



*Managing Metamorphosis.
Building for Change*




Session: 100105

Date: Wednesday, October 1, 2014


Time: 1:00 pm – 3:00 pm






*Managing Metamorphosis.
Building for Change*


***Labs 101: Maximizing
Resources in Design
for Science and
Equipment Planning***





Presented by:

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- Kathryn Cavender, CSP, Rice University, Dir. of Environmental Health & Safety
- Andy Lewis, AIA, Equipment Collaborative


FKP Architects







ASSOCIATION OF
Texas College & University Facilities
PROFESSIONALS

*Managing Metamorphosis,
Building for Change*



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Learning Objectives

- Understand current trends in lab design and how smart lab planning can increase safety efficiency, reduce waste and enhance collaboration
- Learn what codes and guidelines need to be followed in lab design.
- Explore what options are available in casework for flexibility and adaptability.
- Understand the laboratory equipment planning process and strategies for successful integration.



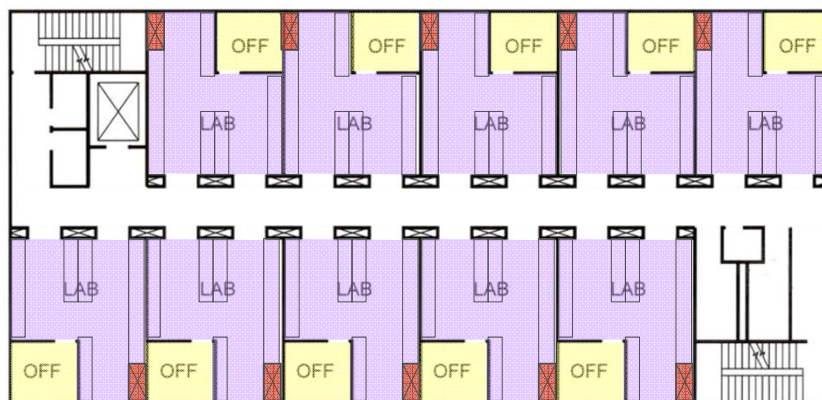
Agenda

- Laboratory Planning History and Trends
- Codes and Guidelines
- Infrastructure Basics
- Programming and Planning
- Equipment planning, procurement and installation process
- Casework Options
- How can we maximize resources?

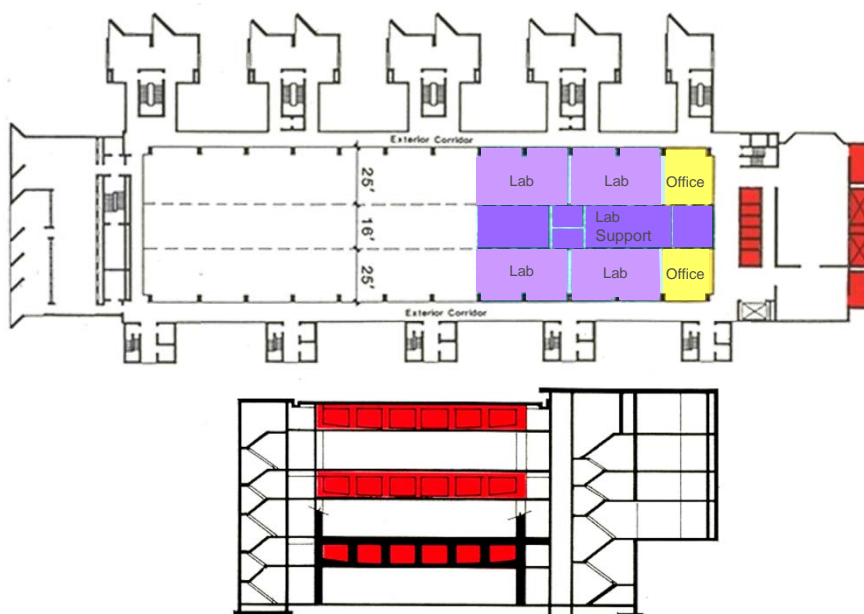




Early Labs

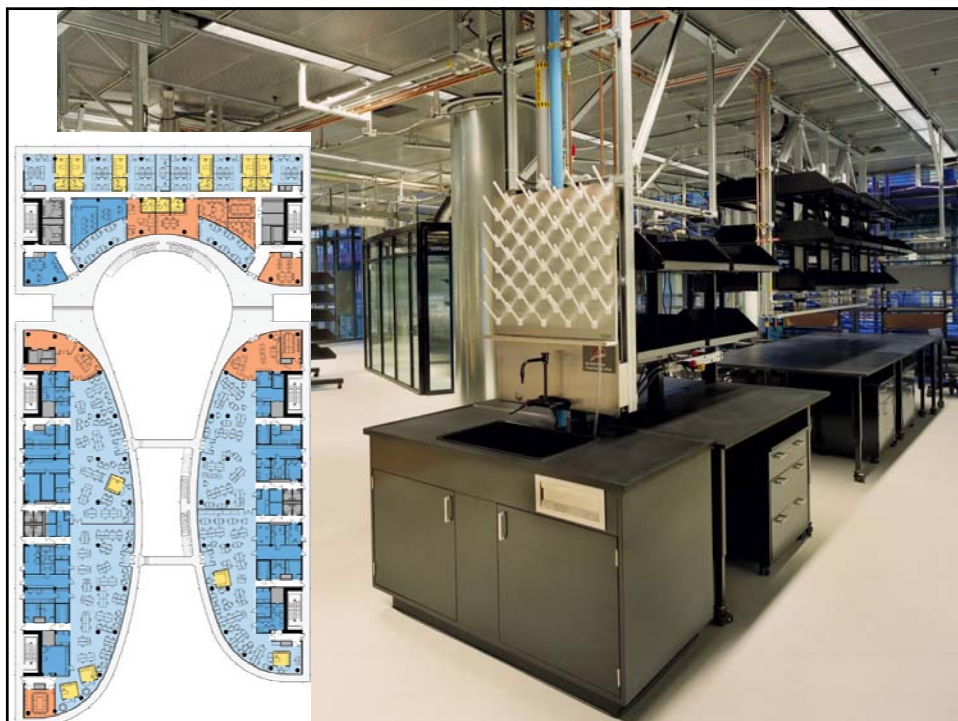
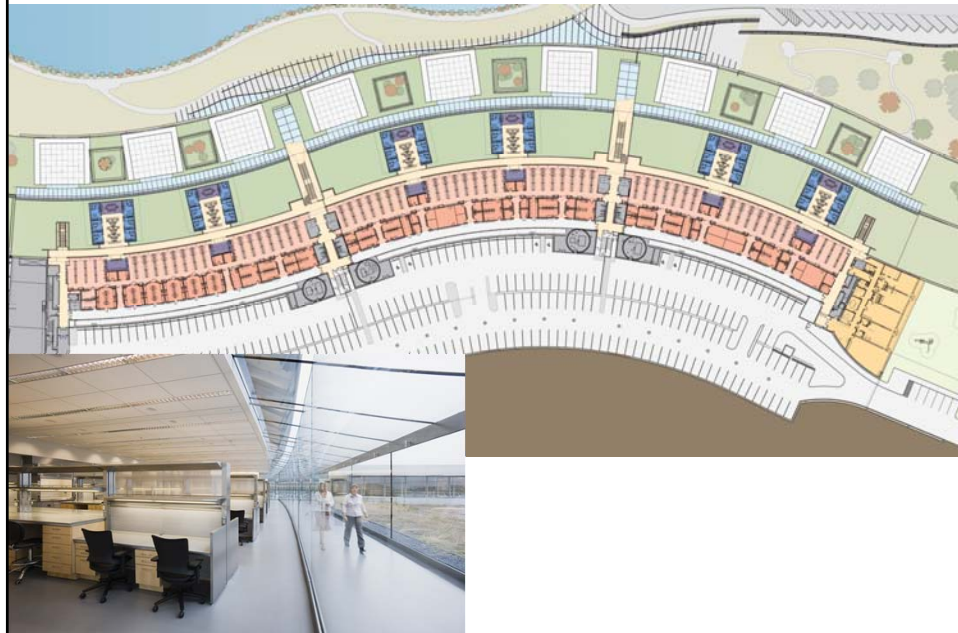


Salk Institute





Janelia Farms



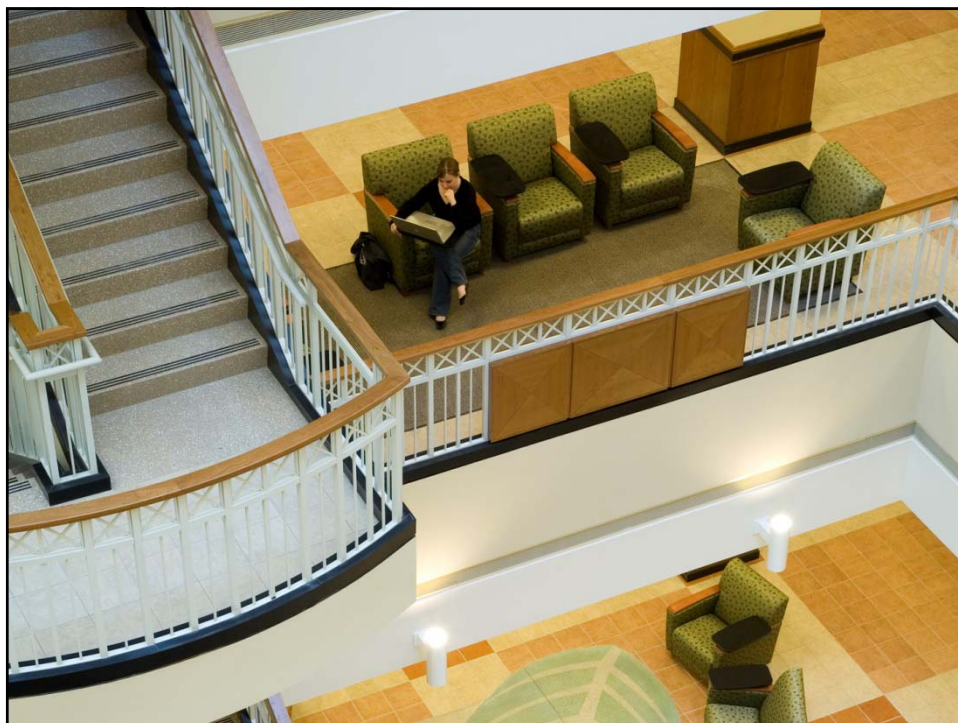
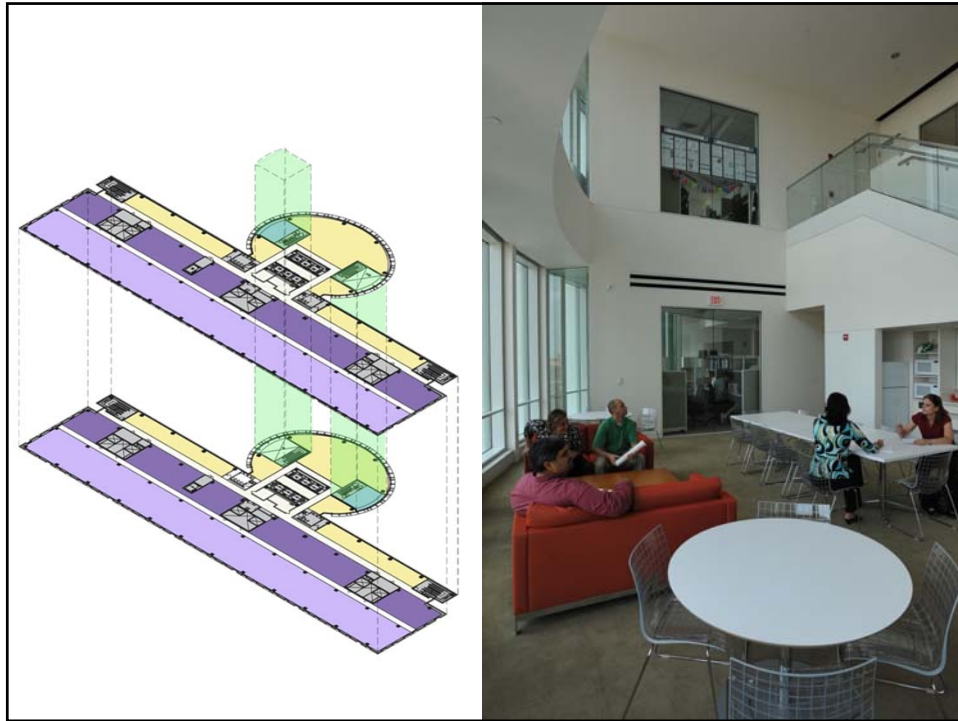


Driving Forces

- Safety
- Accurate research data
- Changing ratios of space – dry vs. wet
- Flexibility and adaptability -space for unknown requirements
- Promote collaboration
- Recruitment and retention
- Make it a good place to work

collaboration







transparency





flexible & adaptable





wellness







Agenda

- Laboratory Planning History and Trends
- **Codes and Guidelines**
- Infrastructure Basics
- Programming and Planning
- Equipment planning, procurement and installation process
- Casework Options
- How can we maximize resources?

