20 June 2005

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NOTES ON AIR-CONDITIONING DUTY CYCLING vs LEAD – LAG CONTROL

The capacity stand-by philosophy adopted by a network operating active cooling plant in small telecommunications environments could be:

1. **Without Stand-by** cooling capacity using one or more capacity blocks. With this scheme the total installed cooling capacity is dimensioned to be just larger than the station heat load.

   When the total cooling capacity is achieved with a single item of plant this unit will be on permanent duty. When the total capacity is achieved with more than one items of plant the first unit at any time will be on permanent duty with second and further units on permanent or intermittent duty to meet the varying heat load requirements.

   Permanent duty in this context means active cooling plant switched on with air-handling in process but not necessarily compressor running. Compressor operation duty remains under thermostat control to meet set cooling targets.

   Lower initial cost will be a motivation to make installations without stand-by cooling capacity with the penalty that any cooling plant failure or dimensioning problem will result in loss of nework on-air time. Repair work or upgrading of cooling capacity will in this type of installation always be made as 'emergency' work requiring immediate action.

   Since active cooling plant represent large fractions of the total site electrical load, planning decisions relating to stand-by cooling capacity often plays a strong role in the dimensioning of related electrical stand-by power plant.

2. **With Stand-by** capacity in a 1 + 1 or n + 1 configuration. With this scheme the unit (units for n + 1) installed cooling capacity is dimensioned to be just larger than the total station heat load and then increased with an additional stand-by unit of the same cooling capacity.

   In a 1 + 1 scheme, one unit will normally be operational and one complete unit on stand-by while dual operation is only called for when the main unit fails to meet the heat load.

   In a 2 + 1 scheme any two units will normally be operational with a complete third unit on stand-by. Operation of the third unit then remains available for when any one of the units in operation should fail. Service duty is rotated across all three units.

   A stand-by cooling capacity philosophy requires higher initial capital investment for:

   - Always having stand-by plant available on site and therefore no need to make emergency repair trips to a site at an inopportune time of the day, week etc;

   - Limiting the instances where network availability is lost due to overheating to the absolute exception.

A. LEAD – LAG CONTROL

A.1 In single cooling plant installations of course no control, except for the machine resident scheme for air-handling and compressor operation, is necessary.

A.2 Lead-lag control is often used in installations **without stand-by** where more than one unit of capacity is used to achieve the required total cooling capacity by staggering operation of the units in stages. Very often the responsibility to first take load is shared between cooling plant by way of regular swapping of thermostat set point values or a similar manual process. Lead-lag control in installations without stand-by are often confused with true stand-by configurations simply on the basis that the site may be equipped with two blocks of cooling capacity.

A.3 Where multiple units of cooling capacity is used in a lead – lag configuration to meet the total heat load within a system, the situation could occur where:

- Due to the loss of a single element of cooling the heat load will dominate the remaining cooling capacity that will lead to thermal runaway and overheating;

- If the cooling plant is over dimensioned or ambient conditions are favourable, failure of a single block of cooling capacity will go undetected for until a second should fail, then again with resulting overheating.

A.4 For systems **with true stand-by** capacity (1 + 1 or other) that are operated on lead – lag control, early warning of unit failure or loss of capacity may not be recorded until a second failure occurs and thereby undermining one of the key benefits of the investment in stand-by capacity.

A.5 Similarly, equal service life sharing between cooling plant in an installation of this nature is not easily achieved.

A.6 Remember that stand-by units that are not exercised regularly can not be relied on to operate at capacity when called to duty and;

A.7 Cooling plant has a technological or product life which means that the best service and serviceability is available from a unit earlier rather than later in its chronological life.

B. DUTY CYCLING CONTROL

B.1 Duty cycling control pre-supposes a **with stand-by** cooling installation operational philosophy.

B.2 By cycling operation between the two (or more) cooling plants and always having the second system fully available for stand-by, the capability of an individual unit is in each operating cycle proved against the total heat load. A dual operation alarm should in this configuration be taken as an early indication of the fact that stand-by machine operation is required in order to meet he total cooling requirement. This could point to:

- A fault or under capacity on one of the cooling plant units;
- Under dimensioning of the cooling plant - with initial design or through growth of equipment on site;
- Temporary particularly strenuous environmental conditions.

any of which can be rectified with the next scheduled site maintenance visit since spare capacity is available and automatically put into service by the control scheme.

B.3 Any performance deviation in cooling plant will be recorded as soon as it occurs.

B.4 Duty cycling control ensures equal service life sharing between cooling plant in an installation.

B.5 The correct cooling capacity applied to the specific site heat load allows the air-conditioning unit to operate within comfortable design margins and correctly for maximum service life. Should for instance in a non-controlled stand-by installation, two units be allowed to operate at the same time and therefore apply excessive cooling capacity to the available site heat load, this situation will manifest as over capacity on cooling. (Refer related Notes on Low Ambient Control.) Air-conditioning units applied in over capacity application where there is insufficient heat loading to fully evaporate the refrigerant in the evaporation cycle is operated outside of the design constraints and will not achieve full service life.

B.6 Duty cycling requires an investment in control equipment that is often more advanced than lead-lag schemes and therefore cost more. Cost/return analysis on this type of investment needs to take account of the fact that these schemes often also provide for general cooling system alarms, station condition monitoring or logging and integral fire shut-off and emergency ventilation control.

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