

CHILLER SCHEDULES

INTRODUCTION

NATSPEC worksections cover a wide range of chillers including those with centrifugal, screw or scroll compressors, air or water cooling and heat recovery. Absorption chillers are also included. The chiller worksections also include options for specifying requirements such as IPLV and NPLV. This TECHnote aims to help specifiers to complete the included schedules.

Note that NCC Deemed-to-Satisfy requirements deal with conventional, non-heat recovery duty and make no provision for heat recovery or gas-fired chillers which may have poorer cooling performance but better overall heating-cooling energy efficiency. Rather than using NCC Deemed-to-Satisfy values, these should be handled using NCC performance requirements verified by one of the NCC verification methods e.g. *JV3 Verification using a reference building*.

IPLV and NPLV

In most projects, the refrigeration chillers are the largest electrical load and the largest, or one of the largest, energy consumers. For this reason, BCA J5.10 mandates minimum Deemed-to-Satisfy COP to AHRI 551/591 at full refrigerant load and for integrated part load (referred to as IPLV in AHRI 551/591). AHRI 551/591 assumes a typical load profile in which the chiller runs for 1% of the time at 100% capacity, 42% at 75% capacity, 45% at 50% capacity and 12% at 25% capacity. As such, it is a measure of the long-term energy consumption of chillers and provides a more (but not completely) realistic assessment of overall energy use than COP at 100% capacity alone. This value is required to demonstrate compliance with MEPS.

For a more accurate comparison of chiller energy performance, consider specifying NPLV performance as well as the mandatory IPLV. NPLV may be used to specify higher performance than the minimum set by the NCC and for performance solutions to the NCC. NPLV is based on the same capacity percentages but with time percentages derived from annual energy modelling for the specific project. In some cases, such as a chiller plant with chillers of different capacities, separate time percentages will be required for each chiller. If specifying NPLV, consider also including non-standard condenser water conditions at part load.

Life cycle cost analysis

For a more comprehensive life cycle cost analysis of chillers, consider calling, in *0121 Tendering*, for tenderers to provide alternative values for these performance items where the equipment offered by the proposed chiller manufacturer does not comply exactly with the design performance requirements. For the purposes of tender evaluation only, consider requesting the following additional information from tenderers based on nominated unit energy cost (\$/kW.h and \$/kV.A):

- Annual equivalent full load running time (h).
- Scrap value (\$).
- Annual maintenance charges (\$).
- Provide relevant economic factors such as discount rate and present worth factor for evaluation.

Noise levels

The chiller schedules provide the options of specifying either by maximum sound power or maximum sound pressure level and as either a dB(A) weighted value or dB by frequency spectrum. Delete the options not specified.

The options specified will depend on data available from manufacturers and used for the acoustic design. If specifying sound power, the reference value (usually dB re 10^{-12} watts) must be included. For sound pressure, include the test conditions. These are typically measured at 1.5 m horizontally at any point around the chiller in free field, but other conditions are possible such as at 3 m instead of 1.5 m or vertically as well as horizontally (especially for air cooled chillers). See also AHRI 575.

Adapting schedules for chiller options

The options in chiller types covered in NATSPEC worksections mean that creating a schedule that covers all options would require including many redundant and potentially conflicting items. For this reason, the chiller worksections only include schedules for a default chiller type.

The following explains how to adapt the default schedule to other chiller options. It is relevant to the following worksections:

- *0711 Chillers – combined.*
- *0716 Chillers – centrifugal.*
- *0717 Chillers - water cooled screw.*

0718 Chillers - air cooled screw and scroll and *0719 Chillers – absorption* include all options in a single **Chillers schedule** so the following does not apply to those worksections.

Definitions

- COP: Coefficient of performance ($W_r/W_{\text{input power}}$). The ratio of the net refrigerating capacity (W_r) to the total input power ($W_{\text{input power}}$) at any given set of rating conditions.
- IPLV: Integrated part-load value to AHRI 551/591. It has the same meaning as IPLV.SI in AHRI 551/591.
- MEPS: Minimum energy performance standard to the NCC.
- NPLV: Non-standard part-load value to AHRI 551/591. It has the same meaning as NPLV.SI in AHRI 551/591.