Who are the rule makers?

- Codes
- Guidelines
- Regulations
- Grant Agency Requirements

THESE ARE ALL MINIMUM STANDARDS



Major Codes:

- International Building Code
- International Fire Code
- International Mechanical Code
- International Plumbing Code
- National Electric Code (NFPA 70)
- NFPA 101 – Life Safety Code
- NFPA 45 – Laboratory Design & Construction
- International Energy Conservation Code (Based on ANSI / ASHREA/ IESNA Standards 90.1.
- Texas Department of Licensing and Regulation

Federal, State and Local Regulations

- Occupational Safety and Health Guidelines
- Drug Controls
- Select Agent Controls
- Texas Dept of State Health Services - Radiation License, Laser, Asbestos Registration
- TX Commission on Environmental Quality (TCEQ)
- Local Building and Fire Codes
- University Controls including training and committee approval



NFPA 45 / Table 10.1.1a

Table 10.1.1(b) Maximum Quantities of Flammable and Combustible Liquids in Laboratory Units Outside of Inside Liquid Storage Areas (U.S. Customary Units)

Laboratory Unit Fire Hazard Class	Flammable and Combustible Liquid Class ^a	Quantities in Use ^a		Quantities in Use and Storage ^a	
		Maximum Quantity ^b per 100 ft ² of Laboratory Unit ^c	Maximum Quantity ^b per Laboratory Unit	Maximum Quantity ^b per 100 ft ² of Laboratory Unit ^c	Maximum Quantity ^b per Laboratory Unit
		gal	gal	gal	gal
A (high fire hazard)	I, II, and IIIA	10	480	20	480
		20	800	40	1600
B ^d (moderate fire hazard)	I, II, and IIIA	5	300	10	480
		10	400	20	800
C ^e (low fire hazard)	I, II, and IIIA	2	150	4	300
		4	200	8	400
D ^e (minimal fire hazard)	I, II, and IIIA	1	75	2	150
		1	75	2	150

Note: For maximum container sizes, see Table 10.1.2.

^aThe maximum amount in use in open systems is limited to 10 percent of the quantities listed.

^bSee 4.2.2 for additional requirements for educational and instructional laboratories.

^cThe quantities per 100 ft² do not imply the quantities must be within that 100 ft² area; the quantities per 100 ft² are for calculation purposes to determine the total quantity allowed per laboratory work area and the total amount overall in the laboratory unit.

^dReduce quantities by 50 percent for B laboratory units located above the 3rd floor.

^eReduce quantities by 25 percent for C and D laboratory units located on the 4th–6th floors of a building and reduce quantities by 50 percent for C and D laboratory units located above the 6th floor.

Separation Requirements and Height Allowances for Laboratory Units NFPA 45 Table 5.1.1

Lab Unit Classifications	Area of Lab	Fire Separation ^(b)	Permitted Stories Above Grade
A	<10,000 Sq. Ft.	2 Hours	1-3 Stories ^(c)
A	>10,000 Sq. Ft.	Not Permitted	
B	<10,000 Sq. Ft.	1 Hour	1-3 Stories ^(c)
B	<10,000 Sq. Ft.	2 Hours	4-6 Stories ^(c)
B	>10,000 Sq. Ft.	Not Permitted	
C	Any Size	Not Required	1-3 Stories
C	Any Size	1 Hour	4-6 Stories
C	Any Size	2 Hours	Over 6 Stories
D	Any Size	Not required	No Limit

(b) – Separation in this table refers to separation from laboratory units(s) to non-laboratory areas and/or separation from laboratory units(s) of equal or lower hazard classification.

(c) – Not allowed in structures below grade.

Notes:

- Per NFPA 45 Section 5.1.3 – Regardless of the construction and fire protection requirements for laboratory units specified in educational occupancies shall be separated from non-laboratory areas by 1-hour construction. Requiring ¼-hour protected openings.
- Per NFPA 45 Section 5.3.1 – Class A, B, and C laboratory units shall be classified as industrial occupancies in accordance with NFPA 101.
- Per NFPA 45 Section 5.3.2 – Educational laboratory units shall be classified as educational occupancies in accordance with NFPA 101.
- Per NFPA 45 Section 5.3.3 – Instructional laboratory units and Class D laboratories shall be classified as business occupancies in accordance with NFPA 101.



Chemical Quantities

		# of Control Areas per floor	IBC Table 414.2.2 "B" Occupancy Percentage of the Maximum Allowable Quantity per Control Area
10+		1	5%
9		2	5%
8		2	5%
7		2	5%
6		2	12.5%
5		2	12.5%
4		2	12.5%
3		2	50%
2		3	75%
1		4	100%
B1		3	75%
B2		2	50%
		0	0%

Allowable Chemical Quantities per Zone

Quantities	per zone	per zone sprinkler	per zone with sprinkler + approved cabinets (assumes 100% increase for sprinkler and another 100% for cabinets - (=listed*2*2)
Combination flammable liquid 1A, 1B, 1C	120 gallons	240 gallons	480 gallons



Chemical Quantities per Floor

Floor level	Percentage of Max allowable quantity per control area	Number of control areas/floor	Fire resistance rating for fire barriers (hr)	Combined flammable maximum per ZONE (with sprinkler and cabinets) (=listed*2*2) (gal)	Combined flammable maximum per FLOOR	Flammable Liquids		
						1A in use per floor (Sprinkler) (gal)	1B in use per floor (Sprinkler) (gal)	1C in use per floor (Sprinkler) (gal)
>9	5	1	2	24	24	1	1.5	2
7 - 9	5	2	2	24	48	2	3	4
6	12.5	2	2	60	120	5	7.5	10
5	12.5	2	2	60	120	5	7.5	10
4	12.5	2	2	60	120	5	7.5	10
3	50	2	1	240	480	30	45	60
2	75	3	1	360	1080	45	67.5	90
1st above grade	100	4	1	480	1920	80	120	160
1st below grade	75	3	1	360	1080	45	67.5	90
2	50	2	1	240	480	20	30	40

Class 1A - Liquids with flashpoint below 73 °F and having a boiling point below 100 °F.

Class 1B - Liquids with flashpoint at or below 73 °F and having a boiling point at or above 100°F.

Class 1C - Liquids with flashpoint at or above 73 °F and below 100°F.

Flashpoint Definition – The minimum temperature in degree Fahrenheit at which a liquid will give off sufficient vapors to form an ignition with air near the surface or in the container but will not sustain combustion.

Chemical Quantities per Floor

Floor level	Percentage of Max allowable quantity per control area	Number of control areas/floor	Fire resistance rating for fire barriers (hr)	Combined flammable maximum per ZONE (with sprinkler and cabinets) (=listed*2*2) (gal)	Combined flammable maximum per FLOOR	Flammable Liquids		
						1A in use per floor (Sprinkler) (gal)	1B in use per floor (Sprinkler) (gal)	1C in use per floor (Sprinkler) (gal)
>9	5	1	2	24	24	1	1.5	2
7 - 9	5	2	2	24	48	2	3	4
6	12.5	2	2	60	120	5	7.5	10
5	12.5	2	2	60	120	5	7.5	10
4	12.5	2	2	60	120	5	7.5	10
3	50	2	1	240	480	30	45	60
2	75	3	1	360	1080	45	67.5	90
1st above grade	100	4	1	480	1920	80	120	160
1st below grade	75	3	1	360	1080	45	67.5	90
2	50	2	1	240	480	20	30	40

Class 1A - Liquids with flashpoint below 73 °F and having a boiling point below 100 °F.

Class 1B - Liquids with flashpoint at or below 73 °F and having a boiling point at or above 100°F.

Class 1C - Liquids with flashpoint at or above 73 °F and below 100°F.

Flashpoint Definition – The minimum temperature in degree Fahrenheit at which a liquid will give off sufficient vapors to form an ignition with air near the surface or in the container but will not sustain combustion.



Chemical & Flammable Gas List

HAZARDOUS MATERIALS INVENTORY ROUTING FORM								
Fill out the forms for the materials stored, used or handled at your site by indicating yes or no in each area provided. These forms in their entirety shall be submitted with each permit application when appropriate. Having permit amounts requires a permit for the operation. The exempt amounts are for use in the routing of those permits.								
PHYSICAL HAZARDS								
MATERIAL	CLASS	DESCRIPTION	PERMIT AMOUNTS	EXEMPT AMOUNTS STORAGE	EXEMPT AMOUNTS USE CLOSED – vapors are not liberated	EXEMPT AMOUNTS USE OPEN – vapors are liberated	HAVE AMOUNTS THAT REQUIRE A PERMIT?	HAVE ABOVE EXEMPT AMOUNTS?
COMBUSTIBLE LIQUIDS	II	Class II liquids include those having flash points at or above 100°F and below 140°F.	> 25 gallons inside or > 60 gallons outside	120 gallons	120 gallons	30 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
COMBUSTIBLE LIQUIDS	IIIA	Class IIIA liquids include those having flash points at or above 140°F and below 200°F.	> 25 gallons inside or > 60 gallons outside	330 gallons	330 gallons	80 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
COMBUSTIBLE LIQUIDS	IIIB	Class IIIB liquids include those liquids having flash points at or above 200°F.	Only – Tanks or Vessels > 60 gallons	13,200 gallons	13,200 gallons	3,300 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
FLAMMABLE LIQUIDS	IA	Class IA liquids include those having flash points below 73°F and having a boiling point below 100°F.	> 5 gallons inside or > 10 gallons outside	30 gallons	30 gallons	10 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
FLAMMABLE LIQUIDS	IB	Class IB liquids include those having flash points less than 73°F and boiling points at or above 100°F.	> 5 gallons inside or > 10 gallons outside	60 gallons	60 gallons	15 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
FLAMMABLE LIQUIDS	IC	Class IC liquids include those having flash points at or above 73°F and below 100°F.	> 5 gallons inside or > 10 gallons outside	90 gallons	90 gallons	20 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
COMBINATION FLAMMABLE LIQUIDS	(IA,IB,IC)	Mixture of storage or use of more than one of these materials.	> 5 gallons inside or > 10 gallons outside	120 gallons	120 gallons	30 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
CRYOGENIC, FLAMMABLE (Flammable in its vapor state)	Definition: A liquid having a boiling point lower than -150°F at 14.7 (psia).	Examples: carbon monoxide, deuterium (heavy hydrogen), ethylene, hydrogen and methane.	> 1 gallon inside or > 60 gallons outside	45 gallons	45 gallons	10 gallons	NO <input type="checkbox"/> YES <input type="checkbox"/>	NO <input type="checkbox"/> YES <input type="checkbox"/>
CRYOGENIC Inert			> 60 gallons inside or 500 gallons outside	Not Limited	Not Limited	Not Limited	NO <input type="checkbox"/> YES <input type="checkbox"/>	Not Limited

HMIRF/3/07/05

1 of 6

H Occupancy

- Hazardous Group H. Hazardous Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or **storage** of materials that constitute a physical or health hazard in quantities in excess of those found in Tables 307.7(1) and 307.7(2)






H2 –H4 Occupancy

- 2 hour separation + panic exit hardware
- IFC 2704.2.2 - Secondary containment for rooms used for the storage of flammable liquids is not required if they are stored in individual containers of 55 gallons or less, or the combined total liquids stored is 1000 gallons or less.
- IBC 415.3 - ... of not more than 500 sf need not be located on a perimeter wall
- IFC 2704.3 – describes mechanical ventilation requirements
 - Accordance with International Mechanical Code
 - Separate 2 hour exhaust required
 - Labeled manual shutoff valve outside the room
 - If gasses heavier than air, low return required



Permitting

- IBC 414.1.3 – requires separate floor plans for each H area with a report of hazardous materials
- A separate statement has to be submitted for each control area and H room



**HOUSTON FIRE DEPARTMENT
PERMIT OFFICE**
1205 Dart, Houston, Texas 77007

HAZARDOUS MATERIALS INVENTORY ROUTING FORMS

SECTION 2704.2 - ENABLER THE C PROVIDED CONTAINING ALL OF THE AN APPLICATION FOR PERMIT.


