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## **Basis of Design (BOD)**

This design basis document is the road map that a project team will follow to build a project. This document establishes the design criteria, outlines the system design, equipment and component design features, as well as the performance characteristics consistent with that criteria. This design basis document also creates the framework for the detailed design, construction documents, and construction specifications. The contents of this document represent the objectives of the owner, project architect, engineers, and consultants in terms of design features, systems functionality, and performance.

## **Basis of Design Template**

**Room Name:**

**Room ID:**

### **Architectural Data:**

Use:

Occupants:

Occupied (hours/day)

Access:

Size:

critical dimensions:

ceiling height:

area:

Location / Adjacency:

Floor Loading

Doors:

Windows:

Cleaning Method:

Room Finishes:

Floors:

Base:

Walls:

Ceiling:

Doors:

Door Frames:

Windows:

Other:

**Furnishings:**

**Process Equipment:**

**HVAC Requirements:**

Cleanliness Level:  
Room Air Changes:  
Pressurization:        pos/neg        with respect to         $\Delta P$   
Temperature:  
Humidity:  
Hours of Operation:  
Recirculation:  
Supply:  
Return:  
Exhaust:  
Hazard Classification:  
Noise Criteria:

**Plumbing Requirements:**

Services Required:  
Plumbing Fixtures:  
Compressed Air:  
    Pressure:  
    Volume:  
    Class:  
Compressed Gasses:  
Waste:  
Safety Equipment:  
Fire Protection:  
Other Requirements:

**Electrical Requirements:**

Lighting:  
    Required Level:  
    Source:  
    Type:  
    Voltage:  
    Emergency:  
Receptacles:  
    Voltage:  
    Amps:  
    Circuits:  
Communications:  
    Data:  
    Phone:  
    Paging:  
    Video:  
Fire Alarm:

## **Considerations for the Future**

### **Layout Changes**

The primary advantage in building a modular cleanroom is flexibility. A manufacturer in production with a gypsum based wall system has to shut down the entire operation in order to add or remove a wall inside the cleanroom. For a gypsum wall system the order of construction is: a) frame, b) gypsum board, c) tape, d) sand and e) paint. Most frequently this means the room is down for an extended time. The resulting lost production time can be quite expensive. Some clients of Gerbig Engineering have stated that lost production time costs more than a million dollars per day. With the AireCell line, modifications are made to wall systems while production continues.

### **Expansion and Upgrades**

With the AireCell modular system, expansion can occur without shutting down the cleanroom. This is because walls are constructed using a heading that holds the ceiling grid and the wall studs. The expansion is built and the wall between the expanded space and the original cleanroom is removed leaving only the header with two wall moldings.

### **Portability**

Many times a cleanroom is built in leased space. When the user moves, the landlord wants the space returned to its original condition. This is not a problem with the AireCell modular cleanroom. The system can be dismantled and moved with only hand tools. In fact, one of our cleanrooms has been moved four times.

## **Code Issues**

### **Introduction**

Most communities today use the 2006 or 2009 International Building Code and the 2006 Fire Code as the basis of construction for code approval. Frequently, cleanrooms and manufacturing facilities exceed the allowable amounts for flammable and hazardous materials and the Fire Code becomes all important in determining a design. However, the front part of the codes state that the local building official's ruling takes precedent over the building code. In constructing cleanrooms, we have encountered this twice in the past three years. There is little that can be done, except to change the design of the cleanroom.

### **Occupancies**

Generally, the occupancy denotes the use of the space such as office, factory, warehouse, etc. If the space has chemicals exceeding limits provided in the IBC, then the occupancy may need to be divided into control areas of hazardous materials or the entire area changed to "H" hazardous. Most frequently, cleanrooms fit into the "F" occupancy rating for manufacturing. However, a typical request for our modular cleanrooms is to construct a cleanroom in a warehouse space. This is a change of occupancy and must involve the local building official. If the cleanroom is small and the warehouse is large it may be viewed as an incidental use area and be OK with the

building official. Technically, a fire wall is required between an “H” occupancy, causing construction issues.

## **Construction Materials**

Commercial buildings today, depending on size, require non-combustible materials with automatic sprinkler systems. Fire resistance rating requirements for building elements are called out per code. Wall and ceiling finish flame spread and smoke developed are classified by use. Cleanroom installation will need to conform to existing construction classification.

## **Egress**

A major concern for building officials is life safety and emergency exiting from the building. Building officials want to see the full floor plan, not just the portion of the project relating to the cleanroom. As the room grows, common path of egress travel may change and additional doors may be required. Handicap access should also be reviewed for accessibility or accessible route.

