Schedule – 21 **14th September, 2018**

Chillers

1. SCOPE

This schedule specifies the energy-labelling requirement for chillers working on vapour compression cycle, manufactured in India or imported for sale in India for central cooling and similar use. The schedule covers all types and sizes/capacity for rated voltage up to and including 250 V, 50 Hz AC, for single phase and up to and including 11kV, 50Hz AC for three phase power supply covered under the scope of IS 16590.

For this schedule, the star rating shall be based on Indian Seasonal Energy Efficiency Ratio (ISEER) and full load COP as the prequalification criteria.

This schedule does not apply to:

a) Chillers working on vapour absorption refrigeration cycle

b) Packages with Condensing unit provided with Heat reclaim;

c) Systems with remote condensing unit;

d) Systems with Evaporative cooled condenser;

e) Condenser less chillers; and

f) Heat pumps

2. NORMATIVE REFERENCES

This schedule shall be read in conjunction with the following standard with all amendments, for the purpose of star labelling: -

Number	Standard
1.	IS 16590 : 2017 Water-cooled Chilling Packages Using the Vapour Compression Cycle− Specification

3. TERMINOLOGY

For the purpose of this schedule, the following definitions in addition to those specified in IS 16950 shall apply. However, in case of dispute, the definitions given in IS 16590 shall prevail.

3.1. Bubble Point

Refrigerant liquid saturation temperature at a specified pressure. It is the temperature at which the first bubble of vapour forms in liquid refrigerant (saturated liquid).

3.2. Condenser

A refrigeration system component which condenses refrigerant vapour. Sub-cooling of the refrigerant may occur as well.

3.2.1. Air Cooled Condenser

A refrigeration system component that condenses refrigerant vapour by rejecting heat to air circulated over its heat transfer surface causing a rise in the air temperature. Sub-cooling of the refrigerant may occur as well.

3.2.2. Water-Cooled Condenser

A component which utilizes refrigerant-to-water heat transfer means, causing the refrigerant to condense and the water to be heated. Sub cooling of refrigerant may occur as well.

3.3. Condenser Heat Rejection Capacity

The heat removed by the heat transfer medium of the condenser per unit of time (kW).

3.4. Cooling Capacity

Heat given off from the liquid to the refrigerant per unit of time, (kW)

3.5. Coefficient of Performance (COP)

A ratio of the cooling capacity in kilo watts to the total power input in kilo watts.

Note: Definition of COP refers to chilling units only.

3.6. Dew Point

Refrigerant vapour saturation temperature at a specified pressure. It is the temperature at which the first droplet of liquid forms in refrigerant vapour (saturated vapour). The evaporating and condensing temperatures should correspond to the mean of bubble and dew points.

3.7. Fouling Factor

The thermal resistance due to fouling on the fluid side of the heat transfer surface (m^2 °C /kW).

3.8. Fouling Factor Allowance

Provision for anticipated fouling during use, specified in (m^2 °C /kW)

3.9. Liquid-Chilling Packages

A refrigeration machine using the vapour compression cycle.

NOTE: Liquid-chilling packages may be operated with any type of compressor and be equipped with air-cooled and liquid-cooled, condensers. Liquid chilling packages can be supplied with or without pumps.

3.10. Liquid Refrigerant Temperature

Temperature of the refrigerant entering the expansion device (°C).

3.11. Basic Model Group [BMG] :

A BMG is a set of models that share characteristics which allow the performance of one model to be generally representative of the performance of other models within the group. This group of products does not necessarily have to share discrete performance.

3.12 Performance Rating

Performance data over the operating range of the unit at various load in the form of performance curves or catalogue or output from a computer selection code or as per labelling process defined in this schedule.

NOTE: The published ratings are the ratings declared by the manufacturer in any form as defined.

3.11.1. Standard Rating

A rating based on standard rating conditions. (See table 1)

3.11.2. Application Rating

A rating based on Application Rating Conditions other than Standard rating conditions.

3.12. Standard Barometric Pressure

Barometric pressure of 101.325 kPa.

3.13. Total Power Input of the System

Power input of all components of the unit in operation shall include:

3.13.1. The power input for operation of the compressor (kW)

3.13.2. The power input of all controls, safety devices, starters, and drives of the unit, including devices necessary for correct operation of the refrigerating circuit (for example oil pump, refrigerant pump) (kW).

