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ASSOCIATION OF Texas College & University Facilities PROFESSIONALS

Managing Metamorphosis, Building for Change

Session: 100105

Date: Wednesday, October 1, 2014

Time: 1:00 pm – 3:00 pm

CONTINUING EDUCATION AIA

ASSOCIATION OF Texas College & University Facilities PROFESSIONALS

Managing Metamorphosis, Building for Change

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

Presented by:

- **Cynthia Walston, FAIA, LEED AP, FKP Architects**
- **Kathryn Cavender, CSP, Rice University, Dir. of Environmental Health & Safety**
- **Andy Lewis, AIA, Equipment Collaborative**

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RICE Unconventional Wisdom

CONTINUING EDUCATION AIA

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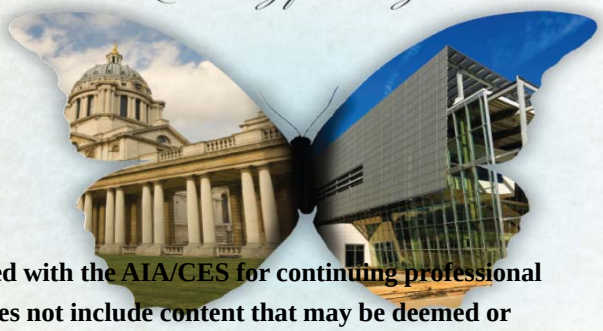
Managing Metamorphosis, Building for Change



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CONTINUING EDUCATION AIA

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.

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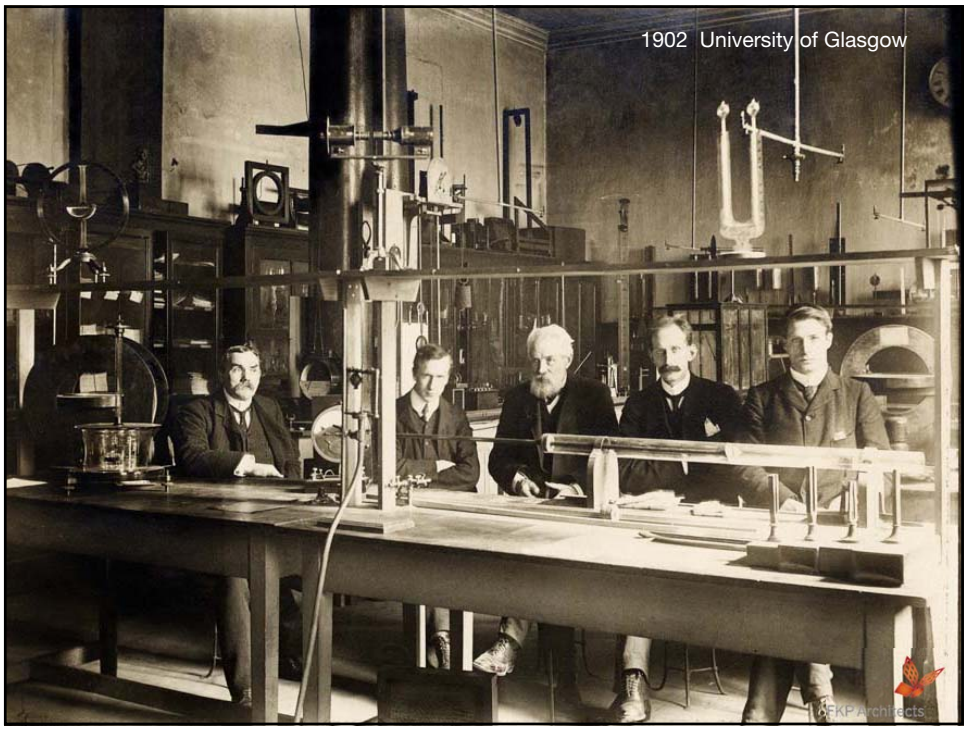
Agenda

- 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?



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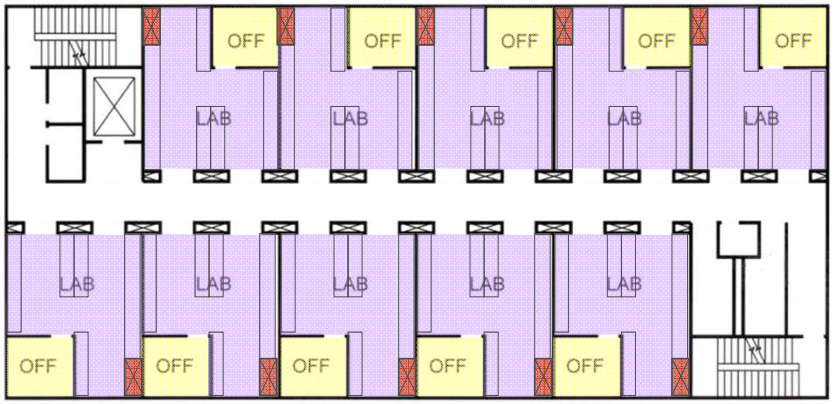
Early Labs



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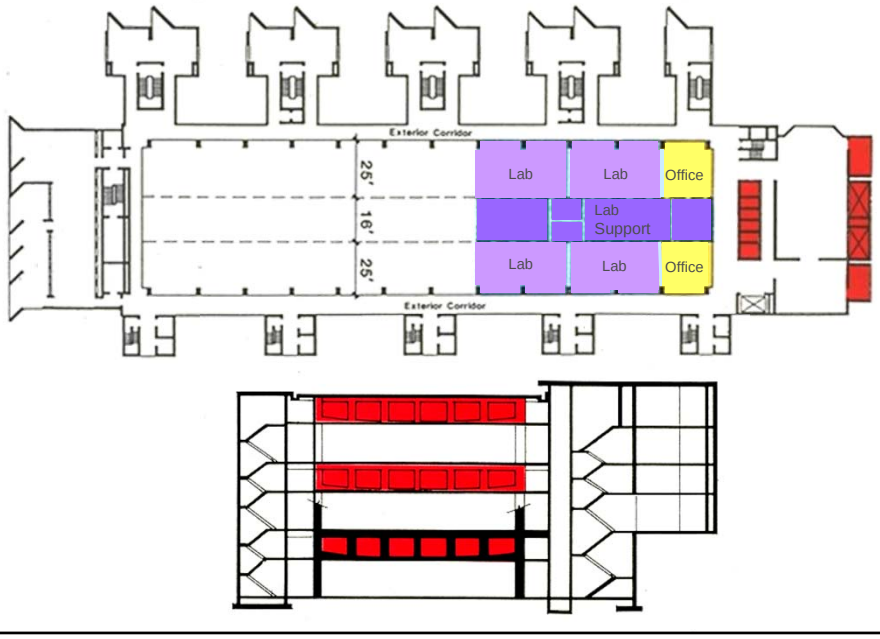

