# Don't base load one chiller and trim with the other.

**In a base-trim unloading plant, only one chiller would unload as total system is decreased. When the total system load is decreased to the point where n-1 chillers were required, the unloading chiller would secure and the remaining chillers would service the system load. As system load continues to decrease, another individual chiller would begin to unload, and the cycle would continue.**

**To understand, one must remember the fundamental capacity equation:**

$$Capacity = GPM * \left(\frac{\Delta T}{24}\right)$$

**Because the ∆T of the unloading chiller would necessarily be different than the ∆T of the chillers at 100% load, there is no way to properly deliver chilled water at the required temperature to the building's loads. The figure shows a simple two (2) chiller plant operating with both chillers equally loaded.**

**In a *constant speed* primary plant, when the capacity of the "Trim" chiller decreases, ∆T will decrease as well. This will result in an unbalanced situation at part load. The figure shows a 1000 ton plant set at nominal AHRI temperatures and flow rates 44°F LCWT, 2.4 gpm/ton & 85°F ECdWT, 3.0 gpm/ton; operating using the Base-Trim Chiller control method. If the total system load drops to 60%, the building still requires 600 Tons worth of cooling. This should result in one chiller operating at 500 tons and the "Trim" chiller operating at 100 tons, or 20% capacity. Because this chilled water is headed out to a common load, all return water should be the same temperature. Assuming the system was designed around a 10°F ∆T at full load, 60% load should result in 50°F water returning to the chillers. Because of the fundamental capacity equation, we know the ∆T across each evaporator:**

$$Base\ Chiller: 500\ Tons = 1200\ gpm * \left(\frac{X}{24}\right)$$

$$Trim\ Chiller: 100\ Tons = 1200\ gpm * \left(\frac{Y}{24}\right)$$

**The ∆T across the Base chiller will be 10°F and 2°F across the trim chiller. Because the return chilled water temperature is determined by demand in the space, the chiller cannot unload and maintain a consistent LCWT with the other fully loaded chillers. Similar problems result from series flow chillers.**

**Complicated flow balancing can solve this problem, where flow control valves balance the flow between chillers to produce the desired common LCWT set point. Such systems are difficult to install and even harder to control. Additionally, a variable primary flow scheme where each chiller has a dedicated pump could be arranged to make the base/trim system work, however that requires installation of additional pumps and piping, increasing first installed**

**cost. Additionally, if variable primary flow is used as a method to obtain Base/Trim staging strategy, minimum flow through the chilled water pumps must be considered. If the chiller requires less flow than the pump can deliver, the ΔT across the trim chiller will be too high, resulting in more capacity than is required. This is less of a concern with sequenced unloading, because it would be rare for a chiller to operate at such a low load/flow condition.**

**A further issue with a plant designed around base-trim unloading is that the system must be designed around the lower LCWT. For a centrifugal, this means designing a system to be able to support higher lift, which negatively impacts efficiency whenever the high lift conditions are absent.**