Purpose: The information provided in this the permit application. The routing for requirements. There are additional routing out for that address. Different addresses not

Directions: Fill out the forms for the materials provided. If you do not have a type of not per NA or RNA. These forms in their listed below. However, if there are multiple out for that address. Different addresses not


Permit Types Requiring Hazardous Materials

CODE	DESCRIPTION
105.6.1	ALCOHOL PRODUCTS
105.6.8	COMBUSTIBLE LIQUIDS
105.6.9	COMBUSTIBLE GASES
105.6.11	CRYOGENIC FLUIDS
105.6.12	EXPLOSIVES OR BLASTING
105.6.17	FLAMMABLE AND COMBUSTIBLE
105.6.21	HAZARDOUS MATERIALS
105.6.28	LP-GAS
105.6.29	MAGNESIUM
105.6.33	ORGANIC COATINGS
105.6.37	PYROLYTIC PLASTICS

Definitions: Hazardous Material - Those chemicals or substances that upon release have the potential to cause harm to humans, animals, property, or the environment.



**THE CITY OF HOUSTON, TEXAS
FIRE DEPARTMENT, FIRE MARSHALS OFFICE
HAZMAT / HIGH PILED INSPECTION TEAM
OWNER'S STATEMENT OF INTENDED USE**



BUILDING ADDRESS _____

CITY OF HOUSTON PROJECT NUMBER _____

CONSTRUCTION TYPE _____

DESCRIPTION OF USE _____

TOTAL BUILDING AREA (SQUARE FEET) _____

HAZARDOUS MATERIALS:

As defined in Chapter 27 of the 2000 Houston Fire Code, which are physical hazards, or health hazards, or both, which are in liquid or solid condition. Liquids in excess of several amounts shall be included.

☐ This building will not be used for the storage of materials listed in the Houston Fire Code.

HIGH-PILED COMBUSTIBLE STORAGE:

As defined in Chapter 23 of the 2000 Houston Fire Code, which are materials in closely packed piles or on racks.

Location of Chemicals (Check One)

Inside _____

Outside _____

This Statement Applies To:

(Check One)

Use Open _____

Use Closed _____

Storage _____

Business name: _____

Address: _____

Declaration:

Under penalty of perjury, I declare the above and subsequent information, provided as part of the hazardous materials inventory statement, is true and correct.

Printed Name: _____ Title: _____

Signature: _____ Date: _____

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
HAZMAT CLASS	Common/Trade Name	Chemical Name, Components and Concentration	Chemical Abstract Service No.	Physical State	Quantity on-hand	Units	Storage Code (Type, Press, Temp)	Remarks



H Occupancy Option



Second Means of Access to a Exit NFPA 45 Section 5.4

A second means of access to an exit shall be provided from a laboratory work area if any of the following situations exist:

- A laboratory work area contains an explosion hazard located that so that an incident would block escape from or access to the laboratory work area.
- A laboratory work area within a Class A laboratory unit exceeds 500 Sq. Ft.
- A laboratory work area within a Class B, C or D exceeds 1,000 Sq. Ft.
- A hood in a laboratory work area is located adjacent to the primary means of exit access.
- A compressed gas cylinder larger than 2" x 13" is located such that it could prevent safe egress in the event of accidental release of cylinder contents.
- A cryogenic container is located such that it could prevent safe egress in the event of accidental release of container contents.



Direction of Door Swing NFPA 45 Section 5.4

- Class A & B Labs - All laboratory work areas shall swing in the direction of exit travel.
- Class C & D Labs - All laboratory work areas shall be permitted to swing against the direction of exit travel or shall be permitted to be a horizontal sliding door complying with NFPA 101.



Safety Equipment

- **Portable Fire Extinguishers** –
Accessible within in each lab
– Look at codes for size and placement
- **Safety Showers/ Eyewash** –
(ANSI Z358.1) Be in accessible locations that require no more than 10 seconds to reach (about 55' unobstructed). For strong acid/caustic – immediately adjacent



Design for Safety



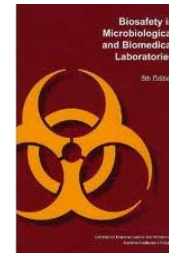
Fire Sprinklers Save Facilities





Guidelines and Funding Agencies

- AALAC
- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition
<http://www.cdc.gov/biosafety/publications/bmb15/index.htm>
- NIH Design Requirements Manual
<http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManualPDF.aspx>
- NIH Guidelines For Research Involving Recombinant DNA Molecules
 October 2011, Appendix G- Physical Containments



BMBL 5 - Biosafety in Microbiological and Biomedical Laboratories 5th Edition

Table 2. Summary of Recommended Biosafety Levels for Infectious Agents

BSL	Agents	Practices	Primary Barriers and Safety Equipment	Facilities (Secondary Barriers)
1	Not known to consistently cause diseases in healthy adults	Standard microbiological practices	<ul style="list-style-type: none"> ■ No primary barriers required. ■ PPE: laboratory coats and gloves; eye, face protection, as needed 	Laboratory bench and sink required
2	<ul style="list-style-type: none"> ■ Agents associated with human disease ■ Routes of transmission include percutaneous injury, ingestion, mucous membrane exposure 	BSL-1 practice plus: <ul style="list-style-type: none"> ■ Limited access ■ Biohazard warning signs ■ "Sharps" precautions ■ Biosafety manual defining any needed waste decontamination or medical surveillance policies 	Primary barriers: <ul style="list-style-type: none"> ■ BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials ■ PPE: Laboratory coats, gloves, face and eye protection, as needed 	BSL-1 plus: <ul style="list-style-type: none"> ■ Autoclave available
3	Indigenous or exotic agents that may cause serious or potentially lethal disease through the inhalation route of exposure	BSL-2 practice plus: <ul style="list-style-type: none"> ■ Controlled access ■ Decontamination of all waste ■ Decontamination of laboratory clothing before laundering 	Primary barriers: <ul style="list-style-type: none"> ■ BSCs or other physical containment devices used for all open manipulations of agents ■ PPE: Protective laboratory clothing, gloves, face, eye and respiratory protection, as needed 	BSL-2 plus: <ul style="list-style-type: none"> ■ Physical separation from access corridors ■ Self-closing, double-door access ■ Exhausted air not recirculated ■ Negative airflow into laboratory ■ Entry through airlock or anteroom ■ Hand washing sink near laboratory exit
4	<ul style="list-style-type: none"> ■ Dangerous/exotic agents which pose high individual risk of aerosol-transmitted laboratory infections that are frequently fatal, for which there are no vaccines or treatments ■ Agents with a close or identical antigenic relationship to an agent requiring BSL-4 until data are available to redesignate the level ■ Related agents with unknown risk of transmission 	BSL-3 practice plus: <ul style="list-style-type: none"> ■ Clothing change before entering ■ Shower on exit ■ All material decontaminated on exit from facility 	Primary barriers: <ul style="list-style-type: none"> ■ All procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure suit 	BSL-3 plus: <ul style="list-style-type: none"> ■ Separate building or isolated zone ■ Dedicated supply and exhaust, vacuum, and decontamination systems ■ Other requirements outlined in the text

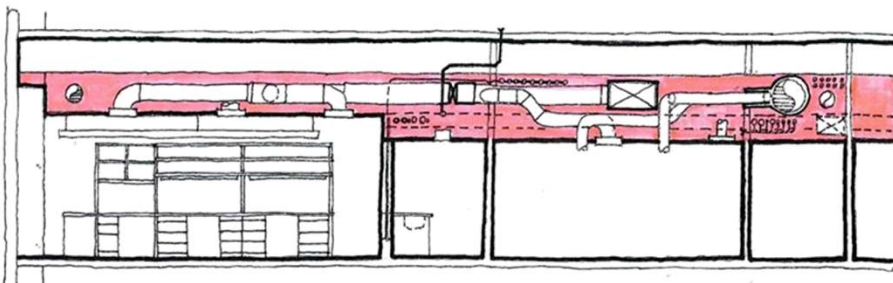


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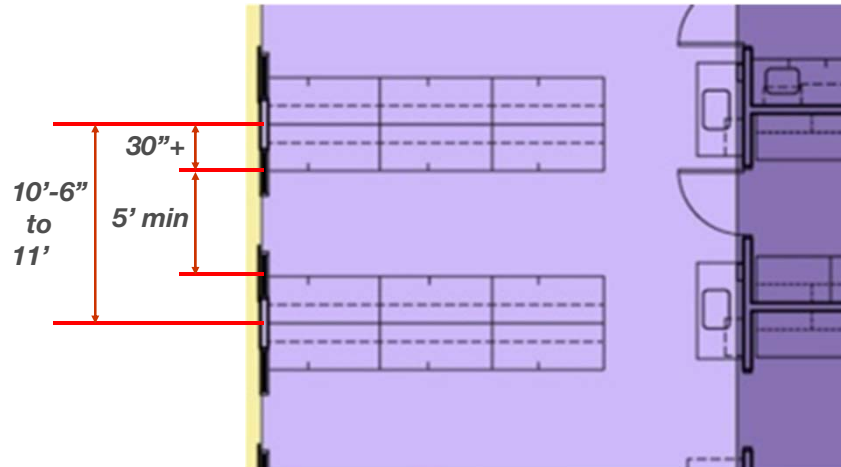
Structural Dimensions

- Floor-to-floor heights – 16 feet desired
- Column bay spacing – to accommodate lab modules of 10'6" to 11'0"





Lab Modules



Structural Considerations

- Structural loading capacity
 - general labs – 100 lbs/sf min.
 - specialty labs / sensitive equipment – 200 lbs/sf
 - path of travel for heavy equipment
 - roof structure for additional mechanical equipment
 - support framing for utility services



Structural Stiffness - Labs 2000 mips

ASHRAE TC 2.6 Vibration Guideline Criteria

Criterion Curve (see Figure 1)			
Description of Use	Max Level ¹ micro inches/sec (dB)	Detail Size ² (microns)	Description
Workshop (ISO)	32,000 (98)	N / A	Distinctly feelable vibration. Appropriate to workshops and nonsensitive areas.
Office (ISO)	16,000 (92)	N / A	Feelable vibration. Appropriate to offices and nonsensitive areas.
Residential Day (ISO)	8,000 (84)	75	Barely feelable vibration. Appropriate to sleep areas in most instances. Probably adequate for computer equipment and low-power (to 50X) microscopes.
Op. Theatre (ISO)	4,000 (80)	25	Vibration not feelable. Suitable for sensitive sleep areas. Suitable in most instances for microscopes to 100X and for other equipment and low sensitivity.
VC-A	2,000 (74)	8	Adequate in most instance for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	1,000 (68)	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 μ line widths.
VC-C	500 (60)	1	A good standard for most lithography and inspection equipment (including electron microscopes) to 1 μ detail size.
VC-D	250 (56)	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	125 (50)	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems requiring extraordinary dynamic stability.