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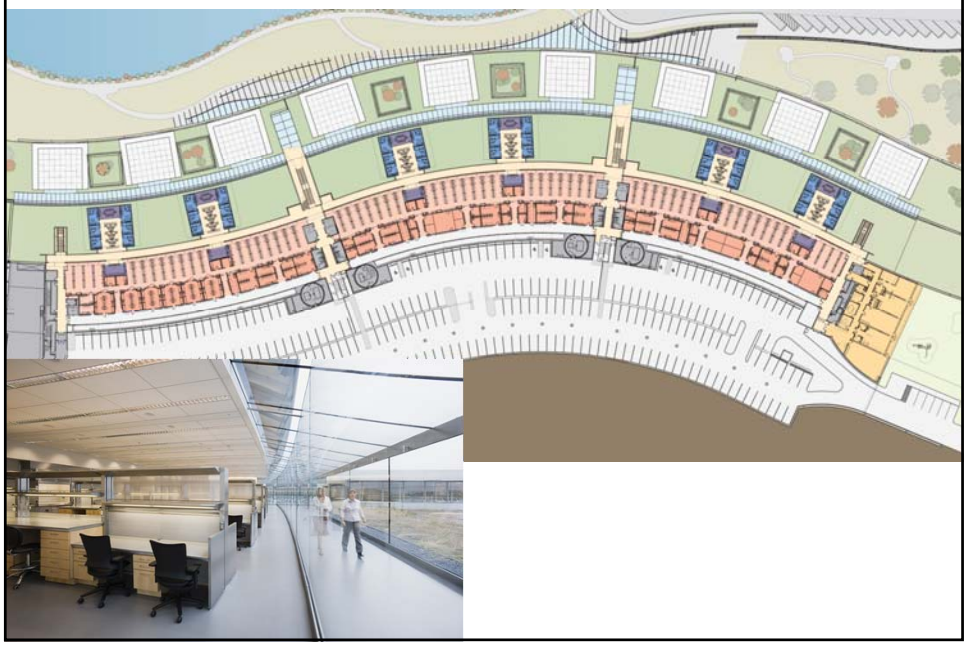
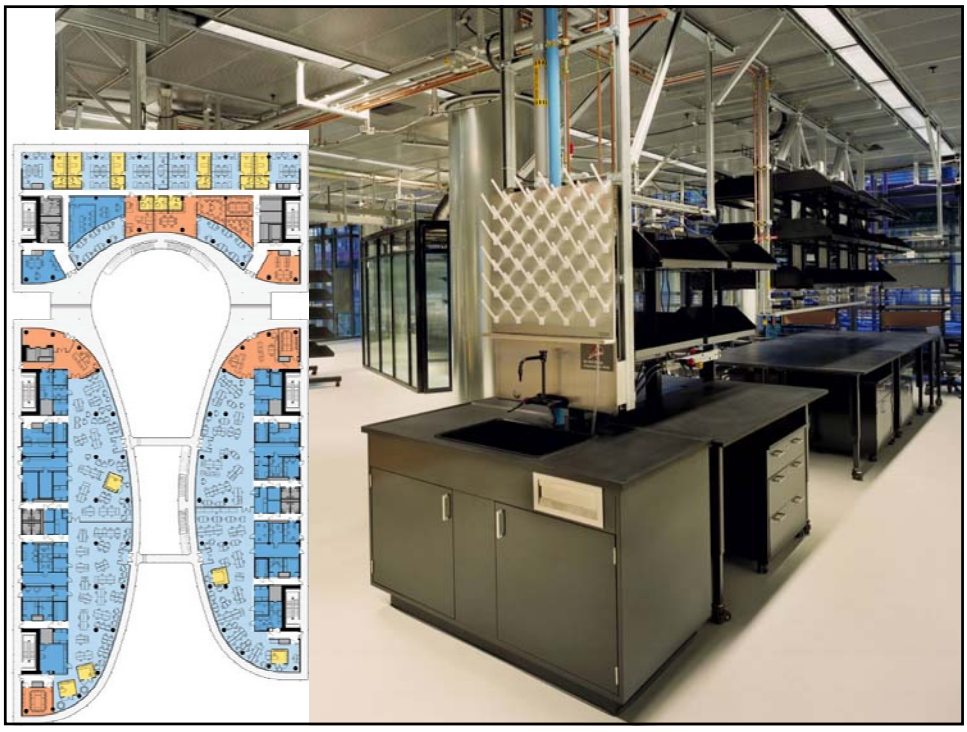
Janelia Farms





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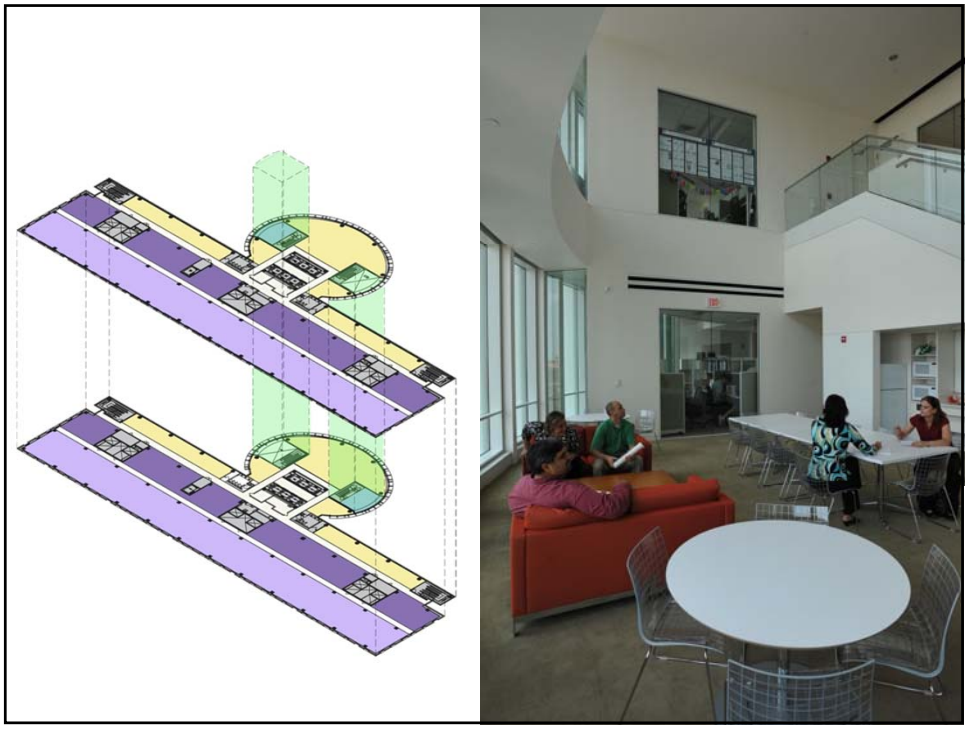
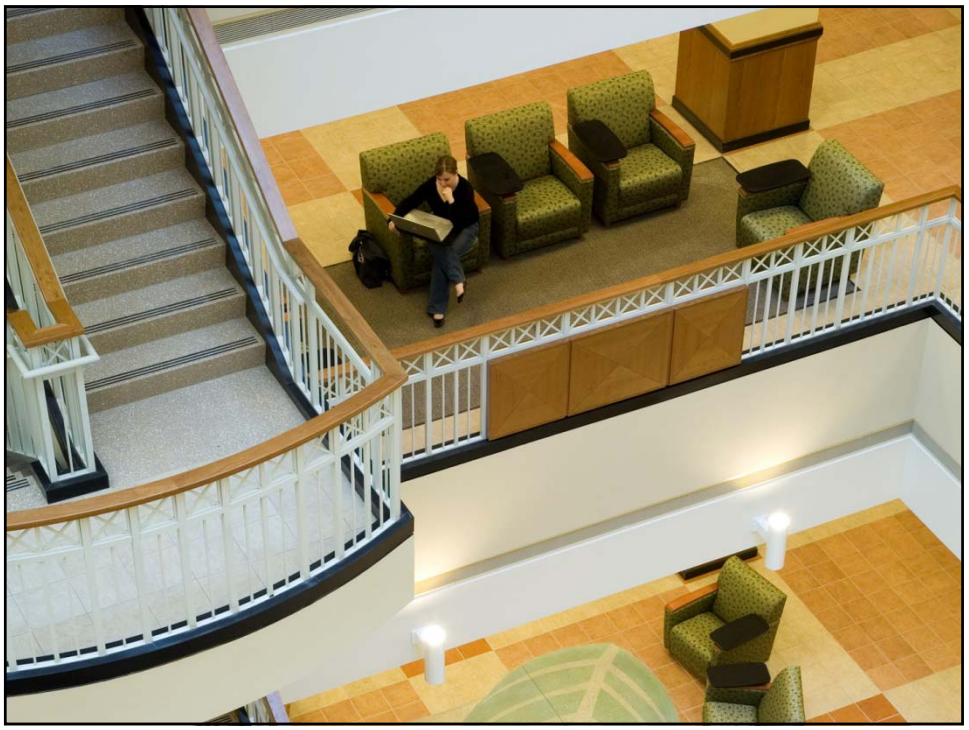
Driving Forces