3.13.3. The power for fans for air cooled liquid chillers (kW).

4. COMPANY REGISTRATION

For participating in the Chiller Star Rating program, the manufacturer has to first register his organization. The manufacturer shall submit to BEE all necessary documents required as per BEE guidelines. BEE after scrutiny and subject to submission of all documents by the manufacturers shall grant company registration to the organization/manufacturers to participate in BEE Chiller labelling program.

5. MODEL REGISTRATION

For registration of a chiller Basic Model Group /model under BEE chiller star rating program, the manufacturer shall submit following documents:-

5.1 Declaration of basic model group, including manufacturers energy performance software reports for all the chillers in the Basic Model Group using the tool/software approved by AHRI / EUROVENT/ILAC/APLAC/COFRAC/NABL.

5.2 One physical test report of a chiller from each BMG containing the COP at 25%,50/%,75% and 100% load, ISEER value as per the test conditions mentioned in IS 16590 along with application for the label.

Additionally, the manufacturers may also register a single chiller model under star labelling program, with a physical test report from NABL/ILAC /APLAC accredited lab tested as per the test conditions mentioned in IS 16590. In the absence of above, BEE may also accept test report from a Test facility accredited by AHRI/EUROVENT/COFRAC etc. having scope of accreditation including the tests mentioned in IS 16590 standards, subject to the conditions that such labs get their lab accredited by their national accreditation body, for tests mentioned as per IS 16590 within a period of one year.

6. TESTING GUIDELINES

The energy performance software report, mentioned at 5.1, shall also contain the COP values at 25 percent, 50 percent,75 percent and 100 percent load and ISEER value as per the test methods and test conditions mentioned in IS 16590.

The physical test report should contain the results of the following parameters in accordance with the test conditions mentioned in IS 16590: -

1. Cooling capacity
2. Power consumption

All the above tests shall be conducted as per the IS 16590. All the measuring instruments shall have accuracy as per clause 10 of IS 16590. The chillers shall also meet Construction and safety requirements as per clause 5.1 and 5.2 of IS 16590. The performance test shall be conducted in the standard rating conditions mentioned in the following table:-

Standard rating conditions

Table 1 Standards rating conditions

	Liquid-cooled	**Air-cooled**
1. Liquid / Air cooled condenser		
Entering temperature	30 °C	Not applicable
ΔT	5 °C	Not applicable
Liquid-side fouling factor allowance	Nominal 0.088 m^2°C/kW	Not applicable
	Not applicable	39°C
Air side fouling factor	Not applicable	0.000m^2 .deg C/kW
2. Evaporator Liquid temperature		
Leaving	7 °C	
T	5 °C	
Evaporator fouling factor allowance :		
Liquid side	Nominal 0.044 m^2°C /kW	
Barometric pressure	101.325 kPa	

The manufacturer shall submit the results of physical test on the prescribed format as given in Annexure B of this Schedule. In addition to the test report, manufacturer shall also submit the data recorded for capacity tests as described in Table 6 of IS16590.

6.1 Acceptance of Test Report from Overseas Laboratories:

BEE shall accept the overseas lab test report for chillers manufactured overseas subject to fulfilling the following requirements:

1) International laboratory shall be accredited by the accreditation body of respective country and the accreditation body shall be the member of ILAC/ APLAC.

2) International laboratory shall be accredited under scope of IEC/ ISO 17025 or equivalent.

3) Scope of accreditation shall cover testing as per IS 16590 and also include all relevant tests as specified in the schedule.

In the absence of above, BEE may also accept test report from a Test facility accredited by AHRI/Eurovent/COFRAC etc. having scope of accreditation including the tests mentioned in IS 16590 standards subject to the conditions that such labs get their lab accredited by their national accreditation body, for tests mentioned as per IS 16590 within a period of one year.

6.2 TOLERANCE LIMIT (Applicable for Check Testing)

a) The tolerances for COP (full load and part load), Cooling Capacity (full load and part load) and ISEER shall be as per IS 16590.
b) There shall be no negative tolerance for the star rating levels and all tested equipment shall meet the minimum threshold for each star rating level.

7 PRE-QUALIFICATION

The chillers shall comply prequalification criteria i.e., every model shall achieve following minimum COP irrespective of the star level to become eligible for star rating plan,

Minimum COP for water cooled (for 100% Load) (Table 2)

kW of cooling	COP required
<260	4.2
>=260 &<530	4.7
>= 530 &<1050	5.0
>=1050 &<1580	5.2
>=1580	5.6

Minimum COP for air cooled (for 100% Load) (Table 3)

kW of cooling	Minimum COP required
<260	*2.4*
>=260	*2.6*

8 STAR RATING PLAN

The water cooled condenser and air cooled condenser chillers shall meet the requirement of ISEER as per the Tables 4 and 5. The star level chosen for the models shall be based on minimum and maximum limits of their relative energy efficiencies of each star level band specified in Table 4 & Table 5.