Power

Right size in programming

- Plug Loads
 - 10 – 25 w/nsf
 - office: 2-4 w/nsf
- Emergency Power
 - Ultra-low Freezers, cold rooms
 - Exhaust
 - Critical equipment





Lab Air

- 100% outside air
- No recirculation
- Higher Air Change Rate
 - 6-15 air changes/hr, 100% make-up
 - office: 4-6 air changes/hr, 25% make-up



Typical Lab Ventilation Rates – Outside Air

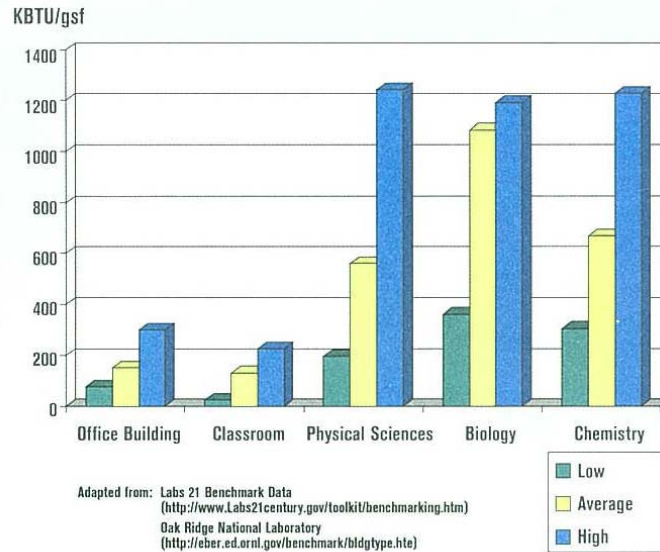
	Lab Ventilation Rates					
Min ACH	6	6	8	8	10	10
Ceiling Height	9	10	9	10	9	10
CFM/sqft	0.9	1.0	1.2	1.3	1.5	1.7

Typical Office will range 0.14 to 0.3 CFM/sqft of equivalent outside air depending on occupancy

One Example :\$5.39/sqft Lab air - \$1.55/sqft Office air

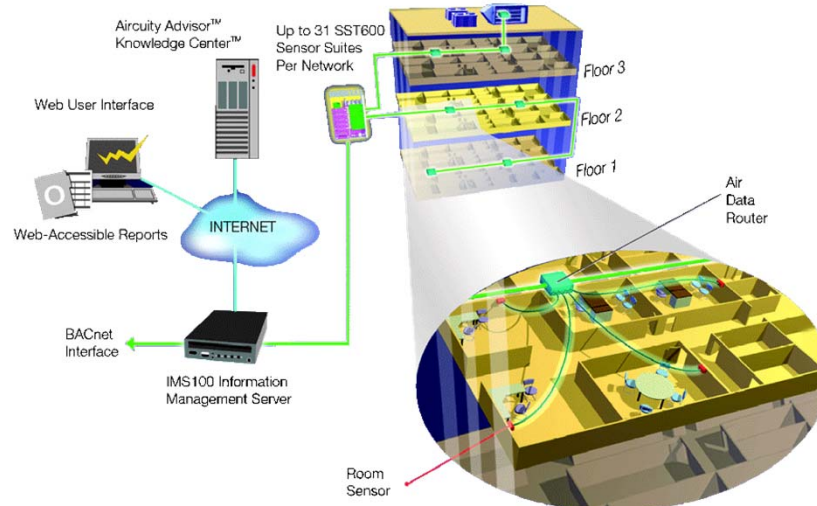


Lab Buildings Use More Energy



Printed from Laboratory Design Newsletter

Air Monitoring System





CFM Savings

- 99.5% of time, Lab exhaust at minimum (reduced flow)
- Outside Air AHU speed set by exhaust requirement
- 4th Floor – CFM Reduced by 7900 CFM
- 7th Floor – CFM Reduced by 5800 CFM
- Estimated annual savings of \$103,000 per year (\$7.50/CFM in 2003)

Payback is approximately 1 Year

www.aircuity.com

Agenda

- Laboratory Planning History and Trends
- Codes and Guidelines
- Infrastructure Basics
- **Programming and Planning**
- Equipment planning, procurement and installation process
- Casework Options
- How can we maximize resources?



How Do you Start

- Standard Questions = Standard Answers
- What we really need to ask.
- Who funds your grants? National Institutes of Health? Department of the Army? Outside company? Clues as to they type of research they will be doing.
- What Licenses or Registrations are required for your research?
 - Drug License – Gives hints of need for a lockable space or special conditions?
 - Laser Registration
 - X-Ray Registration
 - Radioactive Material Registration

Chemical List

- For classification of lab
- Need for permit
- Will determine special needs
 - Aqua Regia





Will Animal or Human Research be Involved?

- Whole set of compliance needs
- Federal, State, and University Compliance will mandate the lab design



RICE UNIVERSITY OFFICE OF SPONSORED RESEARCH

6100 MAIN STREET, MS-16
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FAX: (713) 348-5425

CAMPUS ADDRESS:
350 ALLEN CENTER



Keys to Unlock Design

Development of Virus-Like Particles as Imaging Contrast Agents
Kelly S. Horn, William D. Shepard, Kellie I. McConnell, Aaron C. Mack & Junghae Suh

MOTIVATION

- Contrast agents important for imaging biological and pathological targets
- Can use to track migration of individual cells in vivo

Need for imaging agents that provide high contrast with high selectivity.

NONVIRAL IMAGING AGENTS

- Lipid, iron oxide, and gold-based nanoparticles
- High contrast

Figure 1: Immunotargeted contrast agent

Major Drawback: Requires prior knowledge of receptor-ligand pair to achieve specificity.

ADENO-ASSOCIATED VIRUS (AAV)

Figure 2: LEFT: capsid of AAV and RIGHT: capsid protein subunit

OUR APPROACH

- Multivalent display of fluorophores on virus-like particles (VLPs)
 - chemical conjugation
 - genetic engineering
- Selective targeting of cells achieved via directed evolution
- Generate noninfectious VLPs → no viral genome

Figure 3: Red fluorescent protein (RFP) expression

FLUORESCENT AAV

Figure 4: LEFT: western blot of AAV with 4xss insert or red fluorescent protein (RFP) insert in N-terminus of VP1 & VP2. RIGHT: titration of fluorescent virus preparations before and after heparin affinity column purification.

Fluorescent protein insertion did not alter natural tropism.

TARGETING CELLS

Figure 5: Directed evolution of AAV

Directed evolution approaches used to generate selective VLPs

SUMMARY

- Reengineer viruses as imaging agents
- Multivalent display of fluorophores
- Use directed evolution to achieve selectivity

Develop AAV-based VLPs in innovative ways as platform technology for biomedical imaging.

SUHLAB@RICE.EDU

Figure 6: Fluorescent AAV (RFP) expression

Figure 7: Fluorescent AAV (RFP) expression

Figure 8: Fluorescent AAV (RFP) expression

Figure 9: Fluorescent AAV (RFP) expression

Figure 10: Fluorescent AAV (RFP) expression

Figure 11: Fluorescent AAV (RFP) expression

Figure 12: Fluorescent AAV (RFP) expression

Figure 13: Fluorescent AAV (RFP) expression

Figure 14: Fluorescent AAV (RFP) expression

Figure 15: Fluorescent AAV (RFP) expression

Figure 16: Fluorescent AAV (RFP) expression

Figure 17: Fluorescent AAV (RFP) expression

Figure 18: Fluorescent AAV (RFP) expression

Figure 19: Fluorescent AAV (RFP) expression

Figure 20: Fluorescent AAV (RFP) expression

Figure 21: Fluorescent AAV (RFP) expression

Figure 22: Fluorescent AAV (RFP) expression

Figure 23: Fluorescent AAV (RFP) expression

Figure 24: Fluorescent AAV (RFP) expression

Figure 25: Fluorescent AAV (RFP) expression

Figure 26: Fluorescent AAV (RFP) expression

Figure 27: Fluorescent AAV (RFP) expression

Figure 28: Fluorescent AAV (RFP) expression

Figure 29: Fluorescent AAV (RFP) expression

Figure 30: Fluorescent AAV (RFP) expression

Figure 31: Fluorescent AAV (RFP) expression

Figure 32: Fluorescent AAV (RFP) expression

Figure 33: Fluorescent AAV (RFP) expression

Figure 34: Fluorescent AAV (RFP) expression

Figure 35: Fluorescent AAV (RFP) expression

Figure 36: Fluorescent AAV (RFP) expression

Figure 37: Fluorescent AAV (RFP) expression

Figure 38: Fluorescent AAV (RFP) expression

Figure 39: Fluorescent AAV (RFP) expression

Figure 40: Fluorescent AAV (RFP) expression

Figure 41: Fluorescent AAV (RFP) expression

Figure 42: Fluorescent AAV (RFP) expression

Figure 43: Fluorescent AAV (RFP) expression

Figure 44: Fluorescent AAV (RFP) expression

Figure 45: Fluorescent AAV (RFP) expression

Figure 46: Fluorescent AAV (RFP) expression

Figure 47: Fluorescent AAV (RFP) expression

Figure 48: Fluorescent AAV (RFP) expression

Figure 49: Fluorescent AAV (RFP) expression

Figure 50: Fluorescent AAV (RFP) expression

Figure 51: Fluorescent AAV (RFP) expression

Figure 52: Fluorescent AAV (RFP) expression

Figure 53: Fluorescent AAV (RFP) expression

Figure 54: Fluorescent AAV (RFP) expression

Figure 55: Fluorescent AAV (RFP) expression

Figure 56: Fluorescent AAV (RFP) expression

Figure 57: Fluorescent AAV (RFP) expression

Figure 58: Fluorescent AAV (RFP) expression

Figure 59: Fluorescent AAV (RFP) expression

Figure 60: Fluorescent AAV (RFP) expression

Figure 61: Fluorescent AAV (RFP) expression

Figure 62: Fluorescent AAV (RFP) expression

Figure 63: Fluorescent AAV (RFP) expression

Figure 64: Fluorescent AAV (RFP) expression

Figure 65: Fluorescent AAV (RFP) expression

Figure 66: Fluorescent AAV (RFP) expression

Figure 67: Fluorescent AAV (RFP) expression

Figure 68: Fluorescent AAV (RFP) expression

Figure 69: Fluorescent AAV (RFP) expression

Figure 70: Fluorescent AAV (RFP) expression

Figure 71: Fluorescent AAV (RFP) expression

Figure 72: Fluorescent AAV (RFP) expression

Figure 73: Fluorescent AAV (RFP) expression

Figure 74: Fluorescent AAV (RFP) expression

Figure 75: Fluorescent AAV (RFP) expression

Figure 76: Fluorescent AAV (RFP) expression

Figure 77: Fluorescent AAV (RFP) expression

Figure 78: Fluorescent AAV (RFP) expression

Figure 79: Fluorescent AAV (RFP) expression

Figure 80: Fluorescent AAV (RFP) expression

Figure 81: Fluorescent AAV (RFP) expression

Figure 82: Fluorescent AAV (RFP) expression

Figure 83: Fluorescent AAV (RFP) expression

Figure 84: Fluorescent AAV (RFP) expression

Figure 85: Fluorescent AAV (RFP) expression

Figure 86: Fluorescent AAV (RFP) expression

Figure 87: Fluorescent AAV (RFP) expression

Figure 88: Fluorescent AAV (RFP) expression

Figure 89: Fluorescent AAV (RFP) expression

Figure 90: Fluorescent AAV (RFP) expression

Figure 91: Fluorescent AAV (RFP) expression

Figure 92: Fluorescent AAV (RFP) expression

Figure 93: Fluorescent AAV (RFP) expression

Figure 94: Fluorescent AAV (RFP) expression

Figure 95: Fluorescent AAV (RFP) expression

Figure 96: Fluorescent AAV (RFP) expression

Figure 97: Fluorescent AAV (RFP) expression

Figure 98: Fluorescent AAV (RFP) expression

Figure 99: Fluorescent AAV (RFP) expression

Figure 100: Fluorescent AAV (RFP) expression



<u>University</u>	<u>Laboratory Questionnaire</u>																								
_____ Laboratory																									
<p>Contact: _____ Name: _____ Phone: _____</p> <p>E-mail: _____</p> <p>This form and the attached "Program Equipment List" will be used during the Space Programming Meeting to determine your space needs for the renovation project. Please be prepared to discuss each item. Disregard any that do not apply to your laboratory. Use additional pages as required. Feel free to include "cut-sheets" or catalog sheets of specific equipment, particularly specialized equipment.</p>																									
<p>1. Briefly describe your department's functions, research and/or services provided. Emphasize any non-typical or special services.</p>																									
<p>2. Staffing/Positions:</p>																									
<p>3. Describe special rooms to be part of your laboratory, such as Tissue Culture, Microscopy, Animal Procedure, etc.</p>																									
<p>4. Primary Lab equipment:</p> <table style="width: 100%;"> <tr> <td>Chemical Fume Hood:</td> <td>Number: _____</td> <td>Size: _____</td> </tr> <tr> <td>Biosafety Cabinet:</td> <td>Number: _____</td> <td>Size: _____</td> </tr> <tr> <td>Snorkel:</td> <td>Number: _____</td> <td>Size: _____</td> </tr> <tr> <td>Other:</td> <td>Number: _____</td> <td>Size: _____</td> </tr> </table> <p>Any specialized hoods (i.e. radioactive, perchloric, etc.)?</p>		Chemical Fume Hood:	Number: _____	Size: _____	Biosafety Cabinet:	Number: _____	Size: _____	Snorkel:	Number: _____	Size: _____	Other:	Number: _____	Size: _____												
Chemical Fume Hood:	Number: _____	Size: _____																							
Biosafety Cabinet:	Number: _____	Size: _____																							
Snorkel:	Number: _____	Size: _____																							
Other:	Number: _____	Size: _____																							
<p>5. Special equipment or process needs:</p> <table style="width: 100%;"> <tr> <td>Vibration sensitive</td> <td>_____</td> </tr> <tr> <td>Heat producing</td> <td>_____</td> </tr> <tr> <td>Noise producing</td> <td>_____</td> </tr> <tr> <td>Light sensitive</td> <td>_____</td> </tr> </table>		Vibration sensitive	_____	Heat producing	_____	Noise producing	_____	Light sensitive	_____																
Vibration sensitive	_____																								
Heat producing	_____																								
Noise producing	_____																								
Light sensitive	_____																								
<p>6. Plumbing:</p> <table style="width: 100%;"> <tr> <td>Water:</td> <td>HW _____</td> <td>CW _____</td> </tr> <tr> <td>High purity water:</td> <td>RO _____</td> <td>DI _____</td> </tr> <tr> <td>Cooling water?:</td> <td colspan="2">Describe use: _____</td> </tr> <tr> <td>Steam?:</td> <td colspan="2">Describe use: _____</td> </tr> <tr> <td>Any "oversized" lab sinks required?</td> <td colspan="2">_____</td> </tr> <tr> <td>Piped services:</td> <td>Lab Air _____</td> <td>Nat Gas _____</td> </tr> <tr> <td></td> <td>CO2 _____</td> <td>N2 _____</td> </tr> <tr> <td></td> <td>Compressed air:</td> <td>_____ psi.</td> </tr> </table> <p>Special gasses: _____</p> <p>Will any gasses require a central or piped distribution system?</p>		Water:	HW _____	CW _____	High purity water:	RO _____	DI _____	Cooling water?:	Describe use: _____		Steam?:	Describe use: _____		Any "oversized" lab sinks required?	_____		Piped services:	Lab Air _____	Nat Gas _____		CO2 _____	N2 _____		Compressed air:	_____ psi.
Water:	HW _____	CW _____																							
High purity water:	RO _____	DI _____																							
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	CO2 _____	N2 _____																							
	Compressed air:	_____ psi.																							