- 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





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transparency

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flexible & adaptable

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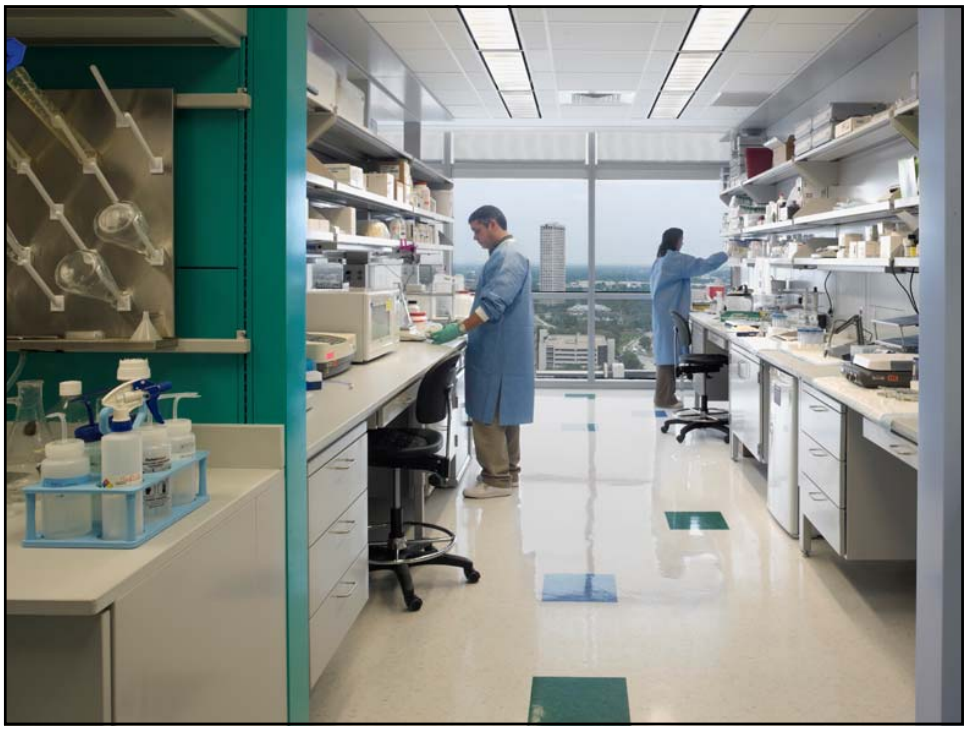
wellness



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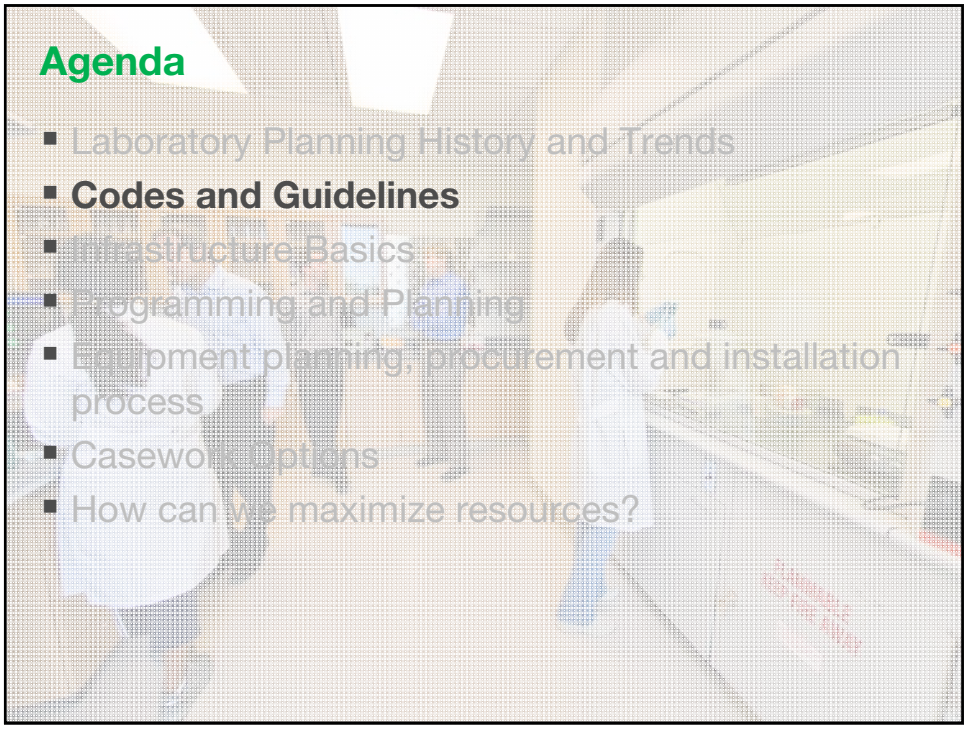

Who are the rule makers?

