Know what you need, get what you need

Ignore the preconceived criteria and determine what is truly required for your cleanroom project

BY TIM LOUGHRAN

Your manager just left your office after dropping the latest impossible task at your feet. The company requires 2,500 square feet of new cleanroom space for a production expansion. As the facilities manager, you're responsible for satisfying the process engineer's whims and constructing the new cleanroom facility post haste.

You can take one of the following logical approaches:

1. Find existing open space within the building and design the space to integrate into that area.
2. Determine the most logical and economical layout for a 2,500-square-foot cleanroom and locate a spot in the building where it can be integrated.
3. Ignore all of your manager's preconceived criteria and determine what is really required to meet the expansion criteria.

If you selected number 3, you're correct; however, you may want to address the issue with your manager in a more "politically correct" manner.

Let's get things rolling

Starting the design before all the requirements have been identified is a grave and all too common mistake made in the design of a cleanroom facility. Always remember that properly executed programming and planning provide the most reliable foundation for a successful cleanroom design and construction project.

Programming, a term utilized in the design community to make information gathering look more attractive to team participants, is the process of gathering the body of information needed to identify, clarify and prioritize the cleanroom requirements. The goal of programming is the management of all preliminary project data assembled in a fashion to help determine design parameters of your new cleanroom facility.

A cleanroom cannot be accurately or responsibly designed without assembling the following process requirements:

Equipment Database: This is the initial information that drives utilities, areas and overall requirements.

Utility Requirement Summary: An analysis of services to each piece of the process equipment.

Equipment Layout: An analysis of cleanroom and other functional areas describing the areas needed for functioning and the additional areas required for support.

Taking the first step

As we work through the process, you'll begin to recognize the significant impact that *not* properly determining accurate requirements can have on the design and operation of the cleanroom.

Cleanroom facilities are typically intensive users of equipment, and therefore, large consumers of utilities and process services. The equipment database should be structured in a manner that allows utility and raw material consumption data to be associated with each process tool and each piece of its associated auxiliary equipment. This information is recorded on an **equipment information sheet** (See www.advancetecllc.com for an example).

There are several ways to develop reliable tool information data. We can acquire data from a similar facility that repeats the process in a new facility on another site. We can utilize equipment data from a pilot plant or R&D facility that will either be scaled-up or relocated and upgraded. We can tap into an engineering database of equipment maintained either by a consulting firm or by the manufacturing plant's process engineers. We can research operations and maintenance manuals for the equipment. Or, we can utilize vendor-supplied catalog data or sales brochures.

In most cases, a proper equipment information sheet is a combination of the above and is compounded by process requirements not fully understood and equipment not yet fully sourced.

The data that needs to be collected should include all utilities and raw materials required for normal process operations. In addition, other items required to properly design the equipment integration into a cleanroom design are environmental parameters of operation, sizes, accessibility requirements and support equipment requirements.

When collecting data, particularly from vendor sources, make sure that the data represent actual consumption data

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and not the nominal service capacity, which does not represent utility usage. For example, many vendor data sheets list for the electrical utility requirements the electrical service, 20 amps at 120 volts, rather than the connected load, which may be only 300 watts or 2.5 amps at 120 volts. Accumulated data errors such as these could dramatically distort demand requirements to the entire facility.

There may be as many individual ways to organize the data as there are people collecting it, which is why transferring the data into a standard format becomes paramount in determining if the information is complete and useful. The proper organization of the information allows for ease of transfer of the information to the next step of the process.

Let's take the second step

We are now ready for the next step in determining our process requirements. This step has several purposes:

1. To group equipment by process requirements and flow.
2. To sort data by equipment to consider grouping of equipment with similar service requirements.
3. To determine overall utility or raw material requirements to measure overall system demand.
4. If process equipment is to be added in phases, the database will allow the engineers to study expansion options for central utility systems.

Depending upon your particular industry, the summary of the accumulated equipment information sheets is known as a **utility matrix, process utility summary, tool matrix** or **utility requirement spreadsheet.**

Depending on the project's size and the number of equipment information sheets, assembling this data can be a huge effort, although some design firms have sophisticated software programs that automatically link equipment information data sheet entries to a summary matrix.

Without assembling this data, however, even experienced professionals will have difficulty guessing process requirements and will have no way of knowing whether the estimates are high or low. Too low will lead to insufficient capacities; while too high will result in expensive over-building and inefficient operation, which can be as problematic as under-sizing.

The alternate to this process is using "rule of thumb" to size systems. Engineers are always seeking techniques to shorten their effort, and as a result, new rules of thumb are always being developed from existing facility data. The problem with this method is that each facility has custom requirements and these requirements cannot be generalized to other situations.

Even when the sources are known, using rules of thumb may produce highly variable and often misleading results that cannot be verified; however, using rules of thumb as a litmus test to validate your results often serves as a valuable check and balance.

Putting data to work

Once the utility and raw material data have been collected and accumulated in a summary spreadsheet, the information can be utilized to properly determine process service requirements for the complete facility. With this, we now have a means by which to properly assess items such as exhaust requirements, which, in turn, allow us to determine make-up air requirements. Make-up air requirements, combined with humidity requirements determined from the equipment information sheets, allow us to specify a make-up air handler. This information, along with heat generation information of equipment and process cooling water needs, allows us to properly size and specify a chiller. The correct chiller size allows for the proper sizing of pumps and piping.

The data gathered to this point will provide the design effort with half of the information needed to successfully produce the appropriate cleanroom design. Prior to the start of design, the project team should examine concepts applicable to work flow, flexibility, utility distribution and other similar issues.

We now need to develop an **equipment layout.** When assembling your tool data information, record equipment size and access requirements and group the equipment by work process. To develop the net area of the cleanroom, begin by developing the areas required for each piece of equipment, workstation and support area such as racks, storage, etc.

Access and maintenance space for equipment should be included with the equipment area requirement. The total of these areas inside the cleanroom walls will produce the net cleanroom space.

In addition to the cleanroom space, service corridors, mechanical rooms, utility rooms or basements will also be needed. We've determined the process services requirements for the equipment and can utilize that information to size support systems and their associated footprints. It is common for a cleanroom to require two to three times its area in available building space when support utility systems and services are incorporated.

We now have the cleanroom programmed and can accurately assess square footage requirements and begin to develop a budget. Until we have carried out this process, we cannot accurately determine either item.

In the realities of business, the extent of this effort varies, but in some type of form or format, it must be completed prior to budgeting or assessing cleanroom requirements. If it hasn't been extensively done, the value of the size and cost estimate you're dealing with is subject to change.

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