<u>University</u>	<u>Laboratory Questionnaire</u>
_____ Laboratory	
<p>7. Electrical:</p> <p>Special power (other than 120v/208v)?</p> <p>Is an Isolation Transformer or other power conditioning required?</p> <p>Is Emergency Power required?</p> <p>Is Uninterruptible Power required?</p> <p>Are there any special EMF/RFI shielding requirements?</p>	
<p>8. Hazardous Materials.</p> <p>What chemicals do you typically use and in what quantities? Please list on separate page.</p> <p>Do you use any radioactive materials?</p> <p>What gasses are anticipated?</p> <p>Will any gasses require a central, or piped distribution system?</p>	
<p>9. Any other very unique space requirements?</p> <p>Clean Room? Humidity controlled room, require darkness</p>	
<p>10. Temperature/Humidity Control.</p> <p>If humidity is a concern, what are the tolerances?</p> <p>If temperature is a concern what range is acceptable (degrees F)</p>	
<p>11. Any other issues that might trigger infrastructure needs?</p>	
<p>12. Any other unique equipment requirements other than described on equipment list?</p> <p>How many Furnaces/Ovens will be used in the lab? List respective BTU/h ratings?</p> <p>How many vacuum pumps will be needed?</p> <p>How many "air-cooled" chillers are required in the lab?</p> <p>How many "water-cooled" chillers are required in the lab?</p> <p>Any Autoclaves or other sterilizers?</p> <p>Any Equipment that requires exhaust?</p>	



Agenda

- Laboratory Planning History and Trends
- Codes and Guidelines
- Infrastructure Basics
- Safety Basics
- Programming and Planning
- **Equipment planning, procurement and installation process**
- Casework Options
- Finish Selections
- How can we maximize resources?

What is Equipment Planning?

Services for Coordination, Specification, Procurement and Installation of:

- **Fixed Equipment** (if you turn the building upside down - everything that stays)
 - environmental rooms, fume hoods, autoclaves, ducted biosafety cabinets, cagewashing, etc.
- **Movable Equipment**
 - Refrigerators, Freezers, Incubators, Centrifuges, Lab stools, trash cans, etc.



Equipment Planning Objectives

In the Drawings – Building Readiness

- **Documenting OF/CI and CF/CI requirements**

- Equipment specifications
- Installation requirements

- **Installation Requirements for OFOI**

- Power/Data/Alarms/Vibration sensitivity
- Mounting Plates, blocking
- Plumbing & Final Connections
- Plug Configurations

8 Laboratory Equipment Related Specifications:

- 11 61 00 : Biosafety Cabinets
- 11 61 20 : Fume Hoods
- 11 70 00 : Laboratory Equipment, General Requirements
- 11 70 20 : Laboratory Equipment, Owner Furnished
- 11 70 50 : Laboratory Equipment, Contractor Furnished
- 11 70 61 : Sterilization Equipment
- 11 70 70 : Ceiling Mounted Procedure Lights & Booms
- 11 71 20 : Washers & Disinfection Equipment

(Utilizing CSI MasterFormat Numbers, 2012)

Equipment Specifications

Project No. 050 295-2005-903.9

CANCER AND CRITICAL CARE TOWER (CCFT)

1. Acceptable manufacturers:
a. Styker Corporation, Model No. ICU 600 Tandem Mount
Unit shall include, but not be limited to, the following features and characteristics:
i. Centrally mounted Dual Arm ceiling mounted support beam used to organize and mount different diagnostics and clinical equipment
ii. Final configurations of gases, electric, and data outlets, TSD
iii. Physiological monitor mount, TSD
iv. Exam Light
v. Dimensions: Refer to vendor drawings
vi. Accessories: TSD Provide allowance for range of dangle and accessories for selection for nursing bedside and other minor items to the equipment
vii. Installation: Install where indicated on the Medical Equipment Documents and in accordance to vendor instructions
viii. Notes: TSD FINAL REVIEW FOLLOWING OWNER / CONTRACTOR MOCK UP EXERCISE - TSD

CC. Item G001, Smoke Evacuation Console: O.R. Basic Module, Mounted on Surgical Support Column
1. Acceptable manufacturers:
a. Benchmark Corporation, Model No. Teltec
Unit shall include, but not be limited to, the following features and characteristics:
i. Variable flow suction rate
ii. Quiet motor operation
iii. Disposable side control/particulate prefilter cassette: 50% efficient at 5 micron
iv. Disposable vacuum tubing
v. To be coordinated with final layout / location vendor, located on equipment beam where suitable
vi. Dimensions: TSD
vii. Accessories: TSD Provide additional set of replacement components
viii. Installation: Install where indicated on the Medical Equipment Documents

DD. Item H0345, Fume Hood Assembly: Laboratory General Purpose, Complete with Counter Top, Base Cabinet and Ceiling Enclosure Panel
1. Acceptable manufacturers:
a. Fisher Hamilton, Model No. 54-733PO
Unit shall include, but not be limited to, the following features and characteristics:
i. Shall be UL 1003 Classified
ii. Shall be tested in accordance with 110 Standard with a containment rating of 4.0AM 2.0PPM
iii. Safety shall be fixed to maximize capture and airflow within hood while removing static pressure and noise levels
iv. Single counter balance each system with adjustable chain link system
v. Sight line to be 30" high
vi. Sight shall travel automatically on delay at the 10" opening when released
vii. Toggle lock installed to secure each at full open position when required
viii. Sight shall be latched without delay at a top hanging counterbalance
ix. Sight shall have low profile to facilitate ease of access to the work surface
x. Include accessory of fume hood environment monitoring device, to successfully connect with future system monitoring infrastructure solution, TSD
xi. If available, unit to include integrated HEPA filter
xii. Dimensions: 48" wide x 31.25" deep x 52" high
xiii. Accessories: None
xiv. Installation: Install where indicated on the Medical Equipment Documents

Example of 11 70 50, CFCI Equipment

CANCER AND CRITICAL CARE TOWER (CCFT)

where's catalog numbers may be listed in the specifications for an Owner furnished medical equipment. Unless modified by the project existing description for indicated number, together with accessories, constitutes requirements for each such unit.

Specific requirements indicated in the specifications, are not to be construed as other comparable medical equipment items, establishing a standard of design, performance, construction, and installation.

SENT

stuffed equipment specified herein shall be installed as work of all labor, transportation, materials, tools, appliances and utilities

owner furnished new equipment, and storage of Owner's existing equipment, present from Owner's present facility, and components including miscellaneous metals for the existing ready to install in operating condition but not including repairs of or malfunctioning components for the existing equipment.

It shall be tested by the owner prior to removal from the present as it is in working condition and/or in compliance with applicable industry's representative shall be present during the test to verify the condition of the item. Cost of repairs of existing to be malfunctioning prior to removal from the present facility is responsibility.

complete, ready for final utility connection, including the testing, of the equipment after utility connections have been made. Takes in conjunction with the installation of the equipment.

if connections remain the work of the sections governing the and and Owner Furnished. (owner installed equipment is tested information and coordination of utility rough-ins, structural revision identified automatically in the construction drawings, and operations of the work with work performed by Owner's

ular intervals to receive receiving dates for Owner's proposed designs for installation that include benefit/owner efficiency study to ensure latest and greatest technology.

of installation and testing drawings, when Owner of construction schedule for Owner's portion of the work. Provide specific to any additional material forwarding all six months notifications of equipment due dates within 60 days.

draw shall be a mutually agreeable time table. Notify Owner if required due to differences in actual construction progress.

Owner representatives at pre-installation conferences covering are to receive Owner's work.

RACTOR INSTALLED EQUIPMENT

Example of 11 70 20, OFCI Equipment

CANCER AND CRITICAL CARE TOWER (CCFT)

obtained from The American National Standards Institute V1 - 10018.

obtained from The American Society of Mechanical Engineers, 370 Street, New York, New York 10017.

Steel Code and Interpretation, Section 130 - Pressure

obtained from The American Society for Testing and Materials, 11933.

obtained from The American Society of Mechanical Engineers, 370 Street, New York, New York 10017.

Materials for Carbon and High-Strength Low-Alloy Steel, Hot and Cold Rolled Steels.

reference: Standards for Mount Metal: (Steel, Lead, Nickel Silver) and Lead Nickel Bronze Alloys.

(stainless Steel, Rods, Shapings, and Tubes, properties of mild steel and other steel materials.

based from the National Fire Protection Association, 60 (standard 02110).

in the Use of Inertion Anesthetics (Flammable and

in Code.

Steel Gas Systems.

based from the Underwriters' Laboratories Incorporated, 60611.

representations of equipment provided under this Section.

NO

in a substantial shipping container or crate complying with Freight Classification to ensure acceptance by the carrier to final destination at the lowest applicable rate.

very equipment shall be in said construction to facilitate

of each container or crate with the name, floor and item description of the contents. Fasten to the outside of the container for securing the equipment and setting in a proper envelope.

responsibility from receiving, unloading, and movement to destination. Protect finished surfaces from damage during.

Keep covered with polyethylene film or other protective material. Protect other trades working in the area to refrain from to exercise caution when performing work that could be damaging on site.

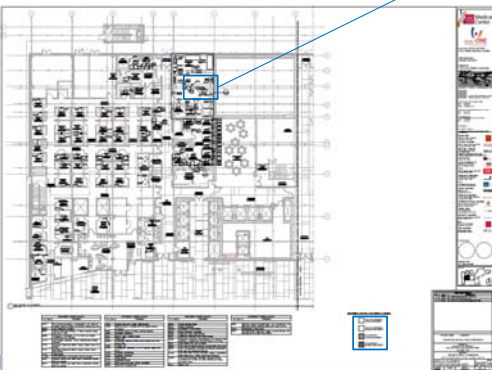
Example of 11 70 00, General Requirements

Specifications

Drawings

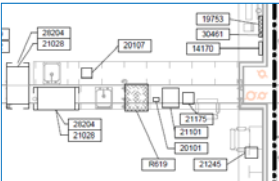
Workbook

Equipment Plan Documentation



Example of 11 70 50, CFCI Equipment

Laboratory Equipment Placed in Plan



Example of 11 70 20, OFCI Equipment

Laboratory Equipment Identified in Legend

20107	Water Bath
20205	Centrifuge: General Purpose, Bench Model, with Fixed Angle Rotor
20304	Freezer: Lab
20705	Refrigerator: Laboratory, 25 cu.ft. Capacity, Single Solid Door
21028	Analyzer: Hematology
21042	Analyzer: Laboratory
21101	Slide Stainer
21175	Specimen Rack
21245	Microscope: Binocular, Clinical, Brightfield
28103	Cart: AGV Transport Cart

Example of 11 70 00, General Requirements

Laboratory Equipment Drawing Symbol Legend

	OUT OF CONTRACT FIXED EQUIPMENT
	OUT OF CONTRACT MOBILE EQUIPMENT
	IN CONTRACT FIXED EQUIPMENT
	IN CONTRACT MOBILE EQUIPMENT

Specifications

Drawings

Workbook

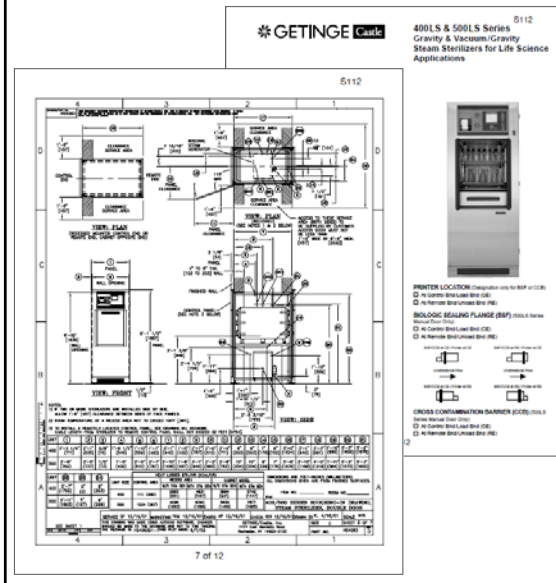
- LAB FLOOR 16 -
CHEMISTRY / CHEMISTRY CORE / CHEMISTRY ANALYTICS / DMPK / OMICS
REVIEWED, REVISED NOVEMBER 12, 2012



Project #: E02010.0100 Sheet: SK-3.1



Equipment Data



Mfr. Provided Cut Sheets

• Product Selection Process

• Details for the A/E Team

- Utility Requirements
 - Power
 - Emergency Power
 - Data
 - Water Supply
 - Drain
 - Ventilation
 - Gas (Air, CO2, Nitrogen, etc)

• Options

- House Steam
- Electric Steam Generator
- Voltage selections
- Emergency Power
- Monitoring
- Remote Diagnostics
- Color!

