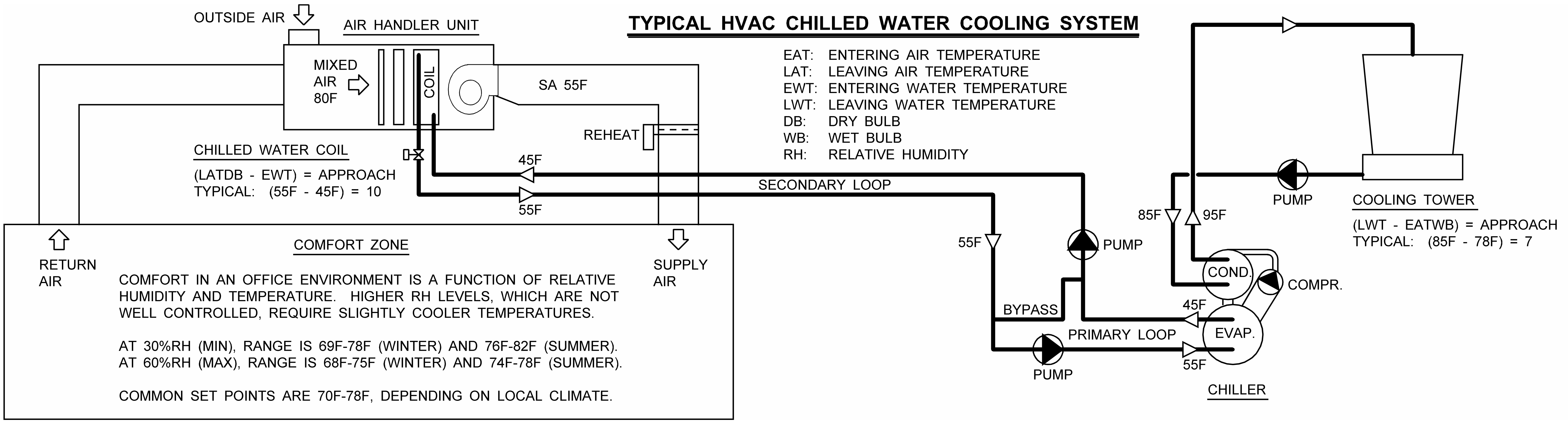

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INTRODUCTION: The diagram illustrates thermal transfer of heat energy from the "comfort zone" to the cooling tower, where that heat is ejected into the atmosphere. It can be said that the purpose of all this is "get the heat to move from in here to out there." Balanced flow rates are essential to achieve thermal balance with desired capacities and efficiencies across all various components. It is basic physics.

Design engineers develop system parameters and design values specified in the construction documents. Manufacturers' submittal data sheets will provide specific flow and pressure data for the components. Note that the values listed on this page are "general practices" for a common chilled water application, and are used only for illustration. Design intent will have variations and special applications specific to each project.

Likewise, the following descriptions are basic and limited. More complete descriptions are within this AABC Technicians Manual. There are abundant web sources for further reading to learn design theory and practice for all components.

APPROACH: A spread of two temperatures used as a baseline reference in establishing thermal transfer performance. A performance test of a component is best when at the intended approach, but this "ideal" condition is not always available and/or stable in field testing. Approach becomes less relevant as system components modulate down from a full load condition.

COMFORT ZONE: A range of relative humidity and dry bulb temperatures at which the conditioned space is maintained for human comfort. Multiple zones may have individual thermostat control of dedicated reheat coils and/or air volume control boxes.

SUPPLY AIR: Temperature is controlled as required to meet thermostat set point. Normal minimum temperature into an occupied space is 55°. Human skin may feel an uncomfortable chilling affect if supply air is more than 20° colder then room temperature.

RETURN AIR: Commonly in the range of 75° to 78°. However, if RA terminals are installed in the ceiling along with SA terminals, return air temperature may be colder than room temperature due to short-circuiting of some SA along the ceiling surface into the RA terminals.

OUTSIDE AIR: OSA is at minimum that is required to maintain indoor air quality during peak load conditions. During milder seasons, there may be an "economizer cycle" capability, which will open the OSA when OSA enthalpy is appreciably lower than RA enthalpy, decreasing or even eliminating load on the CHW system.

