

How to Estimate the Cost of a Laboratory Renovation

Candidate Number: 0714144

December 15, 2014

Table of Contents

Cover Page	Page 1
Table of Contents	Page 2
Introduction	Page 3
Types & Methods of Measurements	Page 5
Specific Factors that may Affect Take-Off & Pricing	Page 8
Overview of Labor, Material, Equipment, Indirect Costs, Approach, & Mark-Ups	Page 10
Special Risk Considerations	Page 15
Ratios and Analysis	Page 15
Miscellaneous Pertinent Information	Page 16
Sample Sketches	Page 17
Sample Take-off & Pricing Sheet	Page 20
Conclusions	Page 23
Terminology/Glossary	Page 24
References	Page 25
Copyright Releases	Page 25

Introduction

Laboratory renovations are often performed in a unique environment with construction activities occurring adjacent to ongoing scientific research. The intent of this paper is to identify how construction activities will adversely affect laboratory operations, address means to mitigate the disruption, and ways to determine the costs of mitigation.

When laboratories are able to cease operations, allow routine construction access, and working environment, then undergo sanitization before commencing operations, cost is minimal and seldom requires in-depth estimating for determining additional cost.

When estimating renovation costs of a laboratory that will continue to maintain operations, many aspects must be taken into consideration. These include access to the work area and containment of the work area (commonly known as “temporary facilities”) as well as utility outages and the overall ability for the laboratory to sustain functionality.

Two distinct methods exist for providing temporary facilities to achieve a successful outcome. The first method, which will be referred as “direct access,” is typically least costly by providing direct access between staging area and work area where workers, material and equipment may pass freely. The second method, which will be referred to as “airlock access” requires workers, material and equipment to pass through controlled environment between the staging area and the work area. In this method, workers, material and equipment must be covered, contained or sanitized to meet requirements of the controlled environment. This process normally occurs within an airlock enclosure.

Although potential risk of impacting laboratory operations during construction is high, a proper procedure for installation, operation, and removal of temporary facilities is seldom included in the bid documents. This task is often left to the contractor to design and install with minimal oversight, few submittals, or a logistics plan. The lack of specified design for temporary facilities places the contractor at risk and introduces an additional task for the estimator to develop a conceptual method, and then quantify the cost.

Main CSI Division

015600 Temporary Barriers and Enclosures

Specific Sub-Division:

01 56 13 Temporary Air Barriers

01 56 16 Temporary Dust Barriers

Brief Description of Subject Matter

Formulation of an accurate estimate for the renovation of a laboratory requires the estimator to develop a conceptual process of logistics and the associated costs of additional temporary facilities to keep construction activities from contaminating the laboratory environment and to keep chemical or biological laboratory preparations free of cross-contamination and contained within the controlled environment.

Types & Methods of Measurements

The majority of an estimate for a laboratory renovation will be similar to a typical renovation utilizing standard estimating procedures. A reduction in productivity for working within temporary enclosures must be taken into consideration. The difference between a typical renovation and a laboratory renovation will be centered on the cost of temporary facilities. When estimating the cost of constructing, maintaining and removing temporary facilities, common measurements include quantity, lineal footage, square footage and volume.

Temporary Facility Common Units of Measure

- Quantity
 - Negative air machines
 - Tack mats
 - Airlock enclosures
 - Temporary doors
 - Cleanroom garments
 - Sanitization units

- Lineal Footage:
 - Temporary plastic partitions
 - Hardwall partitions
 - Length of worker travel

- Square Footage
 - Floor protection
 - Temporary plastic partitions
 - Hardwall partitions
- Volume
 - Temporary enclosure
 - Adjacent Areas

Additional Requirements of Measure May Include:

- Negative Air Design Requirements:
 - Rate of airflow commonly expressed in cubic feet per minute (CFM)
 - Quantity of air changes per hour (ACH)
 - Pressure differential expressed in pounds per square foot (PSF)
- Classification of Controlled Space and Containment:
 - GMP “Good Manufacturing Practice”
 - Guidelines recommended by agencies that control manufacture of food, drug products, and pharmaceutical products may have a significant cost impact.
 - ISO “International Standards Organization”
 - Indicates requirements of a clean room environment and may have significant cost impact. Two measurements of concern are as follows:
 - Airborne Particulate Cleanliness Class Comparison expressed in an ISO classification

- Airborne Particulate Cleanliness Classes expressed in Number of Particles per Cubic Meter by Micrometer Size
- ICRA “Infection Control Risk Assessment”
 - Expressed as a matrix of precautions.
 - Established for hospital use, this will not have a cost impact on a laboratory renovation. This term is included since many ICRA requirements are similar in nature to those employed in a laboratory renovation and may be used as a source of reference.

“Negative Air Design Requirements” and “Classification of Controlled Space and Containment” are outside the scope of this paper and have been included as a notification to the estimator that additional investigation and associated cost must be included when these items impact the project or when the project must conform to the classification.

Specific Factors That May Affect Take-Off & Pricing

Small Quantities vs. Large Quantities

Typically the unit cost of temporary facilities is not affected greatly by the quantity of temporary facilities installed.

Geographic Location

Geographic location will similarly affect the cost of construction and the cost of temporary facilities with wage rates as the primary variable.

Seasonal Effect on Work

Seasonal effect will have minimal adjustments on the cost of temporary facilities since the work is generally done within a tightly controlled environment.

Access between Staging Area & Work Area

Work area access is one of the most significant cost impacts of a laboratory renovation. A relatively small cost involves the distance between the staging area and the conditioned space that must be taken into consideration for time spent moving materials and equipment as well as maintaining the route of travel in a clean and orderly manner. Security detail may be a requirement for access to the laboratory normally resulting in a small cost. A moderate cost involves establishing direct access between the staging area and the work area by installing temporary enclosures within the controlled environment. A substantial cost involves access between the staging area and work area that passes through controlled space requiring the

construction of temporary airlock entrances, proper cleanroom garments of personnel, and sanitization of material and equipment.

Disruption of Facilities

When a laboratory renovation occurs during a time of shutdown, the owner will determine whether temporary facilities are required to isolate construction areas. Occasionally, major renovations may be performed with minimal temporary facilities thus requiring extensive cleaning and sanitization at project completion. This type of renovation is outside the scope of this paper.

Laboratory renovations described in this paper will require temporary facilities to avoid costly cleaning and sanitization of adjacent areas. These facilities are typically installed whether the laboratory is shut down or will remain in operation. In an active laboratory, temporary facilities are often installed off-hours resulting in overtime costs. Equipment arrangement must be carefully reviewed to avoid temporary facilities restricting ongoing laboratory operations. Overcoming these restrictions while allowing access to work areas will involve significant costs by requiring airlock entrances and costly preparation prior to transport of workers, materials, and equipment through the controlled environment.

Scheduling of outages for utility connections often result in overtime or second shift costs needing to be captured in the estimate.

Overview of Labor, Material, Equipment, Indirect Costs, Approach, & Mark-Ups

The outlined approach to protecting a laboratory during renovation must be well planned since failure to provide adequate temporary facilities may result in costly or unreparable damages.

Labor, Material & Equipment

Temporary single-layer, fire retardant, plastic isolation barrier installation and removal are one of the basic procedures required for laboratory renovations. Prior to entering a laboratory for installation of temporary barriers, workers must have proper cleanroom garments to meet the requirements of the specific classification of controlled space. Fire retardant plastic barriers or “enclosures” are placed from floor to ceiling or underside of deck utilizing a sealant tape to maintain as close to an airtight barrier as possible. All piping, ducts, conduits and other utilities passing through the barrier must also be sealed. Once inside an enclosure with negative air equipment operating properly cleanroom garments are seldom required. Upon completion of work and after sanitization of the work area, removal of the barrier will proceed in reverse order of installation requiring proper cleanroom garments when workers are exposed to the controlled environment of the laboratory space.