Table 4: Star Rating levels for water cooled

Table Validity Period 1st January 2019 to 31 December 2020					
kW of cooling	ISEER				
	1 Star	2 Star	3 Star	4 Star	5 Star
<260	4.80	5.20	5.60	6.10	6.60
>=260 & <530	5.00	5.60	6.20	6.80	7.40
>= 530 & < 1050	5.50	6.10	6.70	7.40	8.20
>= 1050 & <1580	5.80	6.50	7.20	7.90	8.70
>=1580	6.00	6.70	7.40	8.20	9.00

Table 5: Star Rating levels for air cooled

Table Validity Period 1st January 2019 to 31 December 2020					
kW of cooling	ISEER				
	1 Star	2 Star	3 Star	4 Star	5 Star
<260	3.00	3.30	3.60	4.00	4.40
>=260	3.10	3.50	3.90	4.30	4.70

All the values shall be recorded to three significant figures. The ISEER and COP shall be rounded off to two significant figures in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

9 FEES

1. Company registration fees shall be Rs.1,00,000(One Lakh Only) which is refundable.

2. Application fee payable on application for assignment of the authority to affix label is INR 2000/ per model- (Rupees two thousand only).

3. Application fee payable on application for degradation/renewal of authority to affix labels is INR 1000/ per model (Rupees one thousand only).

4. Labelling fee for affixation of label on each unit of chiller is INR 3/kW/- (Rupees three per kilowatt of refrigeration only).

10 LABEL DESIGN AND MANNER OF DISPLAY

Placement: The label shall be firmly fixed on chiller and near the nameplate of the chiller.

Material, Dimension and Shape

The label shall be of durable material (aluminium anodized) and be printed as per the size given below. The name plate of corrosion resistant material shall be affixed on the chiller. The markings required by the schedule shall be legible, indelible and durable.

11 CHECK TESTING

The chiller manufacturer shall submit the chiller production schedule and delivery schedule about the chillers which are registered under star rating program, quarterly in the BEE portal.

1. For check testing, BEE will depute their representative to witness check testing in the presence of AHRI/EUROVENT/client. Physical testing to be carried out on a chiller for each basic model group in factory/independent lab(30% of total BMG'S will be tested each year, per manufacturer)

2. During check testing, if the chiller fails:

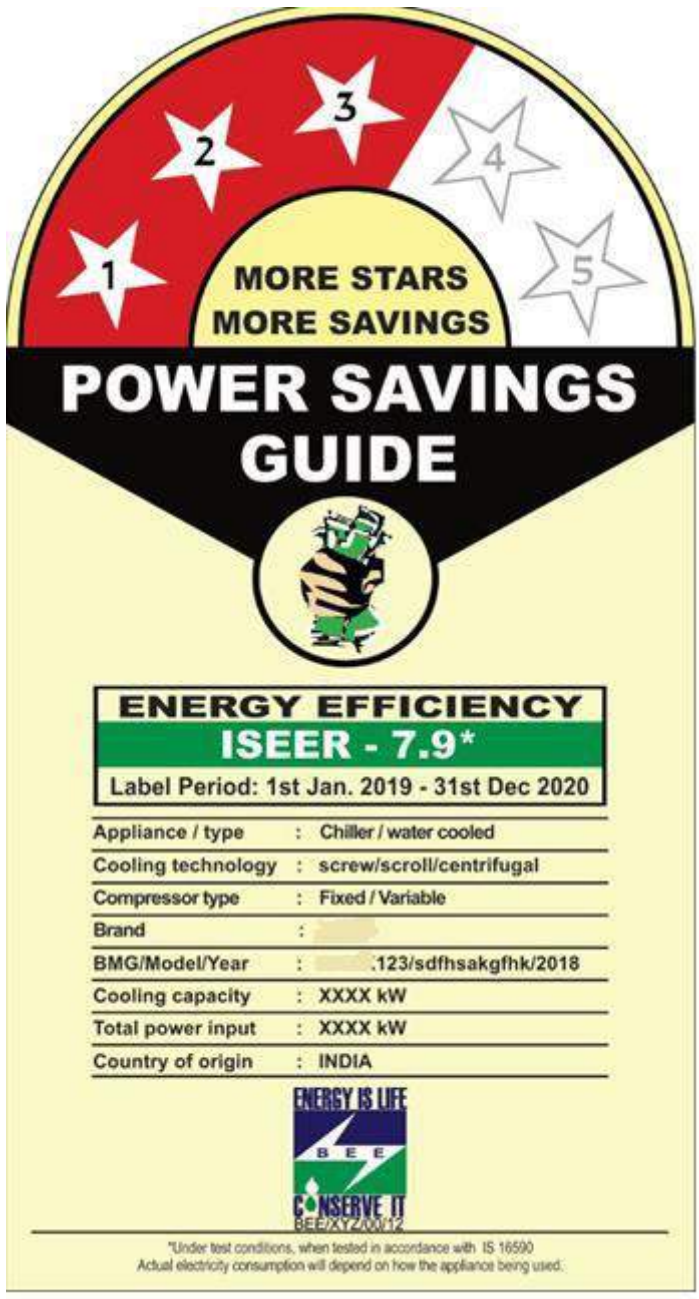
   a) BEE will publish, for the benefit of the consumers, the name of the permittee, brand name, model name or model number, logo and other specific action in any national or regional daily newspaper and in any electronic or in any l other manner as it deems fit within two months;