## **Summary**

Most of our hardwall projects involve an architect. The vendor drawings for the cleanroom become construction or submittal drawings.

## **Cost Issues**

### **Design Type**

An open loop system is one in which the HEPA filtered air passes through the room, exits through or under the wall and flows freely back to the fan unit(s). In a closed loop system, the HEPA filtered air is not allowed to flow through the adjacent space.

Open loop (single pass) type cleanrooms are typically designed with exterior walls, an interior ceiling with filtration, and no second ceiling on above. Ambient air is drawn thru HEPA fan filter units (FFUs) to pressurize the room where it is then discharged under the cleanroom walls into the ambient space. This type of design provides performance and value as they are simple to install and require the least amount of construction materials, thus allowing for a quick and economical installation. Open loop systems require less complicated HVAC requirements and still provide temperature control, rooms that require humidity control would require a closed loop type of system.

Closed loop differs in that it would feature a sealed second ceiling creating a plenum that would have humidity and temperature controlled air introduced, with return air being re-circulated. Closed loop designs allow excellent temperature and humidity control, but they can add substantial costs to the job, in the form of additional construction materials, added installation time, labor, design costs, and HVAC requirements. If humidity is to be controlled, a closed loop system is required.

## **Cleanroom class**

Class 100,000 vs. 1: As cleanrooms get cleaner they get more expensive, these costs are related to the need for additional HEPA FFU's to provide the additional air flow required for greater air changes per hour (ACH) and the additional materials and labor needed to construct return air risers or double walls.

## **Materials of Construction**

Choice of construction materials can have a substantial effect on project costs, depending on size of project, where a small change in a material selection could add substantial cost if a large quantity of material is being used or where an exotic material is specified on even small scale projects. Typically, cleanrooms are fabricated using Class A fire rated materials.

## **Filter Types**

Most modular cleanrooms are currently being designed using HEPA FFU's, although some designs use ducted filters that are pressurized by expensive HVAC equipment, but typically FFU's are used. When selecting the FFU you must consider media efficiency and FFU performance. Most FFU's are HEPA 99.99% efficient @ .3 microns, whereas some cleanrooms will require the use of ULPA 99.9995% efficient filter media, and this can add about \$40.00 extra per unit. There are also more expensive FFU models with features such as:

1. EC Motor for reduced power consumption.
2. Digital controller to adjust for changes in static pressure and allow constant airflow.
3. Low sound
4. Room side replaceable filters
5. Infrared remote controls
6. Control systems that allow night set back

## **Door types**

There are many types of doors used in modular cleanrooms, the most common being a full glass commercial passage door 3' x 7'. Each door adds significant project costs, so the quantity and types of doors used should be decided carefully. Doors are typically used for passageways, material transfer, storage, and utility access. Doors can be highly specialized, with pneumatics, automation, including materials and finishes.

## **Pre-filter Location:**

Pre-filters are located either at the fan inlet on the FFU, or at the return air riser. Pre-filters are necessary to protect the longevity of the HEPA filters, but many cleanrooms could benefit from having an integrated return air riser with pre-filter, allowing them easy access to pre-filters for inspection and replacement.

## **Softwall vs. Hardwall:**

The decision on hardwall vs. softwall is usually made by the user after carefully reviewing project requirements. For small clean enclosures without separate HVAC, a softwall cleanroom can save on initial expense

## **Introduction to Facility Qualification**

Certain manufacturing industries and operations require quality testing and documentation to ensure that the manufacturing environment is suitable for the product being produced. The foremost examples are medical device, pharmaceutical and biological products manufacturers, and contamination critical micro electronics manufacturers.

The medical industry is regulated by the US FDA and international agencies, and is required to document that the facilities in which its products are manufactured conform to various applicable quality standards. In the US these are known as cGMP or current Good Manufacturing Practices. Microelectronics manufactures have products which are extremely sensitive to micro contamination and other process parameters and require rigorous facility and process qualifications to maximize quality output. Within a regulated or contamination critical facility, operations are assessed for potential impact on final quality of the product, and critical systems are thoroughly inspected, tested and documented.

This process is referred to as Facility Qualification. The table of contents presented below is an example of the items required to be verified, inspected and tested in a critical facility qualification.

Gerbig Engineering Company has been specializing in critical facility and systems testing and certification since 1985, and can provide turnkey validation solutions for customers who require this service. Our resources include over 30 years of collective experience in cleanroom and facility qualification, certification with the National Environmental Balancing Bureau as a cleanroom performance testing contractor, and dozens of specialty test instruments maintained in current calibration to NIST traceable standards. Gerbig Engineering Validation Services also provides equipment and systems (utilities such as compressed air and gasses, and purified water) qualification and validation.

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