Single-layer plastic isolation barrier is the most common form of temporary enclosure, but it is not suitable for operations that require cutting or chipping where a foreign object may penetrate the plastic enclosure. Work sites requiring additional protection may use temporary hardwall construction. Once the initial plastic isolation barrier and negative air equipment is installed, the construction of the temporary hardwall may begin. Metal studs and fire retardant plastic sheets

resembling corrugated cardboard will often comprise the hardwall construction. Sealing of this wall is similar to the plastic enclosure with taping of joints, floor abutment, ceiling abutment, and all penetrations. Removal of the temporary hardwall will occur prior to removal of the outer plastic enclosure.

Negative air equipment is another of the basic procedures required for laboratory renovation. A negative air machine will be installed to provide negative pressure inside the temporary enclosure preventing dust migration from the work area to adjacent spaces. Negative air equipment is a blower-equipped with high-efficiency particulate air (HEPA) filtration and is preferably vented to the exterior. Many locations have no venting to the exterior and the filtered air will be recirculate within the facility. Negative air machines normally operate the duration of renovation and will require periodic filter replacement. Inspection and maintenance may be required during the weekend or full-time attendance during non-working hours may be required.

Prevention of contamination to adjacent areas is accomplished by placement of HEPA filters on building HVAC system return air ducts within the enclosed work area, airlocks, temporary enclosures and other locations which contaminants may be present.

Cleanroom garments may include gowns, double gowns, booties, overboots, gloves, respirators, and self-contained breathing apparatus. The combination thereof is determined by the classification of the controlled environment.

Isolation of work areas in a laboratory allowing “direct access” between staging area and work areas is the preferred method of providing temporary facility. The most common approach to isolation of the work area from adjacent laboratory space comprises temporary “enclosures” sealed tightly to existing surfaces with negative air equipment to provide a slight negative pressure within the enclosure. Workers, material, and equipment may move freely and renovation work may be performed within the enclosed space without the use of cleanroom garments, bagging, or sanitization of materials or equipment with minimal risk of contaminating the adjacent laboratory.

Isolation of work areas in a laboratory requiring “airlock access” to pass through a controlled environment between staging area and work area is a sophisticated system requiring adherence to protocol of the controlled environment. A temporary airlock often comprised of a plastic enclosure with doors and negative air equipment will be constructed outside the point of entrance into the controlled environment. Line of demarcation placed within the airlock enclosure defines the dirty side and the clean side of the airlock. Within this airlock workers will dress in proper cleanroom garments prior to crossing the line of demarcation. All materials and equipment, whether for temporary facility or permanent construction, must be sanitized before entering the controlled environment. This may involve spraying or wiping each individual item with a sanitizing agent.

Workers with proper cleanroom garments, sanitized materials, and equipment will then enter the controlled environment and proceed to construct a plastic enclosure around the work area and a second airlock enclosure. Negative pressure inside the temporary enclosures will be required in

both the work area and the second airlock. During construction garmenting and sanitization will continue to occur at the first airlock before entering the controlled environment. All will pass through the controlled environment and enter the second airlock structure. Within the second airlock structure, workers will put on an over-layer of cleanroom garments for use while performing renovation work. Material and equipment may be moved from the second airlock entrance to the work area with no further precautions.

Exiting the work area enclosure involves a similar process as entering the controlled area. Workers will remove the dirty cleanroom garments and place them in a bin for disposal. A new set of secondary cleanroom garments may be required prior to exiting the second airlock into the controlled environment. Debris must be bagged and sealed; excess material and equipment must be bagged or sanitized within the airlock before exiting into the controlled environment. All will pass through the controlled environment and exit through the first airlock.

Upon completion of renovations all temporary enclosed space must be sanitized prior to removal of temporary facilities.