   b) BEE will cancel the registration of the particular chiller model.

c) intimate to the concerned State Designated Agencies to initiate further adjudication proceedings against the permittee and the trader under section 27 of the Act.

3. Incase of non-compliance as per manufacturer's declaration, the manufacturer has to again submit a fresh application with derated COP/ISEER for the respective the basic model groups.

12 SAMPLE LABEL:



APPENDIX -A

The method to calculate India Seasonal Energy Efficiency Ratio (ISEER) can be referred as per methodology laid out in Annexure B of 'IS 16590: 2017 Water-cooled Chilling Packages Using the Vapour Compression Cycle− Specification'

Purpose

The purpose of this appendix is to define a uniform procedure for the calculation of a single value number that is a representation of the part load efficiency of a chiller. The single value number will be called an India Seasonal Energy Efficiency Ratio or ISEER. It is somewhat like highway and city fuel efficiency for cars, which both are intended to be typical efficiency number, but will likely not exactly match actual efficiencies obtained under actual operating conditions.

Scope

The procedure mentioned in this appendix is only for equipment covered by IS 16590: 2017. The ISEER equation and procedure are intended to be an average representation of a single chiller in a typical commercial application with conventional operating parameters. The procedure is intended to provide a consistent uniform method for calculating the single number for part load operation. A fixed set of operating load points and conditions are defined to allow for equal comparison of products. But allowances have been made to allow for correlation to ambient and building operational and construction standards. The intent is that this single value metric be used by efficiency standards and certification programs that require more than a full load efficiency level.

The equation has been derived to provide a representation of the average part load efficiency for a single chiller only. However, for operating cost and energy analysis it is best to use a comprehensive analysis tool that reflects the actual weather data, building load characteristics, operational hours, economizer capabilities and energy drawn by auxiliaries such as pumps and cooling towers when calculating the applied chiller system efficiency. This becomes increasingly important with multiple chiller systems because individual chillers operating within multiple chiller systems can have significantly different load profiles than a single chiller.

Equation and Definition of Terms

The single value part load rating shall be determined by using the following equation;

$$ISEER = A \times COP_{100\%} + B \times COP_{75\%} + C \times COP_{50\%} + D \times COP_{25\%}$$

where:

$COP_{100\%}$ = COP at full load rating point and operating conditions

$COP_{75\%}$ = COP at 75% load rating point and operating conditions

$COP_{50\%}$ = COP at 50% load rating point and operating conditions

$COP_{25\%}$ = COP at 25% load rating point and operating conditions

A= weighting factor for 100% load

B= weighting factor for 75% load

C= weighting factor for 50% load

D= weighting factor for 25% load

The values of A, B, C, and D are based on the weighted average of the most common building types across climatic zones of India. Values that have been developed are given in: in Table 6.

Table 6 Weighting coefficients A to D for calculation of ISEER

Load rate (%)	100	75	50	25
Weighting Co-efficient	A=6	B=48	C=36	D=10

The ISEER rating requires that the unit efficiency be determined at 100%, 75%, 50% and 25% at the conditions specified in Table 7.

