15680-2

MECHANICAL DESIGN MANUAL SUMMARY SHEET

Date: June 06, 1995

Subject: Chiller Plant Design

Description: Criteria and guidelines for the selection and application of central chiller plant equipment.

CSI Sections: 15681-15730

Prepared By: James K. Edward

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CENTRAL CHILLER PLANT DESIGN

Chillers

Reciprocating - Air-cooled, range from 20 - 100 tons in capacity, average efficiency of 1.1 kW/Ton.

Centrifugal - Water-cooled, range from 150 - 2,000 tons, low pressure machines using R123 or medium pressure R134A. Design uses a constant speed impeller with inlet vanes for capacity control. Efficiencies down to .55 kW/Ton can be expected. Being low pressure, a pump-out unit is required to remove refrigerant. Some manufacturers offer an engine driven drive line from 400 - 2,000 Tons.

Helical Rotary - (Screw) Water-cooled, ranges of 100 - 600 Tons and 1000 - 1250 tons. Larger custom machines can be field assembled up to 10,000 Tons, R22 high pressure machines. Use a screw compressor with a slide valve for capacity control. Efficiencies down to .57 kW/Ton in the smaller machines and .60 kW/Ton in the larger ones can be expected. A pump out unit is not required and refrigerant can be stored in the condenser bundle.

Absorption - Generally two-stage using steam pressures of 115# - 135#. Efficiency of 10#/Ton can be expected. Single stage machines are used for low pressure (15#-60#) requiring up to 19#/Ton.

Selection

The installed air-conditioning coil capacity is the basis for selection of chiller size. An internal *building* diversity factor can be taken in most VAV systems relative to occupancy and orientation. In single building systems a diversity of 80% may be common. The designer needs to be aware of building use and outdoor air requirements, prior to making selections in schematic and design development phases of the project. Campus and district systems may also use a *site* diversity since buildings may have different orientations, uses, and hours of occupancy; their peaks do not coincide. This may also be 80% at times.

While diversities may be used to reduce plant capacity, the designer must also consider that the system itself adds load to the plant. An open drive motor will add heat to the space, while a hermetically sealed will subtract from the chiller capacity. Pump and transmission heat should also be considered. A single building may see a 5% increase and campus systems up to 15% that must be considered in sizing the chiller.

Example:

Air-condition loads (tons)	6500
Internal building diversity	80%
Site distribution diversity	80%
Overall Diversity	64%
Max instantaneous load (tons)	4160
pump/transmission	10%
Selection	4576
chillers	4 @ 1150
Installed capacity (tons)	4600

Cooling Towers

Induced Draft - These towers use a single propeller type fan and draw air thru the fill. configurations include cross-flow which pulls air in from the sides across the fill and counter-flow which draws air from the bottom of the unit and pulls it up thru horizontal fill. Motors are generally mounted in the air-stream using either belt or shaft drive lines.

Blow-thru - Blow thru are similar to counter-flow towers, however centrifugal direct drive blowers are used at the base of the units to force air up thru the fill. These units are used for indoor applications or in areas of tight enclosures.

Selection

Towers are first selected based on connected chiller loads. Selection of the towers uses the desired flow and in/out temperatures at a given wet bulb. The designer needs to consider possible operating ambient temperatures and condenser flows when making this selection. It is common for the designer to add 2 Degrees to the wet-bulb temperature to ensure adequate capacity. Other selection considerations are the location of the slump indoors, tower slump outlet, and winter operation. These items are covered under *Cooling Tower Operation* by Jeff Newcomb, P.E. KJWW Engineering.