Indirect Costs

Indirect costs are not easily defined since all temporary facilities may be viewed as an indirect cost. For purposes of this paper, indirect costs will be defined as occasional costs specific to a project that are not required by construction documents or work performance.

General condition costs.

Design of temporary facilities.

Air quality monitoring validating effectiveness of containment.

Surface testing for contaminants.

Engineering of negative design pressure.

Movement of large equipment through controlled environment.

Energy resources and fume control within enclosures.

Security detail and overtime expense as previously mentioned.

Calculation of these costs is specific to each project and will often require subcontractor quotation or equipment rental costs. Overtime expense is based on required off hour work schedule to avoid disruption of the facility including installation and removal of temporary facility, passage through controlled environment and utility outages. Additional general condition costs include project management time for creating, conveying and refining the proposed concept of temporary facility to the owner as well as superintendent time to oversee implementation.

Mark-Ups

In general, mark-up on temporary facility will be the same as the project mark-up. Laboratory renovation mark-ups tend to be higher than average due to greater potential risk.

Special Risk Considerations

Risk involved in a laboratory renovation will depend on the function of the laboratory and preparations in use. Proper precautions are critical for a successful outcome.

Three examples of risk demonstrate why the magnitude of potential damage should be taken into consideration when conceptualizing a suitable means of temporary protection.

1. Dust may enter the laboratory, requiring the additional expense of cleaning and sterilization.
2. Dust from construction activities may contaminate a multi-generation biological preparation, destroying years of work.
3. Improper containment may cause release of pathogens into the environment placing workers lives at risk as well as the possibility of an epidemic.

Most laboratory processes with potential for great risk will be discontinued during renovations while others must remain operational without disruption. Consequences of improper isolation and containment facilities pose serious monetary and life safety risk.

Ratios & Analysis (Tools Used to Test Final Bid)

Historical data is among the best tools an estimator possesses. The ability to compare costs from similar projects to the present estimate provides a degree of validation. Historical data may be a useful tool for analyzing cost however these costs are easily skewed in a laboratory renovation. Access to a particular area may increase the cost of temporary facility 1,000%. Diligence in project detail is crucial for accurate analysis.

Comparative historic cost analysis is useful for lineal feet of temporary plastic enclosure or temporary hardwall enclosure as well as the quantity of temporary airlocks.

Another useful comparative historic cost analysis is the overall cost of isolation through direct access. Comparison may be based on lump sum cost per project with adjustments for volume of enclosure.

Ratios become an important tool when comparing the amount of permanent material required on a project to the resources required for sanitization of materials passing through an airlock. Comparison of lump sum historic costs is not effective due to varying amounts of materials required on each project; instead historic unit cost data may be used. Ratios are then applied to validate overall sanitization costs.

See the Comparative Matrix for further information.

Miscellaneous Pertinent Information

Many companies that have laboratories as part of their operation also have their own safety policies that exceed OSHA requirements. The cost of adhering to company safety policies must be included in the estimate.

Companies that have laboratories as part of their operation are often involved in patented research. This may result in background checks being required, daily badging requirements, and

sometime a security guard escort while within the facility. The cost of adhering to company policy must be included in the estimate.