- Codes
- Guidelines
- Regulations
- Grant Agency Requirements

THESE ARE ALL MINIMUM STANDARDS

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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

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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)

		Quantities in Use[a]		Quantities in Use and Storage[a]	
Laboratory Unit Fire Hazard Class	Flammable and Combustible Liquid Class[a]	Maximum Quantity[b] per 100 ft² of Laboratory Unit[c]	Maximum Quantity[b] per Laboratory Unit	Maximum Quantity[b] per 100 ft² of Laboratory Unit[c]	Maximum Quantity[b] per Laboratory Unit
		gal	gal	gal	gal
A (high fire hazard)	I	10	480	20	480
	I, II, and IIIA	20	800	40	1600
B[d] (moderate fire hazard)	I	5	300	10	480
	I, II, and IIIA	10	400	20	800
C[e] (low fire hazard)	I	2	150	4	300
	I, II, and IIIA	4	200	8	400
D[e] (minimal fire hazard)	I	1	75	2	150
	I, II, and IIIA	1	75	2	150

Note: For maximum container sizes, see Table 10.1.2.
[a] The maximum amount in use in open systems is limited to 10 percent of the quantities listed.
[b] See 4.2.2 for additional requirements for educational and instructional laboratories.
[c] The 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.
[d] Reduce quantities by 50 percent for B laboratory units located above the 3rd floor.
[e] Reduce 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 Requited	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 top 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 ¾" hour protected openings.*
- *Per NFPA 45 Section 5.3.1 - Class A, B, and C laboratories 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.*

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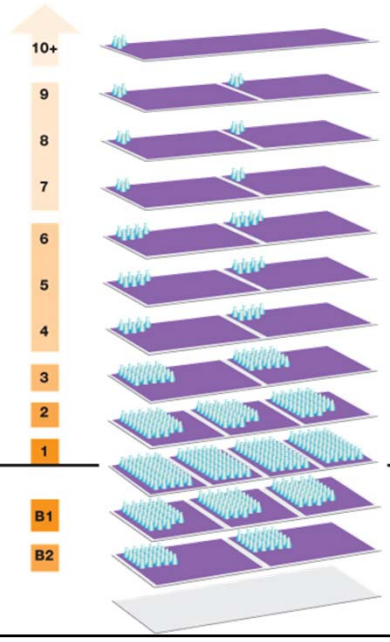
Chemical Quantities



# of Control Areas per floor	IBC Table 414.2.2 "B" Occupancy Percentage of the Maximum Allowable Quantity per Control Area
1	5%
2	5%
2	5%
2	5%
2	12.5%
2	12.5%
2	12.5%
2	50%
3	75%
4	100%
3	75%
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

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Chemical Quantities per Floor

						Flammable Liquids		
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**	**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

						Flammable Liquids		
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**	**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.

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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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
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 ☐ YES ☐	NO ☐ YES ☐
CRYOGENIC Inert			> 60 gallons inside or 500 gallons outside	Not Limited	Not Limited	Not Limited	NO ☐ YES ☐	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)

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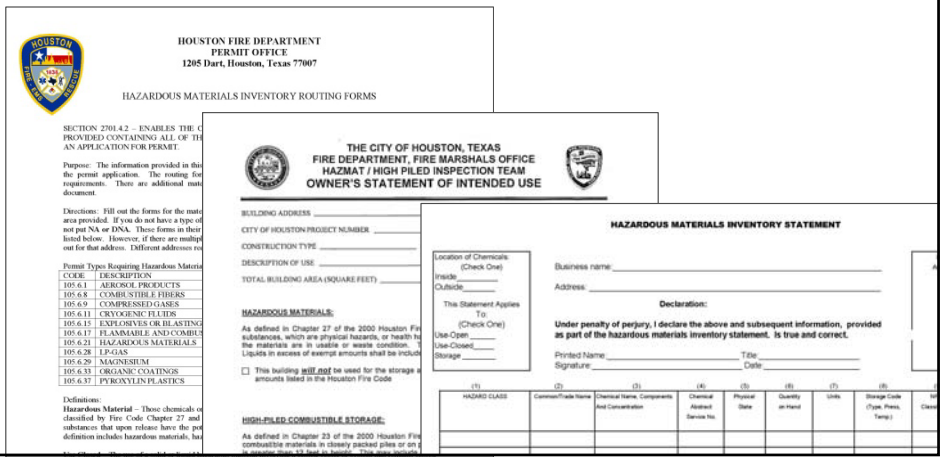
H2 –H4 Occupancy

- 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

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

HAZARDOUS MATERIALS INVENTORY STATEMENT

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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.

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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

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Design for Safety

Fire Sprinklers Save Facilities

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Guidelines and Funding Agencies

- AALAC
- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition

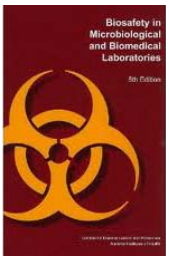
  http://www.cdc.gov/biosafety/publications/bmbl5/index.htm

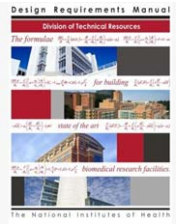
- NIH Design Requirements Manual

  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	▪ No primary barriers required. ▪ PPE: laboratory coats and gloves; eye, face protection, as needed	Laboratory bench and sink required
2	▪ Agents associated with human disease ▪ Routes of transmission include percutaneous injury, ingestion, mucous membrane exposure	BSL-1 practice plus: ▪ Limited access ▪ Biohazard warning signs ▪ "Sharps" precautions ▪ Biosafety manual defining any needed waste decontamination or medical surveillance policies	Primary barriers: ▪ 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: ▪ 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: ▪ Controlled access ▪ Decontamination of all waste ▪ Decontamination of laboratory clothing before laundering	Primary barriers: ▪ 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: ▪ 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	▪ Dangerous/exotic agents which post 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 practices plus: ▪ Clothing change before entering ▪ Shower on exit ▪ All material decontaminated on exit from facility	Primary barriers: ▪ 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: ▪ Separate building or isolated zone ▪ Dedicated supply and exhaust, vacuum, and decontamination systems ▪ Other requirements outlined in the text

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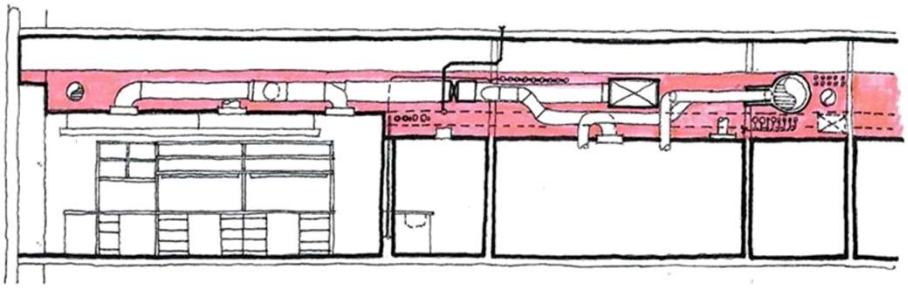
Agenda

- 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?