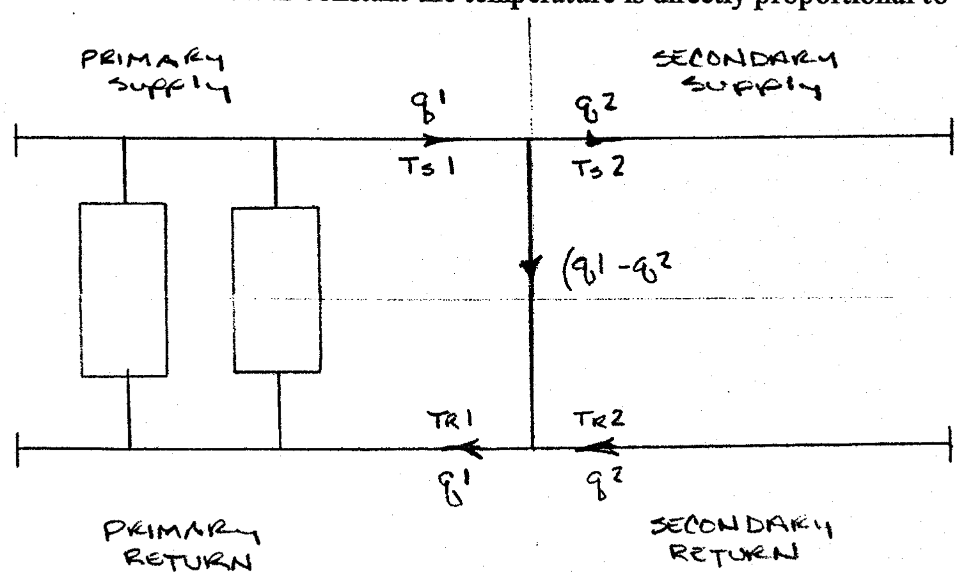
The Loop

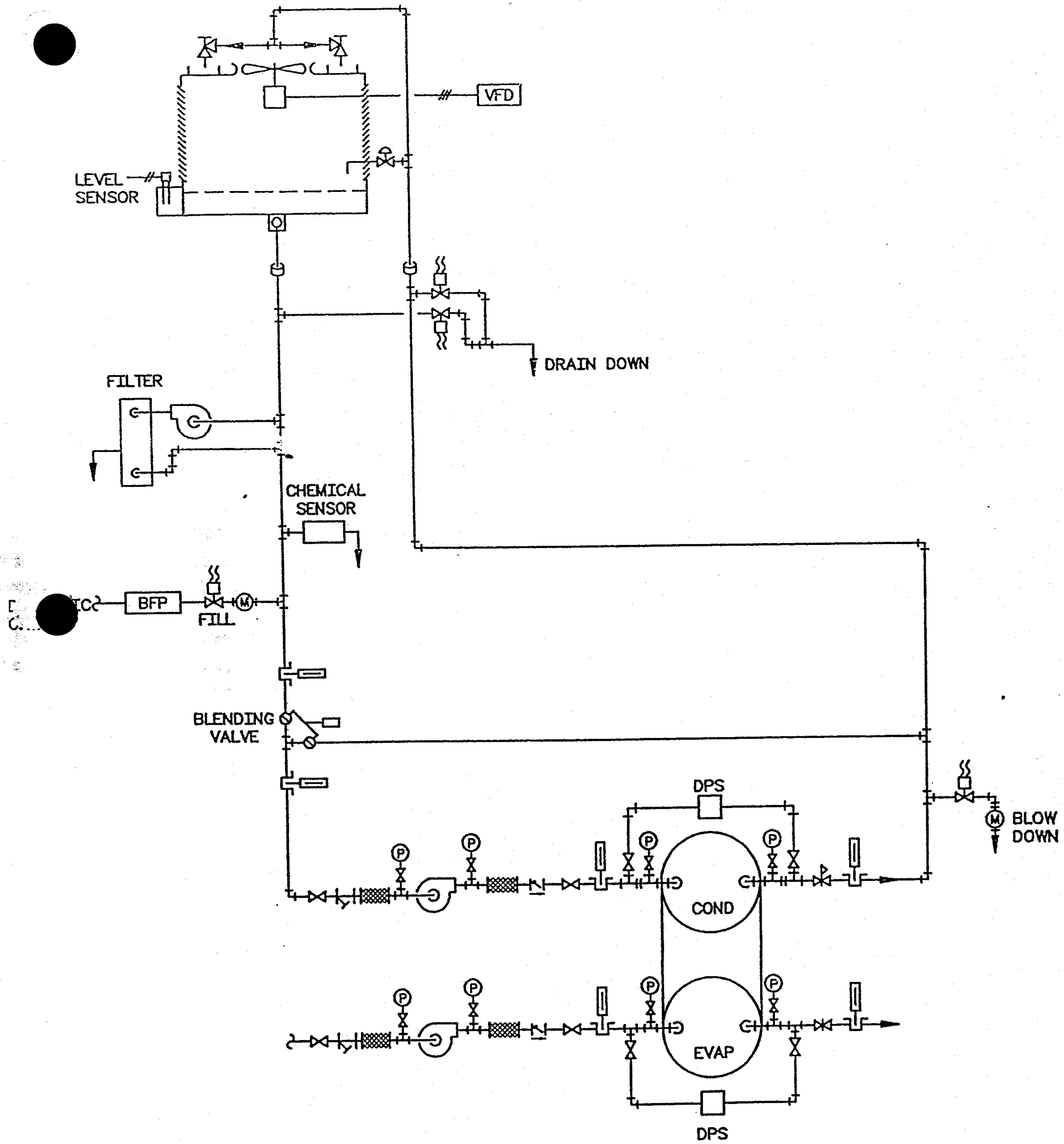
The flow diagram is considered by many to be the most important drawing as related to the chilled water plant. While it is not common, a contractor should be able to bid, construct, and operate a chiller plant using a simple flow diagram.

Chiller and tower flow requirements are generally given with the vendor selections. These flows are commonly seen as 2.5 GPM/Ton for evaporator and 3.0 GPM/Ton for the condenser bundles (absorption machines require 5 GPM/Ton). These flows are considered the primary circuit and air condition loads the secondary. GPM for the air-conditioning loads are derived from Btuh, taken from a psych chart, divided by (500 X Delta T).

The primary circuit pumps are selected for the flow and head required by the tower/chiller + friction. Condenser head calculations only require the friction loss be considered in supply/return lines that feed the tower. Head must be added for the elevation of the distribution nozzles above the basin outlet. Secondary pumps are selected for flow and head/pipe loss as calculated to the furthest coil.