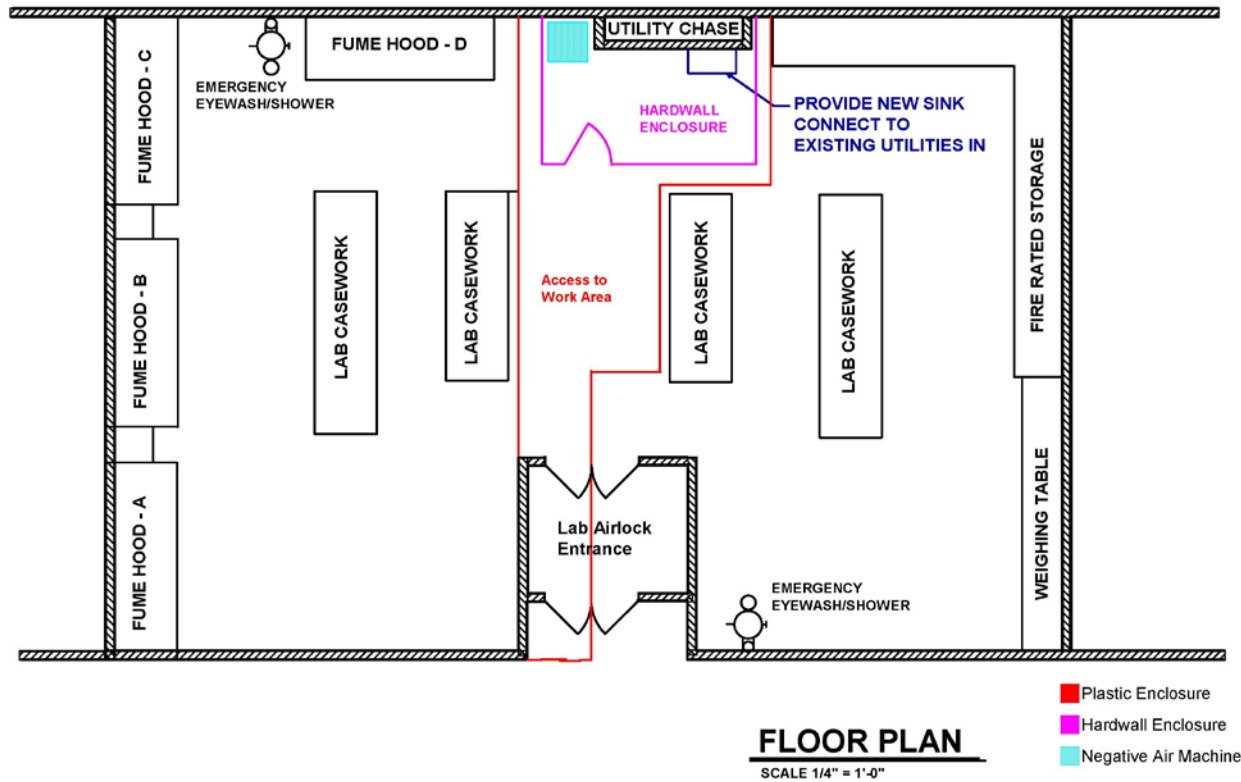
Some laboratories work with explosive gases or materials causing part or the entire laboratory to be within a classified area requiring the use of certain tools that are less apt to cause a spark. Additional time spent using a tool, which is slow for the task being performed, must be included in the estimate.

The widespread use of cell phones for business communication may be curtailed within some companies that do not allow picture taking devices on company property. A phone with no camera must be purchased with the associated cost captured within the estimated.