Relevant worksections

- *0711 Chillers – combined.*
- *0716 Chillers – centrifugal.*
- *0717 Chillers - water cooled screw.*
- *0718 Chillers - air cooled screw and scroll.*
- *0719 Chillers – absorption*

Relevant standards

- AHRI 551/591
Performance rating of water chilling and heat pump water-heating packages using the vapor compression cycle
- AHRI 575 Method of measuring machinery sound within an equipment space

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Heat recovery chillers

Heat recovery chillers have two condensers (sometimes called double bundle condensers), one for cooling tower water and the other for heat recovery (heating) water. For heat recovery chillers, duplicate the Water cooled condenser rows in the schedule and rename each set Cooling tower condenser and Heat recovery condenser.

Air cooled chillers

For air cooled chillers, delete the Water cooled condenser rows in the schedule and replace with rows applicable to air cooled condensers. Note the following:

- Air cooled condenser: Fan external static pressure (Pa) including the effect of additional acoustic treatment if applicable.
- Air cooled condenser: Sub cooling: Specify actual subcooling required at outlet of the subcooling coil. Request manufacturer's data on pressure drop through both condensing and subcooling coils and ensure satisfactory pressure drop figures.
- Air cooled condenser: Heat rejection (kW): Specify air cooled condenser capacity on heat rejection figures preferably supplied by the manufacturer of the associated compressor units. Specify altitude of installation relative to sea level. Check that the tolerances permitted by AHRI 460 are acceptable or alternatively, specify a minimum heat rejection capacity.
- Air cooled condenser: Altitude above sea level (m). For non-sea level locations to enable manufacturer to de-rate condenser performance.

Replacement schedules

The table below shows changes in the Water cooled condenser rows in the **Chillers schedule** to accommodate heat recovery and air cooled chillers. Highlighted text indicates new or replacement rows in the left hand column of the **Chillers schedule**. All other rows remain unaltered.

Default table	Heat recovery chiller	Air cooled chiller
Water cooled condenser: Water flow rate (L/s)	Cooling tower condenser: Water flow rate (L/s)	Air cooled condenser: Total air flow rate (L/s)
Water cooled condenser: Water entering temperature (°C)	Cooling tower condenser: Water entering temperature (°C)	Air cooled condenser: Maximum coil face velocity (m/s)
Water cooled condenser: Water leaving temperature (°C)	Cooling tower condenser: Water leaving temperature (°C)	Air cooled condenser: Fan external static pressure (Pa)
Water cooled condenser: Water velocity (maximum (m/s))	Cooling tower condenser: Water velocity (maximum (m/s))	Air cooled condenser: Entering air dry bulb temperature (°C)
Water cooled condenser: Maximum water pressure drop at design flow rate (kPa)	Cooling tower condenser: Maximum water pressure drop at design flow rate (kPa)	Air cooled condenser: Maximum condensing temperature (°C)
Water cooled condenser: Fouling factor (m ² K/kW)	Cooling tower condenser: Fouling factor (m ² K/kW)	Air cooled condenser: Sub cooling (K)
Water cooled condenser: Marine water boxes	Cooling tower condenser: Marine water boxes	Air cooled condenser: Heat rejection (kW)
Water cooled condenser: Corrosion protection of tube plates and water boxes	Cooling tower condenser: Corrosion protection of tube plates and water boxes	Air cooled condenser: Altitude above sea level (m)
	Heat recovery condenser: Water flow rate (L/s)	Air cooled condenser: Fan impeller type
	Heat recovery condenser: Water entering temperature (°C)	Air cooled condenser: Fan impeller diameter (mm)
	Heat recovery condenser: Water leaving temperature (°C)	Air cooled condenser: Fan external static pressure (Pa)
	Heat recovery condenser: Water velocity (maximum (m/s))	Air cooled condenser: Additional fan corrosion protection
	Heat recovery condenser: Maximum water pressure drop at design flow rate (kPa)	Air cooled condenser: Additional coil corrosion protection
	Heat recovery condenser: Fouling factor (m ² K/kW)	
	Heat recovery condenser: Marine water boxes	
	Heat recovery condenser: Corrosion protection of tube plates and water boxes	