Structural Dimensions

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



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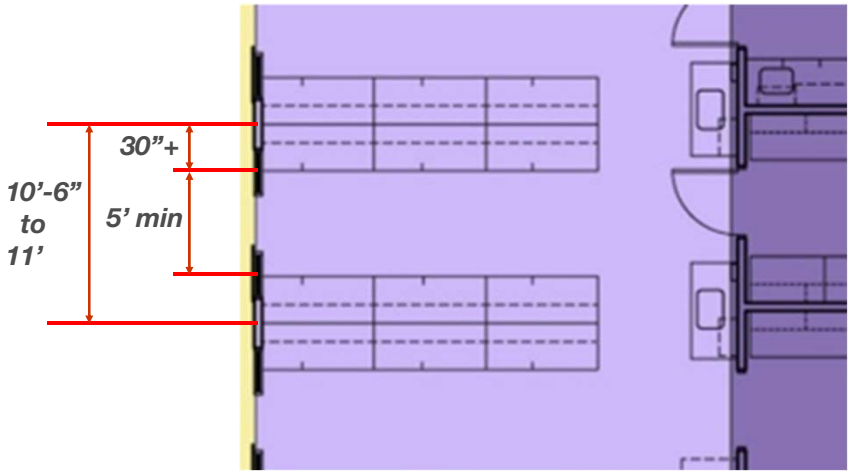
Lab Modules



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

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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

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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

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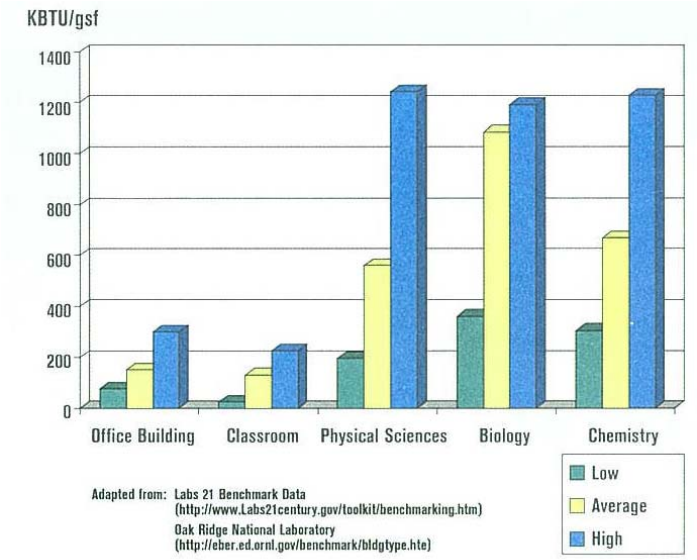
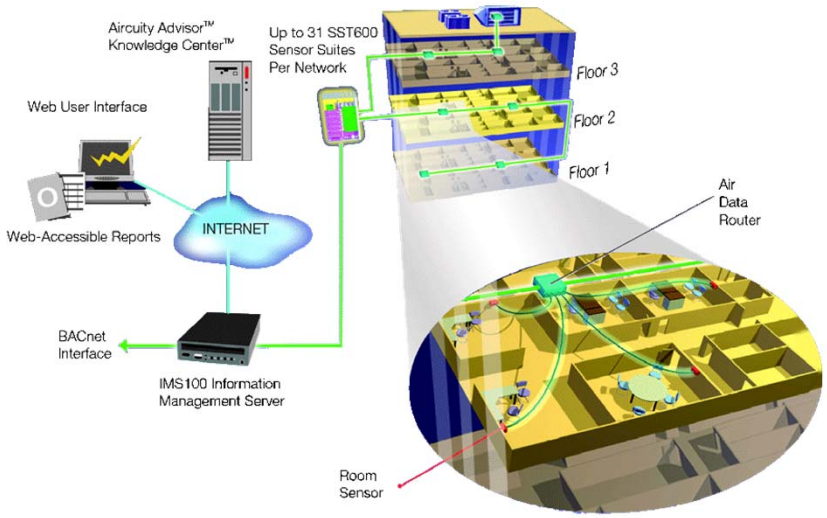
Lab Buildings Use More Energy



Printed from Laboratory Design Newsletter

Air Monitoring System



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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

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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

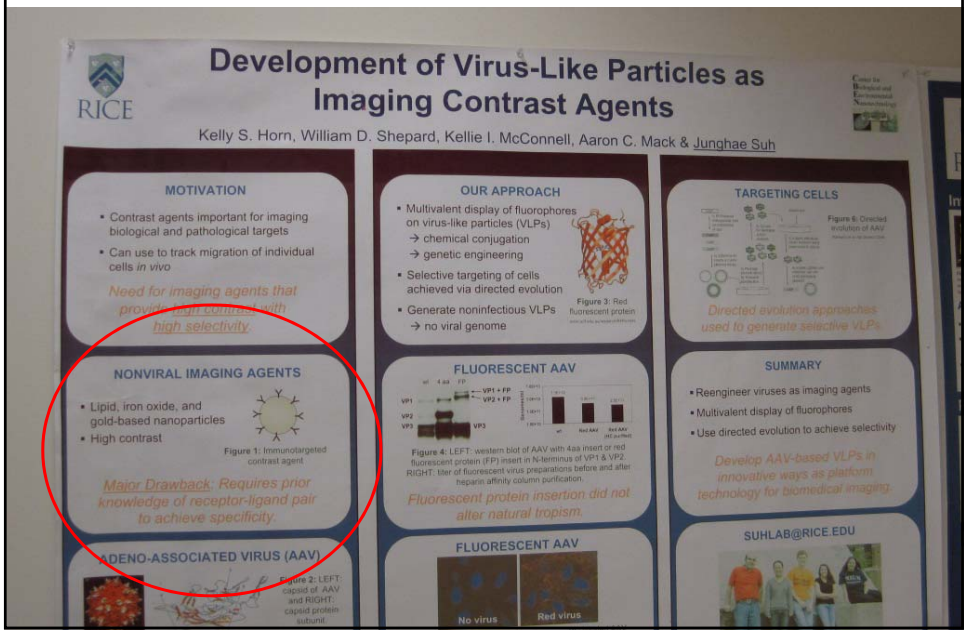
RICE UNIVERSITY
OFFICE OF SPONSORED RESEARCH

6100 MAIN STREET, MS-16
HOUSTON, TX 77005
PHONE: (713) 348-4820
FAX: (713) 348-5425

CAMPUS ADDRESS:
350 ALLEN CENTER

RICE

Keys to Unlock Design



University — **Laboratory Questionnaire**

_____Laboratory

Contact: Name: Phone:
E-mail:

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.

1. Briefly describe your department's functions, research and/or services provided. Emphasize any non-typical or special services.

2. Staffing/Positions:

3. Describe special rooms to be part of your laboratory, such as Tissue Culture, Microscopy, Animal Procedure, etc.

4. Primary Lab equipment:
   Chemical Fume Hood: Number:___ Size: _____
   Biosafety Cabinet: Number:___ Size: _____
   Snorkel Number:___ Size: _____
   Other _____ Number:___ Size: _____
   Any specialized hoods (i.e. radioactive, perchloric, etc.)?

5. Special equipment or process needs:
   Vibration sensitive _____
   Heat producing _____
   Noise producing _____
   Light sensitive _____

6. Plumbing:
   Water: HW___ CW___
   High purity water: RO__ DI___ Will you have a final polisher?_____
   Cooling water?: Describe use:
   Steam? Describe use:
   Any "oversized" lab sinks required?
   Piped services Lab Air ___ Nat.Gas ___ Vacuum:____
   CO2 __ N2_____
   Compressed air: ____ psi.
   Special gasses: _____
   Will any gases require a central or piped distribution system?

University — **Laboratory Questionnaire**

_____Laboratory

7. Electrical:
   Special power (other than 120v/208v)?
   Is an Isolation Transformer or other power conditioning required?
   Is Emergency Power required?
   Is Uninterruptible Power required?
   Are there any special EMF/RFI shielding requirements?

8. Hazardous Materials.
   What chemicals do you typically use and in what quantities? Please list on separate page.
   Do you use any radioactive materials?
   What gasses are anticipated?
   Will any gases require a central, or piped distribution system?