Laboratory Equipment Inventory

Well Cornell Medical College										Well Cornell Medical College Solar Research Building (SRB)										
Laboratory Equipment Inventory										Well Cornell Medical College Solar Research Building (SRB)										
Prepared by: Marina Kim										Consulting Group: Phoenix Home, 100, 10000, 1										
Revision: 10/1/2014										Email: /Phone Contact: info@wellcorncoll.edu										
This existing equipment inventory will be used to identify and place equipment to be moved into new spaces within the SRB and to identify locations where adequate space and utilities. Please list all floor equipment and any major bench or countertop equipment that will move to the SRB that is either over 12" wide or requires special power or other.																				
Notes: FSCM - Floor Space; CMT - Countertop																				
Equipment	Manufacturer	Itemized	Qty	Model #	Year	Product	Manufacturer	Model	Qty	Manufacturer	Model	Qty	Manufacturer	Model	Qty	Manufacturer	Model	Qty	Manufacturer	Model
1. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
2. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
3. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
4. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
5. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
6. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
7. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
8. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
9. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
10. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
11. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
12. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
13. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
14. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
15. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
16. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
17. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
18. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
19. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
20. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
21. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
22. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
23. Autoclave	Getinge	400LS	1	400LS	2011	Autoclave	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS	1	Getinge	400LS
24. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS
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72. Autoclave	Getinge	500LS	1	500LS	2011	Autoclave	Getinge	500LS	1	Getinge	500LS	1	Getinge	500LS						

ASE Priority List - Status [page](#)

Diagram illustrating the layout and dimensions of laboratory equipment, including incubators, a centrifuge, and freezers, along with a list of cylinder types.

Equipment and Dimensions:

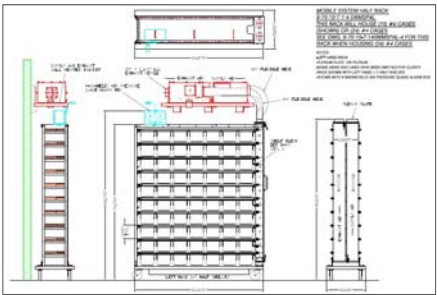
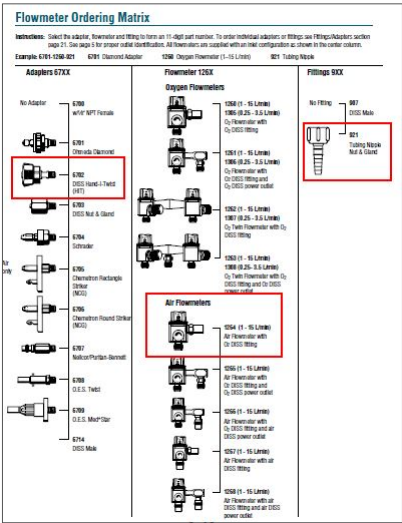
- Incubators:** CSE60, CSE20, C8030
- Centrifuge:** C890
- Freezers:** C1500, C5020, C1500
- Dimensions:**
 - Overall height: 10'-6" to 11'
 - Overall width: 8' + 3'

Cylinder types:

AZ, EA, ZA/ZB, ZC, C, AD, ED, CD/DO, ZD, D, E, AF, DF, F, LF, VF, AV, EX, HX, ZX, G, AK, J, L/HL



Plan Utilities for Equipment



	01 Inlet	02 Inlet	03 Inlet	04 Inlet
01 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
02 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
03 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
04 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
05 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
06 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
07 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
08 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
09 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
10 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
11 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
12 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
13 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
14 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet
15 Inlet	01 Inlet	02 Inlet	03 Inlet	04 Inlet

Control of Heat Loads





"Hoods"



Chemical Fume Hood (CFH)

Protects User, not material
2', 3', 4', 5', 6', 8', custom
(outside dimensions)



Biological Safety Cabinet (BSC)

Protects User and material
4', 5', 6',
(inside dimensions)

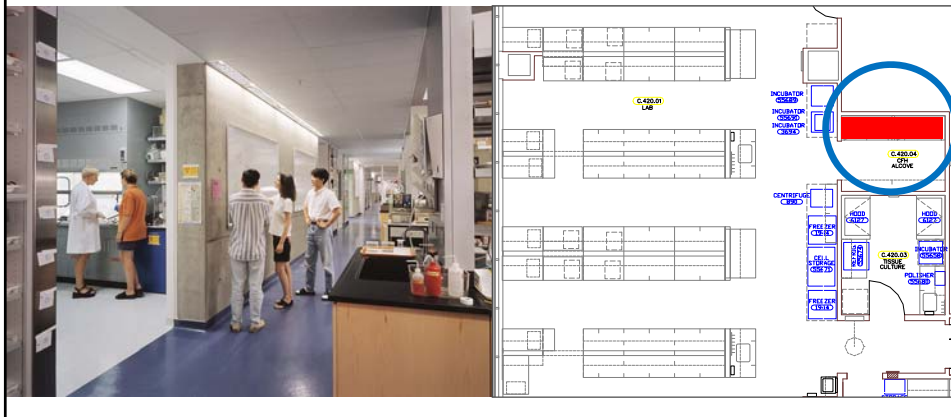


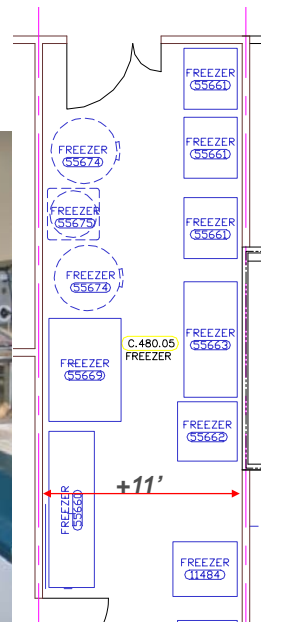
Laminar Flow Hood

Protects material only
Rarely used in research

Fume Hoods

- Away from paths – Away from exits
- Work better in alcoves
- Don't forget workspace for PCs, notebooks, etc







Plan for Equipment Delivery

- Scheduling / Building Access
- Elevator Access & Capacity
- Corridor Transport & Clearances
- Door Clearances



Agenda

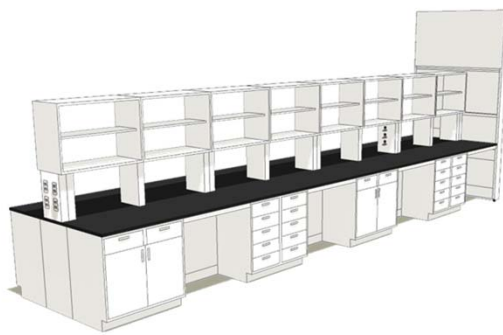
- Laboratory Planning History and Trends
- Codes and Guidelines
- Infrastructure Basics
- Programming and Planning
- Equipment planning, procurement and installation process
- **Casework Options**
- How can we maximize resources?



Casework System Options

1. Floor Mounted, Fixed Upper Cabinets
2. Floor Mounted, Adjustable Shelving
3. 6" Wall System, Cantilevered Tables
4. 6" Wall System, Mobile Tables
5. Mobile Instrument Carts
6. Mobile Heavy-Duty Equipment Racks
7. Movable Technical Bench
8. Movable Four-Leg Bench

Floor Mounted, Fixed Upper Cabinets

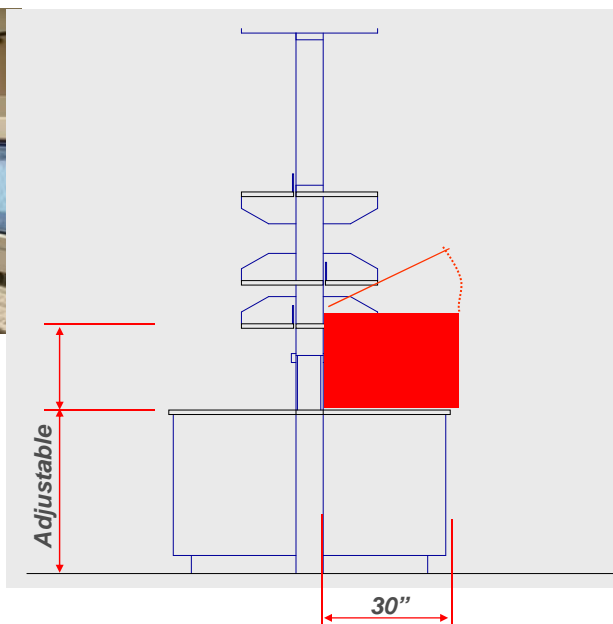
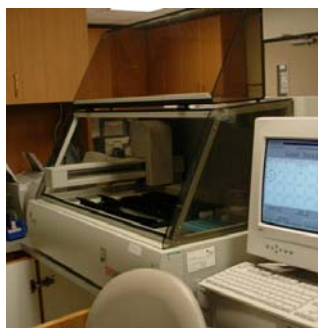


- Traditional
- Stable
- Durable
- Not flexible

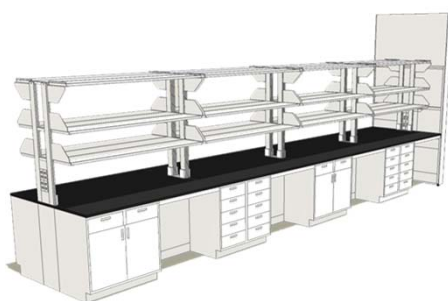




Bench



Floor Mounted, Adjustable Shelving

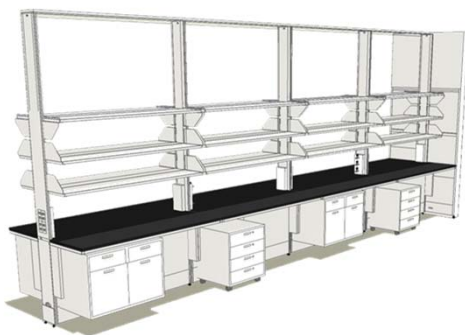


- Traditional
- Some flexibility





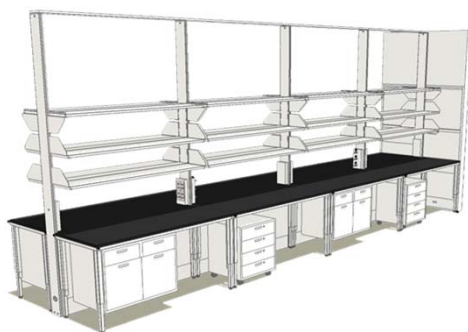
6" Wall System, Cantilevered Tables



- Complete component adjustability at 1"
- Reduced core width
- Demountable



6" Wall System, Mobile Tables



- Complete component adjustability at 1"
- Reduced core width
- Demountable
- User adjustability

