive performance when operating	{PerformanceMap})			✓	

RS0006.3.2.5 RS0006.Performance.PerformanceMap

Data Element Name	Description	Data Type	Units	Range	Req	Notes
grid_variables	Data group describing grid variables for drive performance	{GridVariables}			✓	
lookup_variables	Data group describing lookup variables for drive performance	{LookupVariables}			✓	

RS0006.3.2.6 RS0006.Performance.PerformanceMap.GridVariables

Data Element Name	Description	Data Type	Units	Range	Req	Notes
output_power	Power delivered to the motor	[Numeric]	W	≥ 0	✓	

RS0006.3.2.7 RS0006.Performance.PerformanceMapContinuous.LookupVariables

Data Element Name	Description	Data Type	Units	Range	Req	Notes
efficiency	Efficiency of drive	[Numeric]	-	≥ 0, ≤1.0	✓	Defined as the ratio of electrical output power (to the motor) to electrical input power (into the drive). Input power shall include any power required to provide active air cooling for the drive.

RS0006.4 Verification Rules

Performance data supplied must satisfy the following verification tests.

RS0006.4.1 Drive Efficiency

The output power delivered to the motor ($\dot{P}_m$) must be less than or equal to the input electrical power to the drive ($\dot{P}_d$). That is, the drive efficiency (ε_d) must be less than or equal to unity.

$$\varepsilon_d = \frac{\dot{P}_m}{\dot{P}_d} \leq 1 \qquad \text{(RS0006-1)}$$

Informative note: All losses are assumed to be added as heat according to the cooling_method defined in the *representation*.

RS0006.4.2 Nomenclature

Symbol	Description
$\dot{P}_m$	Output power to motor, W
$\dot{P}_d$	Input power to drive, W
ε_d	Drive efficiency, -

RS0006.5 References

None

RS0006.6 Example (Informative)

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