Sample Sketches

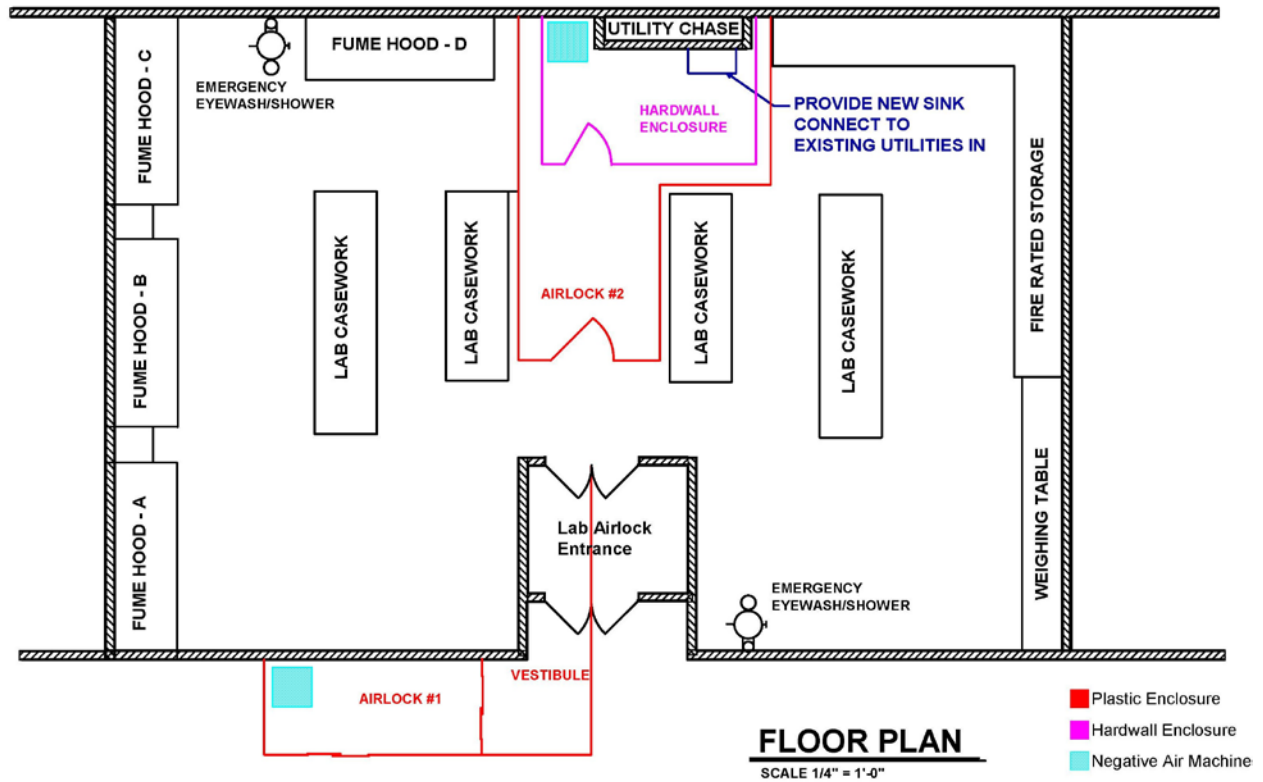
A laboratory renovation consisting of the addition of one sink is shown on the following sketches. The scope of work is to demolish a portion of the masonry wall at the utility chase, connect to existing piping, install carriers and a sink, repair masonry and paint disturbed area. Also included in the scope of work is a generic specification 01 56 00 Temporary Barriers and Enclosures. The request for quotation indicates the laboratory will remain in operation during construction.

The following sketches indicate two methods of providing temporary facility to allow the laboratory to continue operation during construction.



Direct Access

The sketch above allows the area around weighing table to continue in operation while the fume hood area is unusable during construction. This layout provides workers direct access from staging area (not shown) to the work area where sink is to be installed. In addition to the plastic enclosure separating work area from laboratory space, a hardwall enclosure is included due to the nature of masonry demolition. Negative air equipment maintains lower air pressure in the enclosure than adjacent laboratory and is vented to the exterior or non-controlled environment after passing through a HEPA filter.



Airlock Access

The sketch above allows continuous operation in all key areas of the laboratory by providing clear access between weighing table and fume hood area. This layout requires workers, material, and equipment passing through controlled space between staging area (not shown) and work area where sink is to be installed. Two temporary airlocks are constructed in addition to the plastic enclosure, hardwall enclosure and negative air equipment surrounding the work area. Airlock A with its own negative air equipment provides a space to dress in cleanroom garments as well as to sanitize material and equipment prior to entering the controlled environment. Airlock B provides space to dress in cleanroom garments, bag debris in tightly sealed containers, and sanitize excess material and equipment being removed from the work area prior to entering the controlled environment.

Sample Take-off & Pricing Sheet

Three estimates follow along with a comparison matrix. The first estimate is for the installation of a sink in a non-laboratory environment. The second and third estimates are for the installation of a sink in a functioning laboratory complete with temporary facilities. The second estimate shows the cost of direct access to the work area while the third estimate shows the cost of accessing the work area through controlled space via airlock entrances.