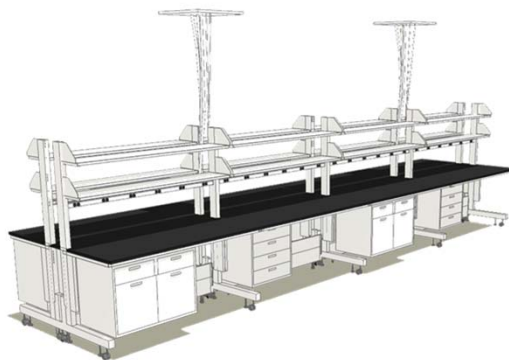




Demountable Casework/Walls



Mobile Instrument Carts

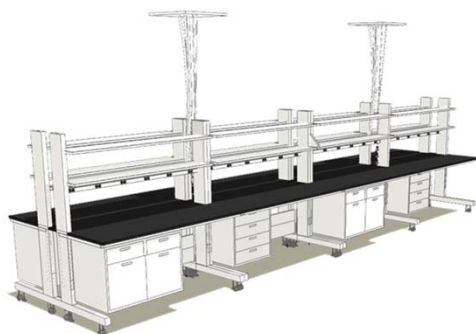


- Overhead utility distribution
- Complete component adjustability at 1"
- Complete mobility and user adjustability
- Design hints – spec levelers with casters, frame conflicts with mobile cabinets





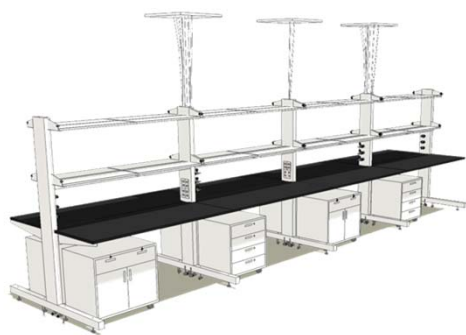
Mobile Heavy-Duty Equipment Racks



- Overhead utility distribution
- Complete component adjustability at 1"
- Complete mobility and user adjustability
- 2600 lb. weight capacity



Movable Technical Bench



- Shared rear upright
- Movable, not mobile
- Services pre-piped, pre-wired





Movable Four-Leg Bench System



- Taller uprights
- Basic design – horizontal bar required
- Rigidity varies by manufacturer (\$\$)



Flexibility Features vs. Cost

The pricing data here is an average of estimated budget quotes from multiple Casework dealers in the Houston area. Pricing includes the inset steel style cabinetry, furniture system, black epoxy resin countertops, service fixtures, accessories, and basic installation. Does not include piping and wiring within the casework assemblies, final utility connections, or contractor's overhead and mark-up. It is to be used for comparisons, not for budgeting.



Floor Mounted/
Fixed Uppers
~\$725/LF



Floor Mounted/
Adj. Shelves
~\$850/LF



6" Wall System
Cant. Tables
~\$1,125/LF



6" Wall System
4 leg Tables
~\$1,200/LF



Mobile Instrument
Carts
~\$1,175/LF



Heavy duty
Instrument carts
~\$1,450/LF



Movable
Technical Bench*
~\$1,375/LF



Movable
4 Leg Bench*
~\$1,325/LF



Overhead Utility Costs



Pre-manufactured (Wing)
~\$450 LF



Fabricated on
~\$375 LF



Ceiling Panels
~\$116 LF



FKP Architects

Utility Distribution – Ceiling Service Panels





Bench Distribution – On the Upright



Bench Distribution – On the Upright





Material, Door and Drawer Styles



Painted Steel and
Stainless Steel-Inset
Doors



Painted Steel and
Stainless Steel-Flush
Overlay Doors



Wood-Lipped Overlay



Wood-Flush
Overlay



Wood-Radius
Overlay



Combination of Wood
and Painted Steel-Inset



Combination of Wood
and Painted Steel-Flush
Overlay



Plastic Laminate,
Phenolic Resin, and
Polypropylene-
Flush Overlay

Sources: Kewaunee Scientific Corporation and Thermo Scientific Hamilton Products

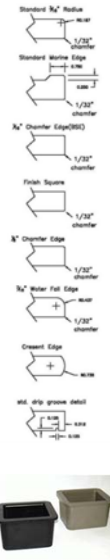
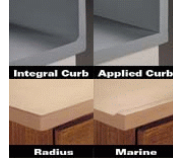
Hardware & Construction Details

- Hinges
- Drawer Suspension
- Shelf Clips
- Lock Types
- Door Catches
- Label Holders
- Drawer Box Construction
- Shelf Depths
- Security Panels
- Core Materials



Countertops, Sinks & Fixtures

- Counter Tops
- Sinks
- Drying Racks
- Water Fixtures
- Service Valves
- Eye/Face Wash
- Safety Stations



Accessories

- Task Lighting
- Marker Boards
- Tack Boards
- Computer Support
- Monitor Arms
- Grommets



Chemical Fume Hood Options



General Purpose,
Traditional Flow Exhaust
~\$1300 LF



General Purpose,
Low Flow Exhaust
~\$1475 LF00



High Performance,
Low Flow Exhaust
~\$1725 LF

Special Purpose, Perchloric
Acid/Radioisotope
~\$1950 - 2150 LF

Chemical Fume Hood Options

- Hood types
- Baffle types
- Liner material
- Work surface construction
- Fixtures
- Valve location
- Cup sinks
- Piping and wiring
- Alarms
- Lighting
- Electrical services
- Blowers and ductwork
- Ceiling enclosures
- Field testing
- Accessories
- Support cabinetry



FPK Architects

Page 3 of 3

FUME HOOD TYPES

FUME HOOD OPTIONS

Many projects require a combination of two hood types.

☐ General Purpose, Bench Type, Bypass, Standard Height
☐ General Purpose, Bench Type, Auxiliary Air, Standard Height
☐ General Purpose, Bench Type, Restricted Bypass, Standard Height
☐ General Purpose, Bench Type, Unrestricted, Standard Height
☐ General Purpose, Bench Type, Bypass, Extended Height
☐ General Purpose, Bench Type, Auxiliary Air, Extended Height
☐ General Purpose, Bench Type, Restricted Bypass, Extended Height
☐ General Purpose, Floor Mounted, Bypass
☐ General Purpose, Floor Mounted, Auxiliary Air
☐ General Purpose, Floor Mounted, Restricted Bypass
☐ General Purpose, Floor Mounted, Restricted Bypass, Disinfection
☐ General Purpose, Floor Mounted, Variable
☐ General Purpose, Research Chemical, Function Area
☐ General Purpose, Research Chemical, Radioisotope
☐ General Purpose, Research Chemical, Positive Seach
☐ General Purpose, ADA, WC/ADA
☐ General Purpose, Education, Full View
☐ General Purpose, Education, Post-Test Demonstration
☐ General Purpose, Education, Economy
☐ General Purpose, Education, Ductless
☐ General Purpose, Other, Table Type
☐ General Purpose, Other, Canopy
☐ Low-Pow, Bench Type, Constant Volume, Standard Height
☐ Low-Pow, Bench Type, Restricted Bypass, Standard Height
☐ Low-Pow, Bench Type, Constant Volume, Extended Height
☐ Low-Pow, Bench Type, Restricted Bypass, Extended Height
☐ Low-Pow, Floor Mounted, Constant Volume
☐ Low-Pow, Floor Mounted, Restricted Bypass
☐ High Performance, Bench Type, Restricted Bypass, Standard Height
☐ Other

☐ Other

FUME HOOD CONSTRUCTION FEATURES

LINE MATERIAL

Each option has advantages and disadvantages. For some hoods and procedures stainless steel is the only

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 FPK-001-00000000000000000000

www.inverness.com

400-727-7272



Establish Quality Standards

- Durability vs. affordability
 - Cabinetry Finish options
 - Wood 3-10% increase over steel
 - Steel bodies, wood faces 2-5%
 - Countertops
 - Materials - Epoxy vs. Trespa
 - Edge and splash details
 - Decrease counter thickness



Limit Customization

- Manufacturer's standard component dimensions
- Manufacturer's standard product line





Standardize

- Bench Lengths
- Shelving lengths
- Cabinet configurations and widths



Limit Components

- Stay Lean
- Perceived vs. actual need
- Avoid maxing out (mobile units and shelving)
- Standardize sizes





Watch How People Work

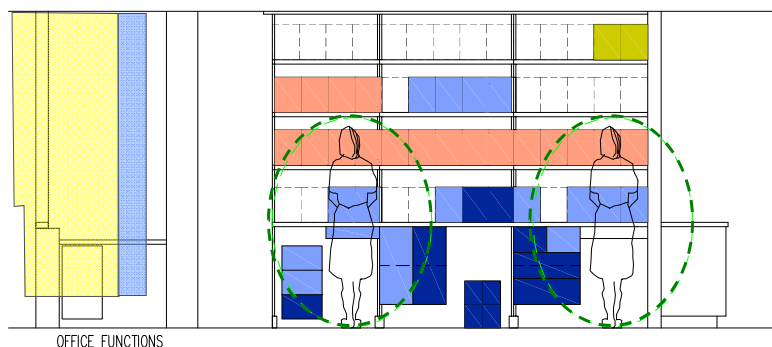


Lab Bench Utilization

63% OF BENCH SPACE USED

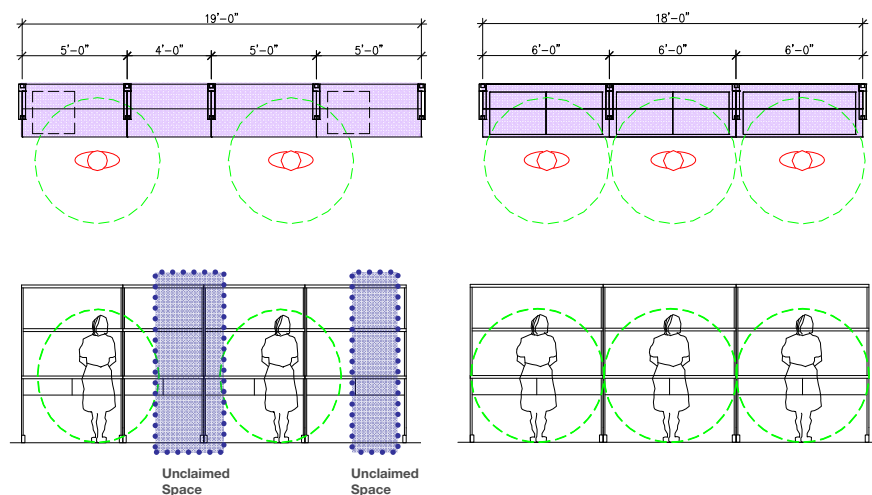
77% OF STORAGE SPACE USED

- Unused space
- General storage
- Unidentified storage
- Solutions storage
- Unused solutions storage
- Office functions
- Equipment storage





Bench Size and Usage



Provide Other Spaces for Storage





Office Functions in Labs



Limit Lab Furniture





Go Green

- High efficiency service fixtures/flow resistors
- Overhead service carriers
- Steel/wood casework
- Task lighting – LED, circuiting
- Adaptable systems



Agenda

- Laboratory Planning History and Trends
- Codes and Guidelines
- Infrastructure Basics
- Programming and Planning
- Equipment planning, procurement and installation process
- Casework Options
- **How can we maximize resources?**



Construction costs (academic lab building)

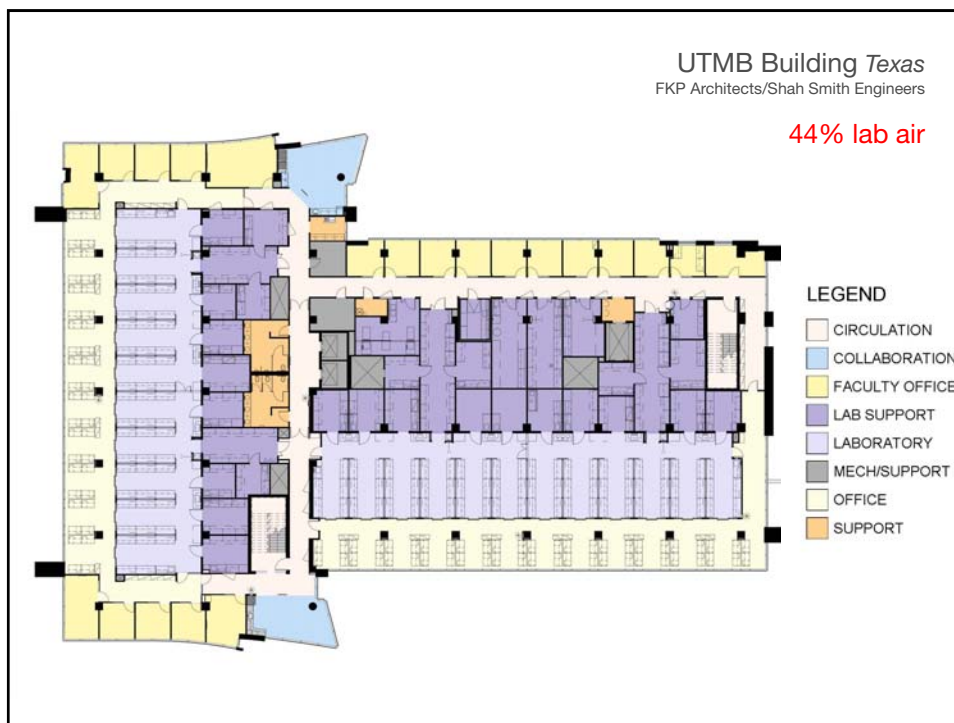
On a recent project...