9. Any other very unique space requirements?
   Clean Room? Humidity controlled room, require darkness

10. Temperature/Humidity Control.
    If humidity is a concern, what are the tolerances?
    If temperature is a concern what range is acceptable (degrees F)

11. Any other issues that might trigger infrastructure needs?

12. Any other unique equipment requirements other than described on equipment list?
    How many Furnaces/Ovens will be used in the lab? List respective BTU/h ratings?
    How many vacuum pumps will be needed?
    How many "air-cooled" chillers are required in the lab?
    How many "water-cooled" chillers are required in the lab?
    Any Autoclaves or other sterilizers?
    Any Equipment that requires exhaust?

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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.

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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)

Specifications Drawings Workbook

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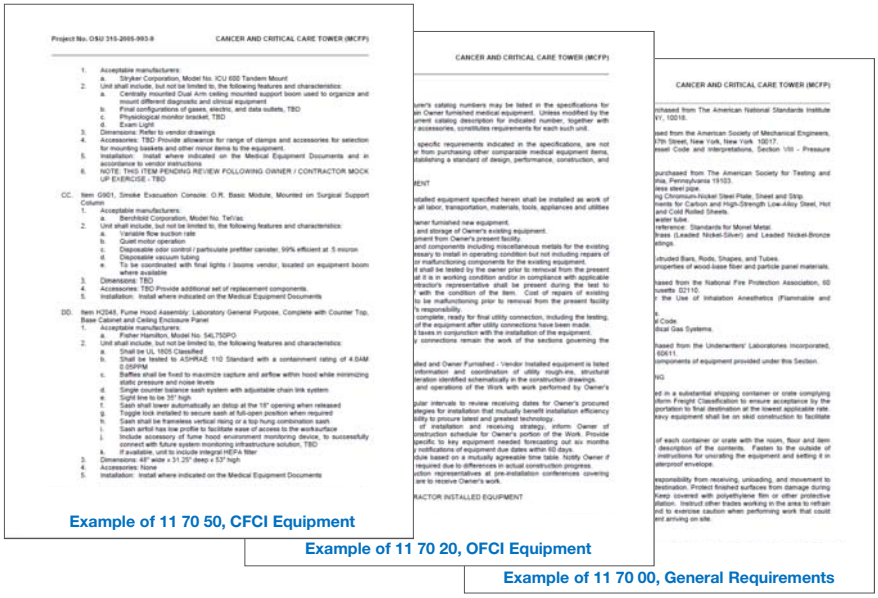
Equipment Specifications



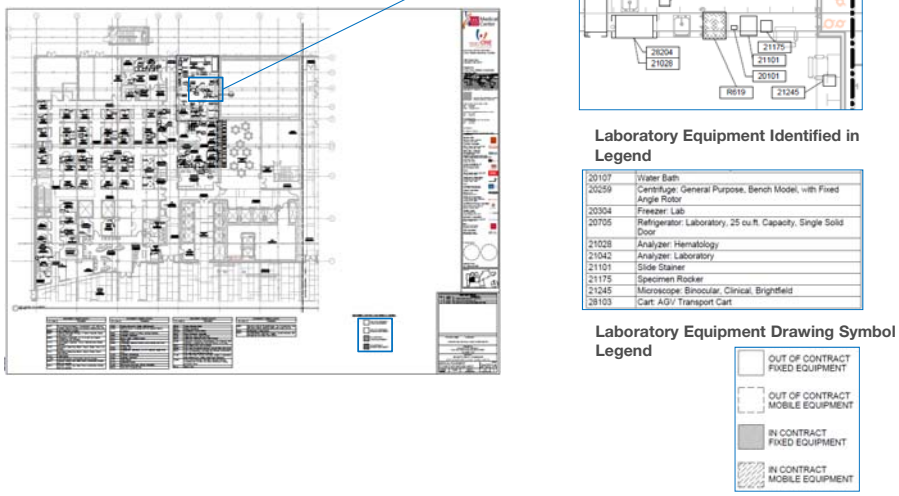
Example of 11 70 50, CFCI Equipment

Example of 11 70 20, OFCI Equipment

Example of 11 70 00, General Requirements

Specifications Drawings Workbook

Equipment Plan Documentation



Specifications Drawings Workbook

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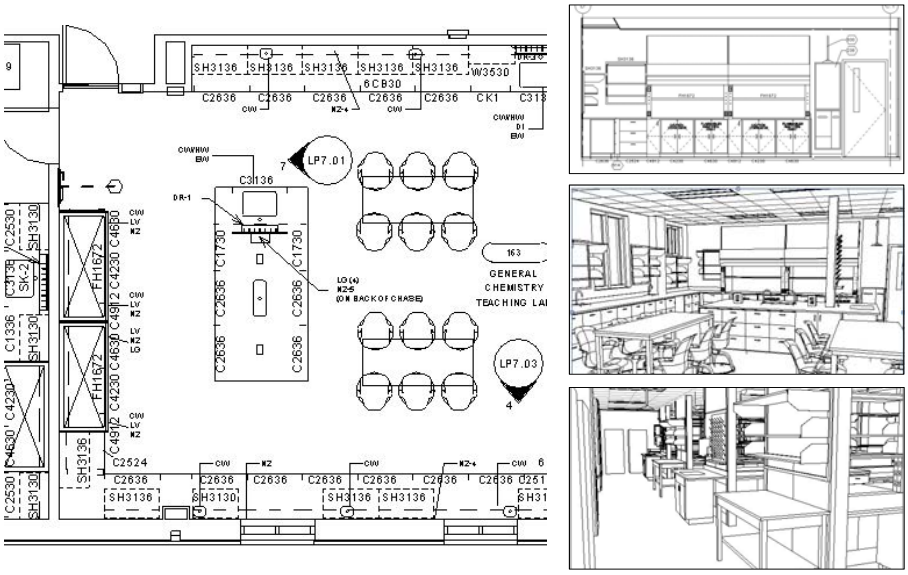
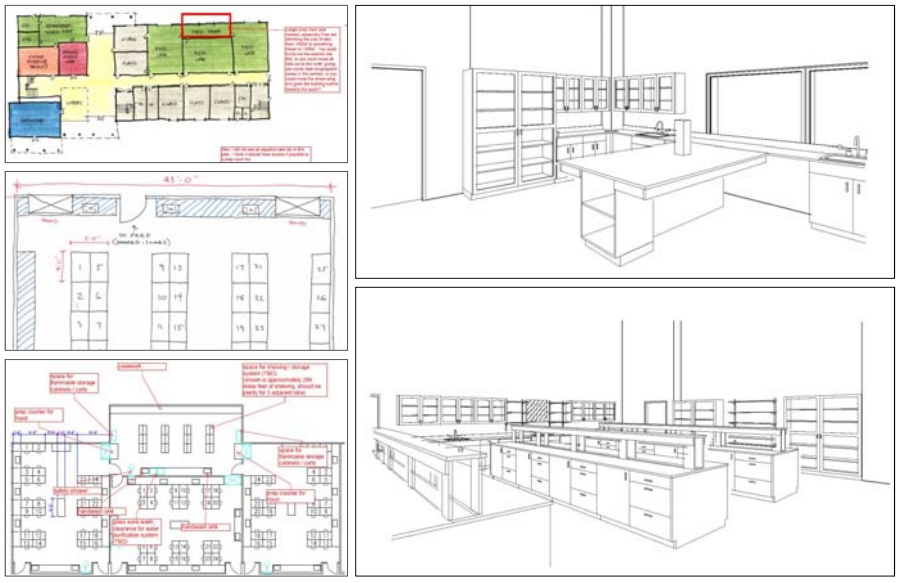
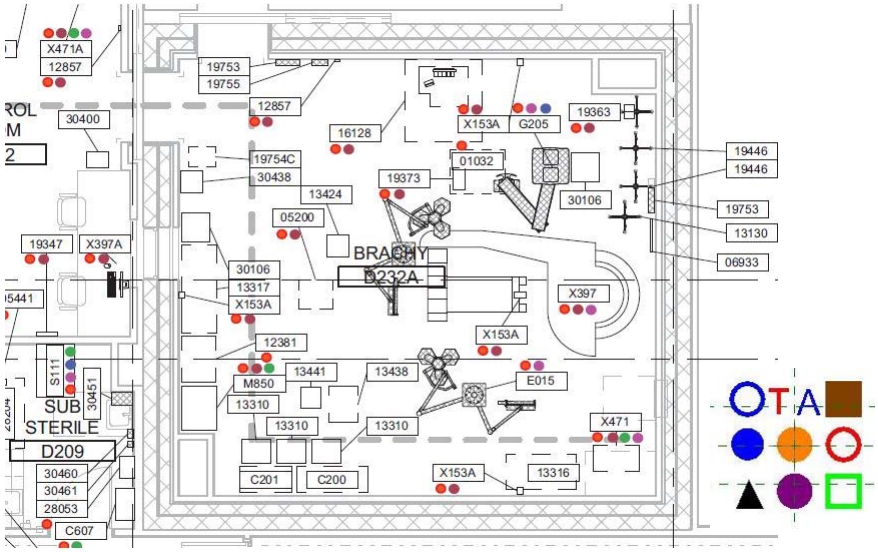
Equipment Planning 3D