The *loop* most commonly seen is called a decouple loop. this uses a supply and return header with a decoupling line and five temperature senors for flow control. The decouple line is sized for the flow of one chiller or 50% of the total plant. The headers are also referred to as the primary circuit. In this system the flows through the chillers and through the distribution (secondary circuit) are independent of each other. Since the resistance through the chillers is constant, the flows through are also constant. The flow rates through the secondary circuit, however, can be higher or lower without disturbing the constant flow through the chillers, yet having an impact on temperature. Under normal conditions the flow through the chillers should be higher than the secondary circuit. The flow through the decouple line being the difference. The secondary leaving temperature is then equal to the chiller supply temperature and the chiller inlet temperature is lower than the secondary return. Since the chiller flow is constant the temperature is directly proportional to chiller loading.





COOLING TOWER PIPING
SINGLE TOWER

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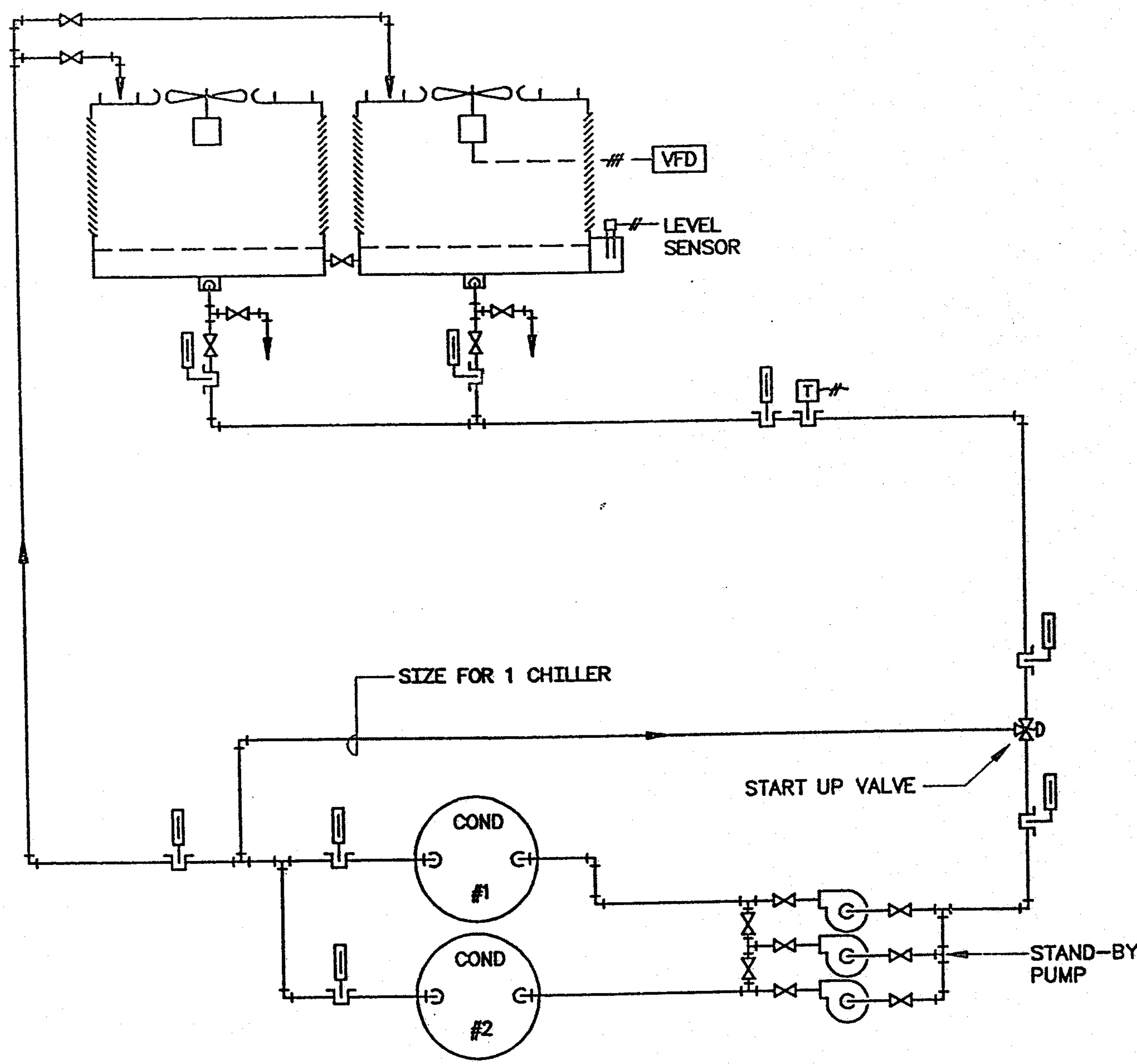

MULTIPLE SYSTEMS – SINGLE LINE
(AUXILLARY COMPONENTS NOT SHOWN)