Table 7 Indian Seasonal Energy Efficiency Rating Conditions

	Liquid-cooled	Air-cooled
Evaporator Liquid temperature		
Leaving	7 °C	
Flow	Flow rate equal to a 5 °C Delta Temperature at 100% rating point	
Evaporator fouling factor allowance		
Water side	0.044 m^2.°C /kW	
Condenser fouling factor allowance		
Water side	0.088 m^2.°C/kW	0.000 m^2.°C/kW
Condenser flow	Flow rate equal to a 5 °C Δ T at 100% rating point	Airflow equal to the full load rating

Condenser Entering Temperature		
100% Load	30.0 °C	39.0 °C
75% Load	26.0 °C	32.0 °C
50% Load	23.0 °C	26.0 °C
25% Load	20.0 °C	20.0 °C

For units with proportional unloading performance should be obtained at the 25%, 50%, 75% and 100% points to calculate the ISEER.

If the unit has discrete steps of unloading, but due to its capacity control logic cannot be operated at 75%, 50% or 25% capacity, then the unit should be operated at other load points and the 75%, 50%, or 25% capacity efficiencies should be determined by interpolating between the two operating points that frame the rating point. The required condenser entering temperature at the requested load point should be used and a capacity test run at each unloading stage on either side of the desired part load rating point then should be interpolated to obtain the desired part load point rating. For example, if the unit has capacity stages at 33% and 66% nominal displacement, then the 50% point can be determined by obtaining the capacity and efficiency at the 66% unloading stage at 50% entering temperature and another test, at the 33% unloading stage at the 50% entering temperature. Extrapolation of data shall not be used and the desired rating point must be framed by two actual operating points. An actual chiller capacity point, equal to or less than the required rating point must be used to plot the data. For example, if the minimum actual capacity is 33%, then the curve can be used to determine the 50% capacity point, but not the 25% capacity point.

If a unit cannot be unloaded to the 25%, 50%, or 75% capacity point, then the unit should be run at the minimum step of unloading at the condenser entering temperature based on Table 7 for 25%, 50% or 75% capacity points as required. The efficiency shall then be determined by using the following equation:

$$COP = \frac{Capacity_{min}}{C_d \times Power_{min}}$$

Where,

$Capacity_{min}$ and $Power_{min}$ are the values from the lowest stage of unloading running at the desired part load rating point.

C_d is a degradation factor to account for cycling of the compressor for capacities less than the minimum step of capacity. Cd should be calculated using the following equation:

$$C_d = (-0.13 \times LF) + 1.13$$

The factor LF should be calculated using the following equation:

$$LF = \frac{\left(\frac{\%load}{100}\right) \times (Full\ load\ unit\ capacity)}{Part\ load\ unit\ capacity}$$

Where:

Percent load = standard rating point at 75%, 50% and 25% of the full load.

Full load capacity is the capacity at the full load 100% rating point as defined in table 9 of IS 16590.

The part load capacity of the unit is the capacity obtained when the machine is run at its lowest stage of capacity at the desired load point rating conditions.

For water cooled units where a unit has been selected for operating conditions that will not allow operation at the full load condenser entering fluid conditions, then an ISEER cannot be calculated. For these applications ISEER can be determined, using the same procedures as defined above except that for the full load rating point the machine will be run at the maximum design entering condenser temperature. The 75%, 50% and 25% points will then be run at the temperatures defined in Table 79 unless the unit will not operate at these conditions and then the maximum option temperature shall be used. For example, if a chiller was selected for 30°C full load condenser entering fluid temperature then the 100% point would be determined at a 30°C entering conditions. For ISEER rating the75% would then be determined at a 26 °C entering temperature, the 50% at 23°C and the 25% point at 20°C.

APPENDIX-B

General Information

Manufacturer/Laboratory name	
Address	
Date of receipt	
Laboratory Registration No.	
Validity of the Test laboratory	
Test report No.	
Tested by	
Date of testing	
Reviewed by	

Details of the Chiller tested in addition to Table 6 of IS 16590

Brand name	
Basic Model Group	
Model 1, model 2, model3….	
Serial number	
Year of manufacture	
Measured cooling capacity kW (at 25% load)	
Measured cooling capacity kW (at 50% load)	
Measured cooling capacity kW (at 75% load)	
Measured cooling capacity kW (at 100% load)	
Measured Power consumption at 25 % load	
Measured Power consumption at 50 % load	
Measured Power consumption at 75 % load	
Measured Power consumption at 100 % load	
COP-25%	
COP-50%	
COP-75%	
COP-100%	
ISEER	