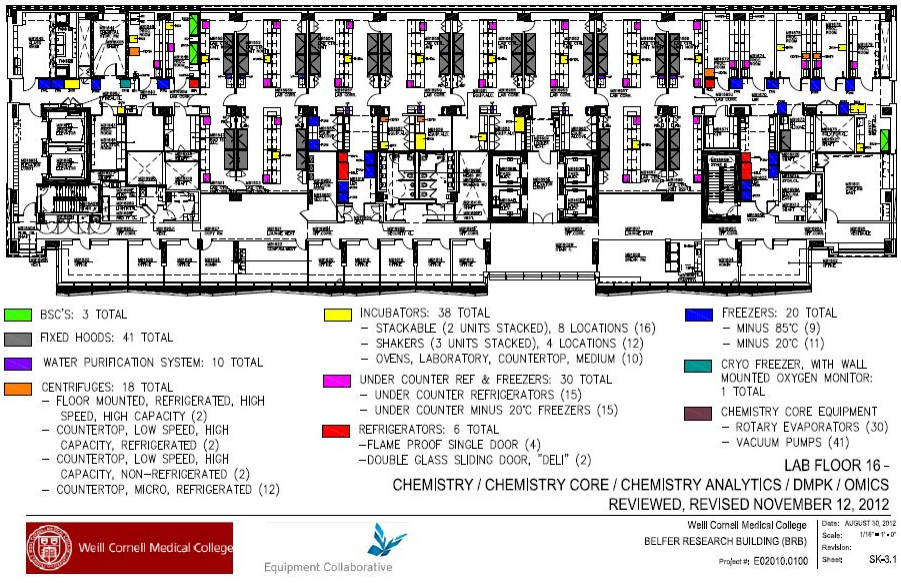
Equipment Planning 3D



Equipment Coordination Plans



Equipment Coordination Plans



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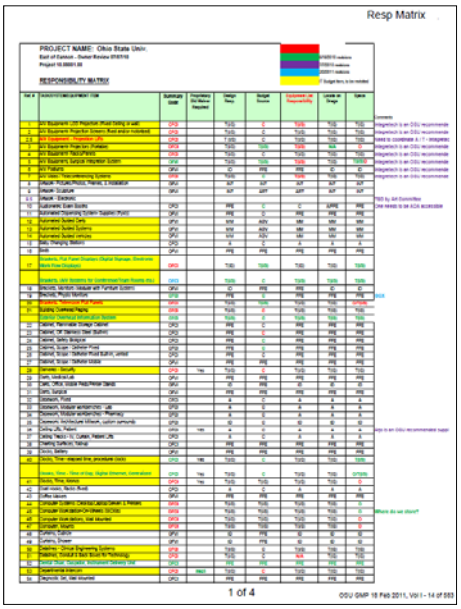
Project Responsibility Matrix



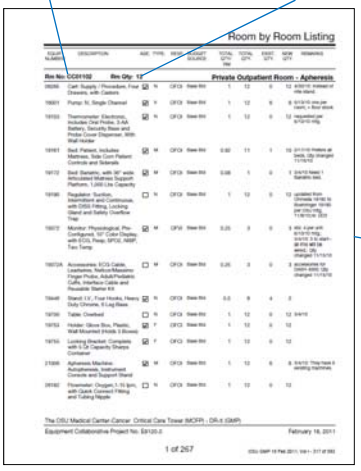
- **Planning Services/**
  Design Responsibility /
  - Prepare Equipment List / Specs
  - Locate Major Pieces in Lab
  - Provide Cut Sheets to Architect
- **Procurement Services**
  Budget Source /
  - Final Specifications & Confirmations
  - Preparation and Execution of Purchase Orders (Requisitions)
- **Installation Services**
  Activation / Move /
  - Receive / Store / Warehousing
  - Unpack / Assembly
  - Transportation
  - Coordination of Warranties / Activation / Commissioning
  - Training

Specifications Drawings **Workbook**

Laboratory Equipment Planning Documentation

Room Number

Quantity of Other Rooms That Follow This Equip List (Re: Typical / Master Room Number Reference)



Volume I

- Equipment Project Narrative
- Project Responsibility Matrix
- Project Equipment Estimates (Department)
- Project Equipment Estimates (Type)
- Equipment Item Quantity Summaries (ID Code)
- Equipment Item Quantity Summaries (Department)
- Typical/Master Room Number Reference
- **Room by Room Equipment Listing**

Volume II

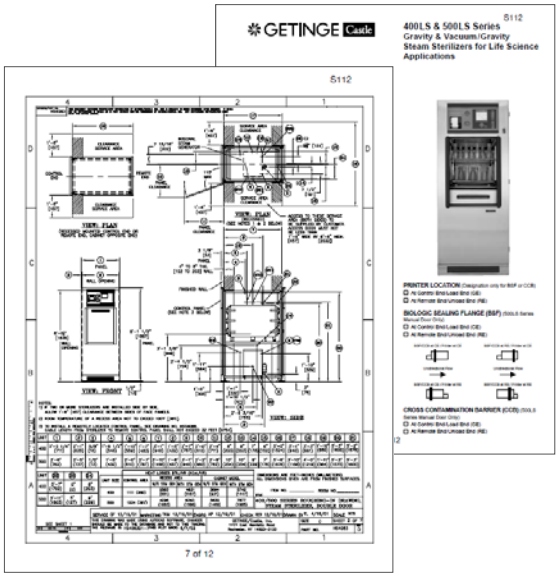
- Product Data Sheets/Cut Sheets (01032 – 30403)