- Lab/Lab support \$274 to \$374/SF
- Office \$199/SF
\$ 75 to \$175 /SF difference!
(Costs are total building, not buildout)



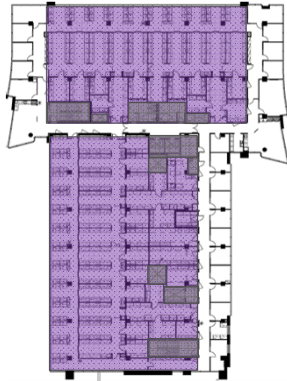
Storage







The cost of Air Changes (3 floors)



Total Air: 105,000 CFM
\$316,000



Total Air: 95,160 CFM
\$248,300
21% Reduction



Total Air: 87,480 CFM
\$170,750
46% Reduction

University of Arkansas Medical Science
Rockefeller Cancer Institute
Little Rock, Arkansas
FKP Architects/Cromwell Engineers

37% lab air

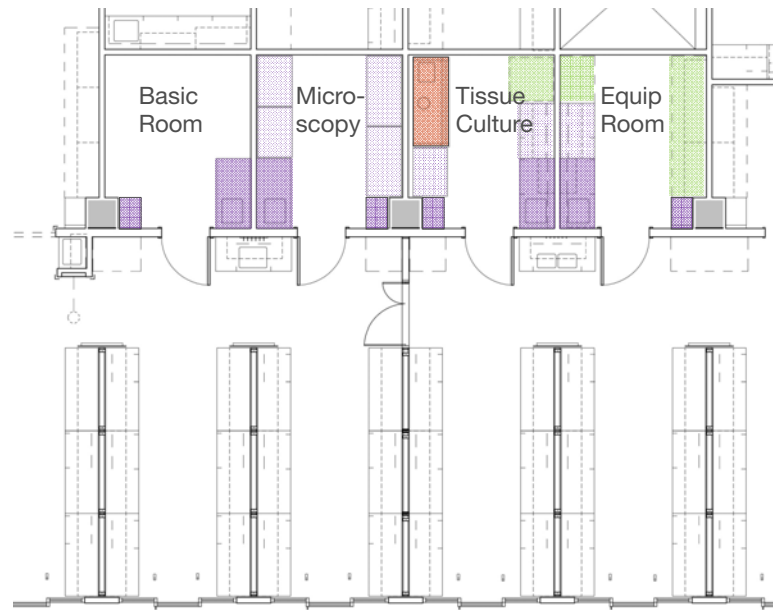


LEGEND

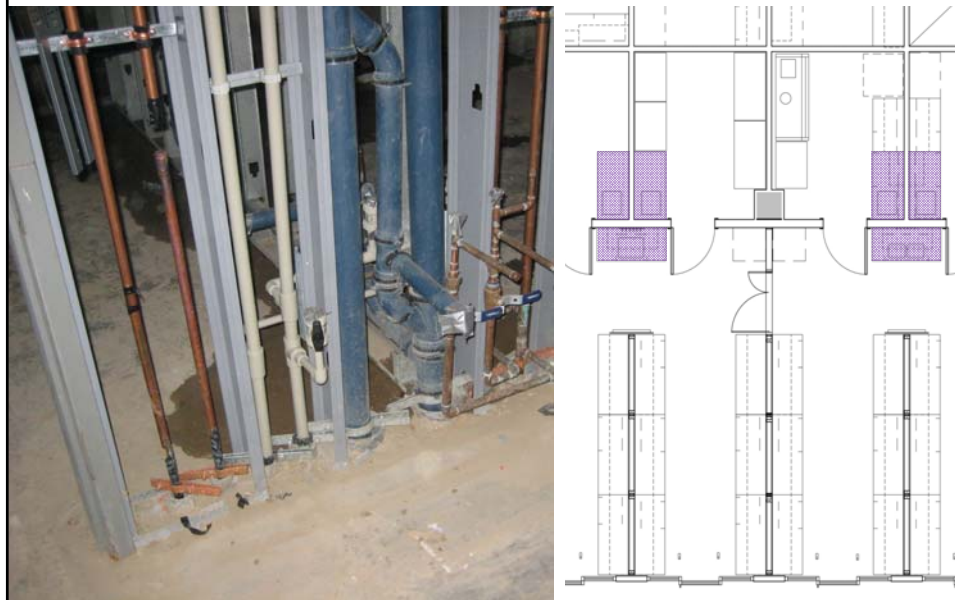
- CIRCULATION
- COLLABORATION
- FACULTY OFFICE
- LAB SUPPORT
- LABORATORY
- MECH/SUPPORT
- OFFICE
- SUPPORT

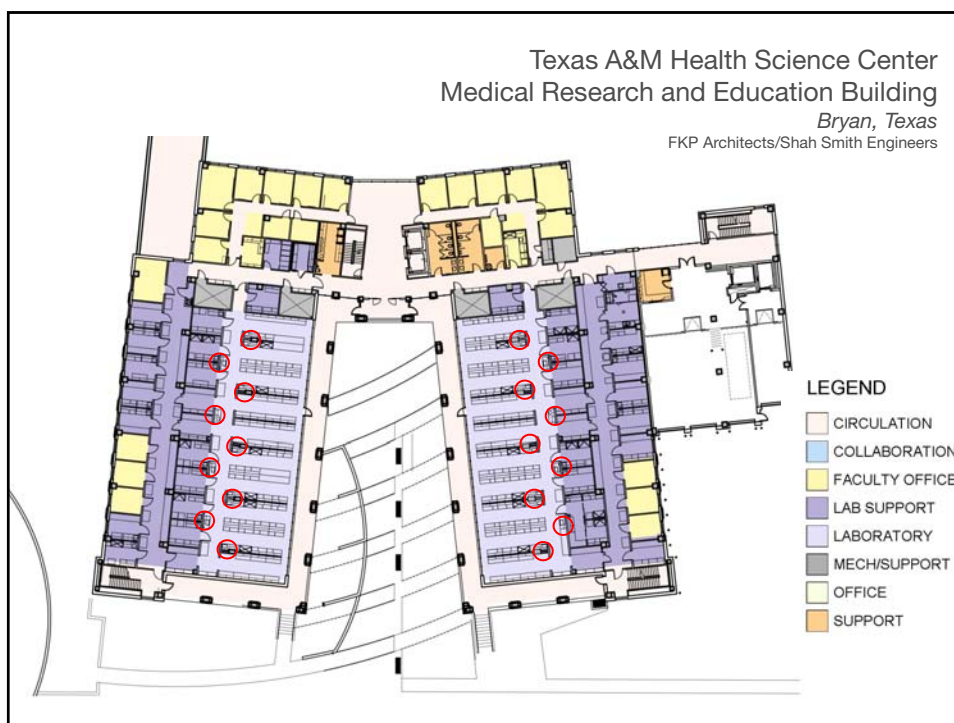


Modular Design

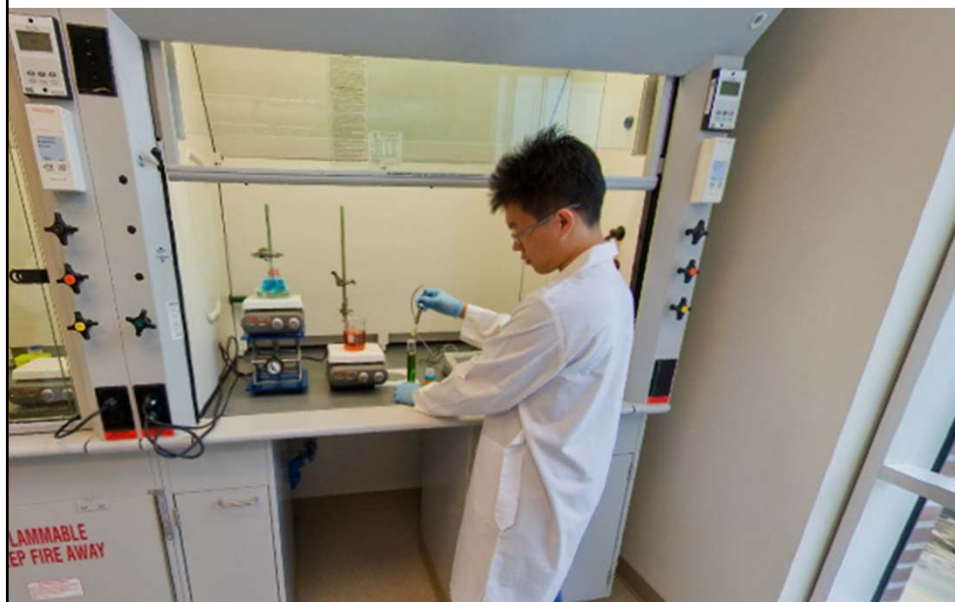


Clustered Plumbing



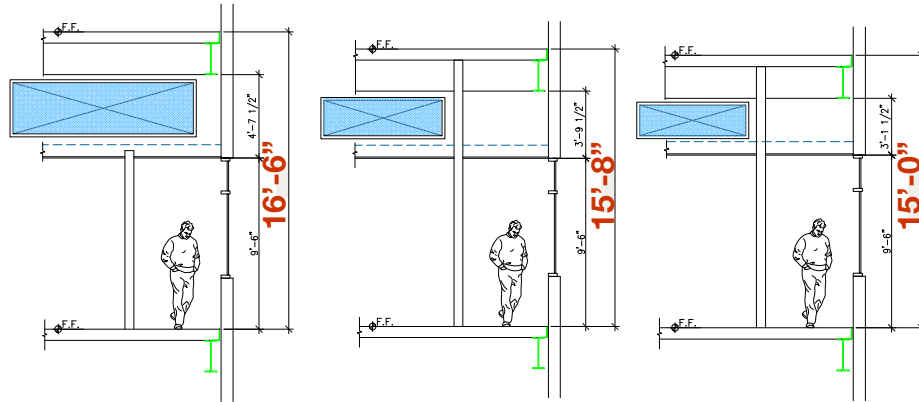


Improve Chemical Fume Hood Efficiencies





Duct Sizing



Reduce Floor to Floor Heights

8" per floor saved \$40,000 in skin costs



Rice University
Bioscience Research Collaborative
Houston, Texas



Toolbox for cost reductions

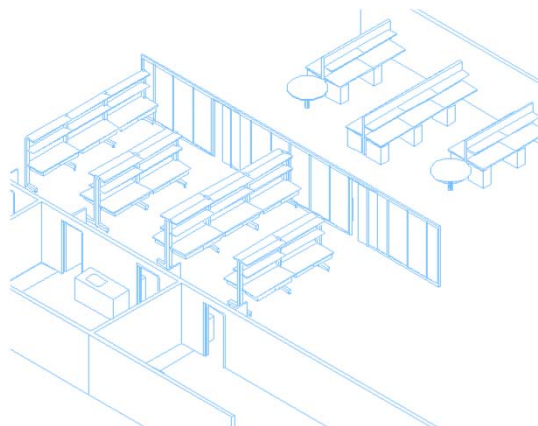
(without quality reductions)

	First Cost	Operating Cost
<u>Architecture:</u>		
•Program/Build appropriate to functions	✓	✓
•Design with modularity	✓	✓
•Use Flexible/adaptable casework		✓
<u>Mechanical / Electrical / Plumbing</u>		
•Reduce outside air quantities	✓	✓
•Improve equipment efficiencies		✓
•Reduce horizontal MEP infrastructure	✓	
•Design with appropriate plug loads	✓	✓

Recommendation

Redefining the Lab

- Reduces.....
 - Outside air
 - AHU Equipment
 - Duct sizes
 - Column spacing
 - Floor to floor heights
- Thereby reducing...
 - First costs
 - Operating costs



“All the big mistakes are made on the first day”

Paul Adams AIA, Denver



Thank You.

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FKP Architects



*Managing Metamorphosis,
Building for Change*



Seminar Evaluation 100105

We hope you enjoyed this session...

Please take a moment to complete the evaluation form.

Thank you!