AIR HANDLER CHW COIL: Transfers heat from the air stream into the water stream. The coil surface is dry during 100% "sensible" cooling, when entering air dew point temperature is lower than entering CHW temperature. A coil that is wet with condensate is providing "latent" cooling, and the amount of condensate is directly proportional to the amount of latent cooling. The latent process may be increased for dehumidification, with reheat then provided to maintain the comfort zone. (Note that dehumidification and reheat will increase the cooling tower load.) CHW coils must be piped with CHWS entering the leaving air side of the coil (counter-flow) to achieve the rated latent cooling capability. Coils are sized for 400 to 500 FPM face velocity. Above 500 FPM the air may carry condensate off the coil surface and into the fan and duct system. Below 400 FPM air turbulence may start to decrease, loosing thermal transfer efficiency. Depending on coil fin/tube density, below 100 FPM turbulence will be lost and most of the air molecules may not actually contact the coil fin surfaces, which will result in a loss of useful cooling.

CHILLED WATER SECONDARY LOOP: Flow rate is infinitely variable depending on actual cooling load. The loop is normally designed for supply/return differential pressure (DP) at 15 PSIG, as measured 2/3 of distance from pumping plant to furthest air handler. Actual DP is dependent on limitations of standard pipe sizes, component pressure drops, and amount of restriction imposed during balancing of coil flow rates. Final balanced DP set point will normally be at a point between 10 PSIG and 20 PSIG. Higher supply/return DP control pressure will be necessary if the DP sensor is located within the central plant.

CHILLED WATER PRIMARY LOOP: Operates at a "constant" flow rate based on number of chillers that are operating. Supply/return differential pressure is as required and measured across the chiller evaporator.

BYPASS: The bypass pipe may also be referred to as a "decoupler" or "bridge". Its purpose is to compensate for an ever-present flow differential of the secondary and primary loops. There are important considerations that should be examined ASAP to give time for piping corrections, if necessary: 1) Verify that the bypass is connected at appropriate locations in the loop piping. 2) Verify that the return connection into the chiller is not too close to the bypass connection, whereby the chiller will receive mostly bypass flow instead of return flow from the secondary loop. 3) Very rarely is there a need to have a valve of any type in the bypass pipe, and never a check valve. 4) There should be at least one 90 degree elbow in the bypass to disperse laminar flow conditions; otherwise it is possible to have flow in both directions at the same time (especially as flow rates in both loops become nearly equal), which may confuse the controlling temperature sensor or flow meter in the bypass pipe. 5) There is not an appreciable differential pressure across some of the supply and return piping within the central plant, due to the free-flow bypass pipe; therefore, a supply pipe to a CHW coil within the central plant must be connected downstream of the secondary loop pump, not to the primary loop supply pipe.

CHILLER: We may think of the chiller machine as nothing more than a means to raise the range of temperatures usable within the building, up to a range of temperatures usable in the much warmer and wetter conditions outside the building. The chiller is a big, finicky, noisy, impressive, energy-hungry and expensive machine, which demands a lot of attention and wants things "just right." But all it does is make a transfer of about forty degrees in temperature conditions from one water circuit to another — a huge chunk of thermal energy.

CONDENSER WATER: Transfers thermal energy from the chiller condenser to the cooling tower.

COOLING TOWER: After all the various thermal transfer and transporting processes across coils and chillers, fans and pumps, all heat removed and transferred from the building is finally ejected into the atmosphere at the cooling tower. As water molecules evaporate from the water stream into the air, "latent heat of vaporization" carries heat energy out of the remaining water stream into the outside atmosphere. Cooling tower performance is very dependent on moisture content of the entering air for evaporation of water molecules. Dryer air, as determined with lower wet bulb temperature, enables more absorption of water molecules and therefore more thermal transfer. Actual dry bulb air temperature has little effect on CT performance. As the CT operates nearer to its rated capacity, flow rates and temperature conditions are just as critical as they are for the chiller, and likewise, the whole system may be compromised if the CT is deficient. Unfortunately, a decrease in available performance may not become evident until a hot summer period, when building cooling load is maximum and entering air wet bulb conditions become elevated to peak design conditions. It is then realized that the "cooling" does take place at the cooling tower.