Estimate #1

Renovation - Provide (1) New Sink Non-Laboratory Renovation						
Description	Qty	Labor	Material	Equipment	Sub	Total
General Conditions	1 ls	\$2,450	-	-	-	\$2,450
Masonry	1 ls	-	-	-	\$5,000	\$5,000
Painting	1 ls	-	-	-	\$1,000	\$1,000
Plumbing	1 ls	-	-	-	\$5,000	\$5,000
Sub-Total:		\$2,450	-	-	\$11,000	\$13,450
					Permit:	\$188
					Tax:	\$392
					O&P:	\$2,018
					Total:	\$16,048

Estimate #1: Non-Laboratory Renovation

The estimate above indicates a typical sink installation. The estimate may be used as a basis in cost comparison when working in a laboratory environment.

Estimate #2

Renovation – Provide (1) New Sink Laboratory with Direct Access from Staging Area						
Description	Qty.	Labor	Mats.	Equip.	Sub	Total
General Conditions	1 ls	\$3,513	-	-	-	\$3,513
Overtime	1 ls	\$969	-	-	-	\$969
Temp. Plastic Enclosure	80 lf	\$682	\$160	-	-	\$842
Temp. Zip Door	1 ea	\$81	\$75	-	-	\$156
Negative Air Equip.	1 ea	\$162	\$50	\$750	-	\$962
Temp. Hardwall	36 lf	\$447	\$228	-	-	\$675
Temp. Door	1 ea	\$243	\$250	-	-	\$493
Floor Protection	420 sf	\$679	\$399	-	-	\$1,078
Tack Mats	1 ea	\$10	\$30	-	-	\$40
Masonry	1 ls	-	-	-	\$6,000	\$6,000
Painting	1 ls	-	-	-	\$1,500	\$1,500
Plumbing	1 ls	-	-	-	\$5,500	\$5,500
Sub-Total:		\$6,786	\$1,192	\$750	\$13,000	\$21,728
					Permit:	\$304
					Tax:	\$590
					O&P:	\$3,259
					Total:	\$25,881

Estimate #2: Laboratory Renovation – Direct Access

The estimate above indicates a sink installation while working in a laboratory environment. Direct access is available from the staging area to the work area without passing through controlled environment.

Estimate #3

Renovation – Provide (1) New Sink Laboratory Renovation with Access through (2) Airlocks						
Description	Qty.	Labor	Material	Equip	Sub.	Total
General Conditions	1 ls	\$5,550	-	-	-	\$5,550
Overtime	1 ls	\$901	-	-	-	\$901
Temp. Plastic – Airlock #1	60 lf	\$512	\$120	-	-	\$632
Temp. Zip Door	2 ea	\$162	\$150	-	-	\$312
Negative Air Equip.	1 ea	\$162	\$50	\$750	-	\$962
Floor Protection	150 sf	\$243	\$143	-	-	\$386
Tack Mats	2 ea	\$20	\$60	-	-	\$80
Temp. Plastic – Airlock #2	65 lf	\$554	\$130	-	-	\$684
Negative Air Equip.	1 ea	\$162	\$50	\$750	-	\$962
Temp. Hardwall	36 lf	\$447	\$228	-	-	\$675
Temp. Door	2 ea	\$486	\$500	-	-	\$986
Floor Protection	240 sf	\$388	\$228	-	-	\$616
Tack Mats	1 ea	\$10	\$30	-	-	\$40
Sanitize & Wipedown Mat'l.	1 ls	\$647	\$150	-	-	\$797
Bagging Mat'l. & Equip.	1 ls	\$485	\$50	-	-	\$535
Bagging Debris	1 ls	\$485	\$50	-	-	\$535
Personnel Gowning	1 ls	\$485	\$500	-	-	\$985
Consumables	1 ls	-	\$350	-	-	\$350
Masonry	1 ls	-	-	-	\$7,000	\$7,000
Painting	1 ls	-	-	-	\$2,000	\$2,000
Plumbing	1 ls	-	-	-	\$6,000	\$6,000
Sub-Total:		\$11,699	\$2,789	\$1,500	\$15,000	\$30,988
					Permit:	\$433
					Tax:	\$825
					O&P:	\$4,648
					Total:	\$36,894

Estimate #3: Laboratory Renovation – Airlock Access

The estimate above indicates a sink installation while working in a laboratory environment.

