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# Designing for reliability

The need to address all relevant design parameters has been discussed in other chapters, in which the general topic either related to design parameters or was more specifically directed to a given subsystem or component.

Reliability is one of the fundamental parameters of the overall integrated building system. And as with any design parameter, the only way in which reliability can be achieved in the integrated system is that it be addressed in the design of all the subsystems and in the selection of all the components that make up the total system. Properly directed sensitivity to the reliability parameter can result not only in vastly improved performance but, in many cases, in reduced investment costs. Improperly directed efforts often result in redundancy and increased costs with little degree of success.

### Consider these basics

Consider some of the logic behind these statements.

- The fewer the number of devices a system contains, the greater is the statistical reliability. Thus, the systems designer should always strive to accomplish the required performance with the fewest number of components. Needless to say, there is a strong likelihood that fewer components will cost less money.
- Major machinery should be matched to the anticipated profiles of the system loads. In heating and cooling systems, load analysis generally reveals that the so-called design load is realized in an extremely small portion of the total operating hours. With proper attention to the basic conversion and distribution system design, the components can be selected in such sizes that they can be staged in their operation to match the load profiles. With this approach, a high degree of reliability can be achieved with little or no investment in redundancy.

### Design for demand, base loads

One example may be the selection of water chillers. In a commercial or institutional building, no one designing for reliability would provide a single chiller (although we have all seen cases in which this has been done). One option that has been employed is to provide a redundant or standby chiller also having the capacity to satisfy the design demand load. A far less costly option in most cases would be to install multiple chillers whose summary capacity is equal to the design load requirements. By matching the sizes of the machines to the part-load profile steps, complete standby capacity of one unit could be available all hours of the year except for those few that the last increment of load is required. An additional advantage of the load match increments is that more costly energy-efficient units can be purchased for the base load units that produce the majority of the ton-hours of cooling, and a less costly unit can be applied to the peaking duty. Properly applied, this type of system can achieve the same degree of reliability as could be attained with a system of 100 percent redundancy.

Another example of machinery selection for reliability is in pumping systems. If the fluid system is designed to vary the flow in proportion to load, multiple pumping without redundant or purely standby machinery can be utilized to achieve a high degree of reliability. Fringe benefits are generally a reduction in pumping energy (operating costs) and a reduction in investment cost, the latter resulting from the reduced installed cost of two-way valves in lieu of three-way valves and the obvious cost reduction related to the elimination of standby equipment.

### Avoid redundant services

It is all too common for building owners to establish guidelines for reliability for their systems designers based on a reaction to previous problems. In some cases, designers themselves develop such reaction approaches. It is this reaction approach that has been responsible for the concept of redundant apparatus. One of the common examples is the concept of 100 percent standby electrical service, whether this service be by an on-site generating unit or from a second utility service from a different substation. In either case, the cost of the second source is borne by the building investment. This solution, however, although costly, does not protect against faults or failures in the electrical system within the building! With a proper understanding of the problem, an improved degree of reliability can be achieved by the installation of less standby equipment with separate circuiting to the more critical loads, again with significant reductions in investment cost.

### Planned maintenance is vital

If the designer successfully addresses the reliability parameter, the next step in achieving the results rests with the building owner or operator. No system or machinery can be expected to operate reliably unless properly maintained. The term "properly maintained" implies a planned maintenance program. The only other option—breakdown maintenance—by its very wording implies lack of reliability of the broken down device. This, in turn, mandates that the device that will be allowed to break down must be accompanied by a standby unit if the overall system is to be reliable.

Thus, addressing the parameter of reliability inevitably leads to the mature approach of so-called life-cycle costing, integrating the investment cost decisions with those of owning and operating. It is the engineering practitioners who should gain a comprehension of the problem of reliability and give the needed advice and direction to the developers and owners of buildings.