air needs are defined by the air quality, quantity, and level of pressure required by the end uses in your plant. Assessing needs carefully will ensure that a compressed air system is configured properly.

Air Quality

As illustrated in the following table, compressed air quality ranges from plant air to breathing air.

Quality	Applications
Plant Air	Air tools, general plant air
Instrument Air	Laboratories, paint spraying, powder coating, climate control
Process Air	Food and pharmaceutical process air, electronics
Breathing Air	Hospital air systems, diving tank refill stations, respirators for cleaning and/or grit blasting

Industrial applications typically use one of the first three air quality levels. Quality is determined by the dryness and contaminant level required by the end-uses, and is accomplished with filtering and drying equipment. The higher the quality, the more the air costs to produce. Higher quality air usually requires additional equipment, which not only increases initial capital investment, but also makes the overall system more expensive to operate in terms of energy consumption and maintenance costs.

One of the main factors in determining air quality is whether or not lubricant-free air is required. Lubricant-free air can be produced with either lubricant-free compressors, or with lubricant-injected compressors that have additional separation and filtration equipment. Lubricant-free rotary screw and reciprocating compressors usually have higher first costs, lower efficiency, and higher maintenance costs than lubricant-injected compressors. However, the additional separation and filtration equipment required by lubricant-injected compressors will cause some reduction in efficiency, especially if systems are not properly maintained. Careful consideration should be given to the specific end-use for the lubricant-free air, including the risk and cost associated with product contamination, before selecting a lubricant-free or lubricant-injected compressor.

Air Quantity - Capacity

Required compressed air system capacity can be determined by summing the requirements of the tools and process operations (taking into account load factors) at the site. The total air requirement

is not the sum of the maximum requirements for each tool and process, but the sum of the average air consumption of each. High short-term demands should be met by air stored in an air receiver. Systems may have more than one air receiver. Strategically locating air receivers near sources of high demand can also be effective. In most cases, a thorough evaluation of system demand may result in a control strategy that will meet system demand with reduced overall compressor capacity.

Oversized air compressors are extremely inefficient because most systems use more energy per unit volume of air produced when operating at part-load. In many cases it makes sense to use multiple, smaller compressors with sequencing controls to allow for efficient operation at times when demand is less than peak.

If a system is properly designed and maintained but is still experiencing capacity problems, an alternative to adding another compressor is to re-examine the use of compressed air for certain applications. For some tasks, blowers or electric tools may be more effective or appropriate. See the Fact Sheet titled *Inappropriate Uses of Compressed Air* for more information on this system improvement opportunity.

Load Profile

Another key to properly designing and operating a compressed air system is assessing a plant's compressed air requirements over time, or load profile. The variation of demand for air over time is a major consideration in system design. Plants with wide variations in air demand need a system that operates efficiently under part-load. Multiple compressors with sequencing controls may provide more economical operation in such a case. Plants with a flatter load profile can use simpler control strategies.

Artificial Demand

Artificial demand is defined as the excess volume of air that is required by unregulated end uses as a result of supplying higher pressure than necessary for applications. Flow controllers (see the Fact Sheet titled *Compressed Air System Controls*) can help to minimize artificial demand.

Pressure

Different tools and process operations require different pressures. Pneumatic tool manufacturers rate tools for specific pressures, and process operation pressure requirements should be specified by the process engineers. Required pressure levels must take into account system losses from dryers, separators, filters, and piping. A rule of thumb is that every 2 psi increase in operating pressure requires an additional 1% in operating energy costs.

See the Fact Sheet titled *Pressure Drop and Controlling System Pressure* for information on ways to reduce system pressure and save energy while maintaining high performance.