Access from the staging area to the work area requires passing through controlled environment.

Conclusions

Comparison Matrix Renovation – Provide (1) New Sink			
Description	Non-Laboratory Renovation	Lab Renovation Direct Access	Lab Renovation Airlock Access
General Conditions	\$2,450	\$3,513	\$5,550
Overtime	-	\$969	\$901
Temporary Enclosures	-	\$4,246	\$6,335
Sanitization	-	-	\$3,202
General Trades	\$11,000	\$13,000	\$15,000
Sub-Total:	\$13,450	\$21,728	\$30,988
Permit, Tax, O&P:	\$2,598	\$4,153	\$5,906
Total:	\$16,048	\$25,881	\$36,894

The matrix above compares the three previous estimates for installation of a sink in various environments. General conditions and overtime are indirect cost increases. The cost of general trades work increases slightly due to the restrictions of working within a temporary enclosure. The cost of constructing and maintaining airlock entrances is typically more than the cost of direct access enclosures.

Cost Impacts affecting “Direct Access” Temporary Facility

The cost of direct access temporary facilities will be greatly affected by the volume of work area. Project duration, complexity, quantity of permanent construction material and the amount of debris generated will have minor cost effects.

Cost Impacts affecting “Airlock Access” Temporary Facility

The cost of airlock access enclosures will be slightly affected by the volume of work area, project duration or complexity. Sanitization costs will have a direct correlation to the amount of material and equipment required on the project, the amount of debris generated and the project duration affecting the number of times workers require garmenting.

Terminology/Glossary

Laboratory	An area of controlled environment for performing scientific or technological research.
Utility Outage	Temporary discontinuation of a utility for the purpose of tie-in or maintenance.
Temporary Facilities	The scope of this paper includes Temporary enclosures, controlling air pressure differential, temporary protective coverings and sanitizing equipment.
Direct access	Work area may be accessed directly from staging area without passing through a controlled environment.
Airlock Access	Work area is accessed from staging area by passing through a controlled environment.
Logistics Plan	Document indicating staging area, work area, routes of travel, temporary facility, impacts to client facility and other pertinent information.
Negative Air Machine	Equipment that reduces air pressure of a contained area minimizing airborne contaminants entering adjacent areas.
Cleanroom Garments	Clothing such as gowns, booties, hairnets gloves as well as respirators or other breathing apparatus required to meet protocol of the controlled environment.
Sanitization	Spray or wipe of surfaces to eliminate contaminants.
Plastic Partitions	Temporary enclosures constructed of clean plastic with perimeter and penetrations sealed to create an air barrier.

Hardwall Partitions	Temporary enclosures constructed of metal stud and corrugated plastic sheets with perimeter and penetrations sealed to create an air barrier that is not easily penetrated.
Temporary Enclosure	Volume of space enclosed by temporary walls and/or ceilings.
Airlock	Volume of enclosed space with entrance and exit doors used to prepare for entering a controlled environment.
Line of Demarcation	In terms of an airlock, one side of the line is normal or dirty while the other side is clean to the standard of the controlled environment being entered.

References

CSI Division	The Construction Specifications Institute
ISO	International Standards Organization
ICRA	Infection Control Risk Assessment
GMP	Good Manufacturing Practice guidelines recommended by agencies that control authorization and licensing for manufacture and sale of food, drug products, and active pharmaceutical products.

Copyright Releases (Non-Original Material)

No copyrighted materials are contained in this paper.