Volume III

- Product Data Sheets/Cut Sheets (30407 – X825)

Specifications Drawings **Workbook**

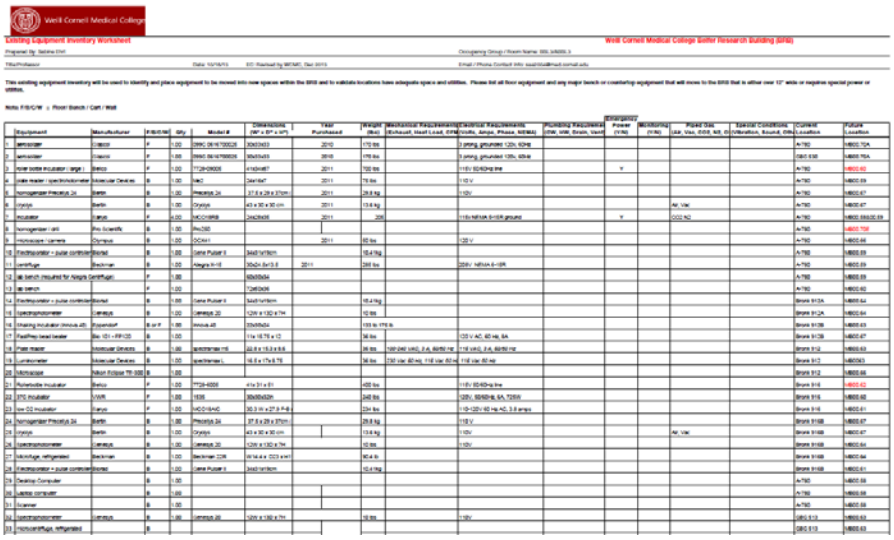
Equipment Data



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



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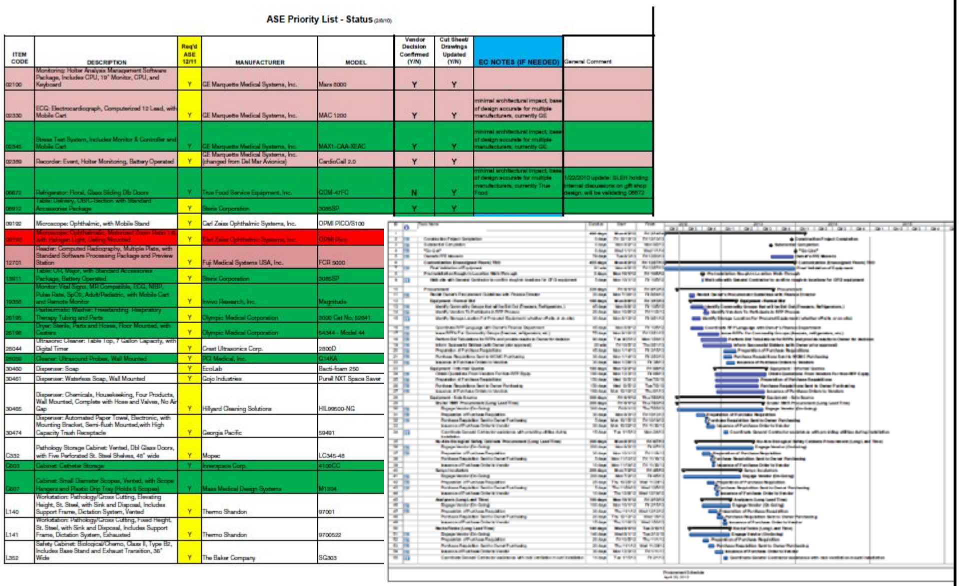
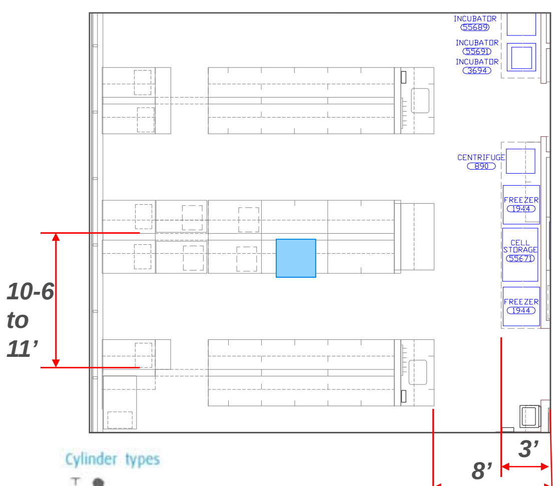
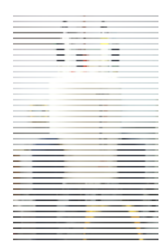
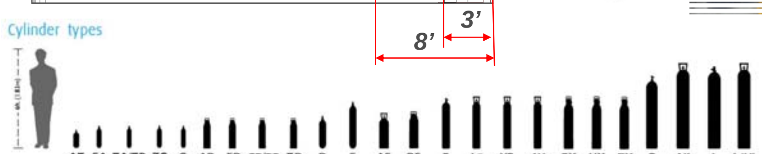
Equipment Selection Status Tracking/Lead Times



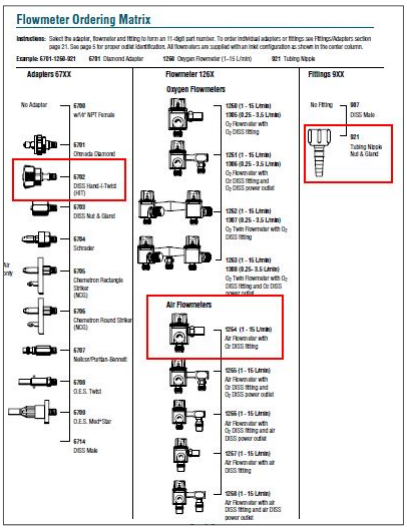
Plan Space for Equipment

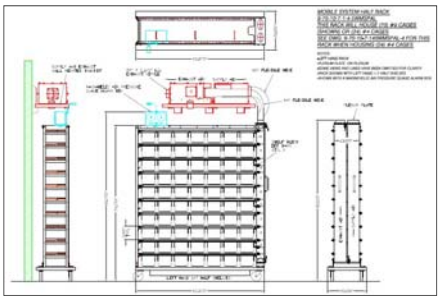


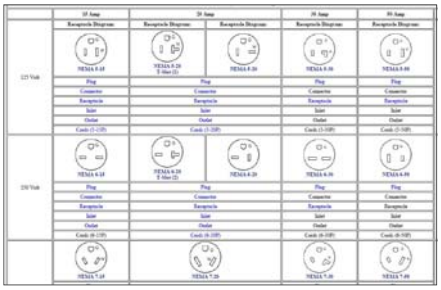




Plan Utilities for Equipment







Control of Heat Loads

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"Hoods"

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

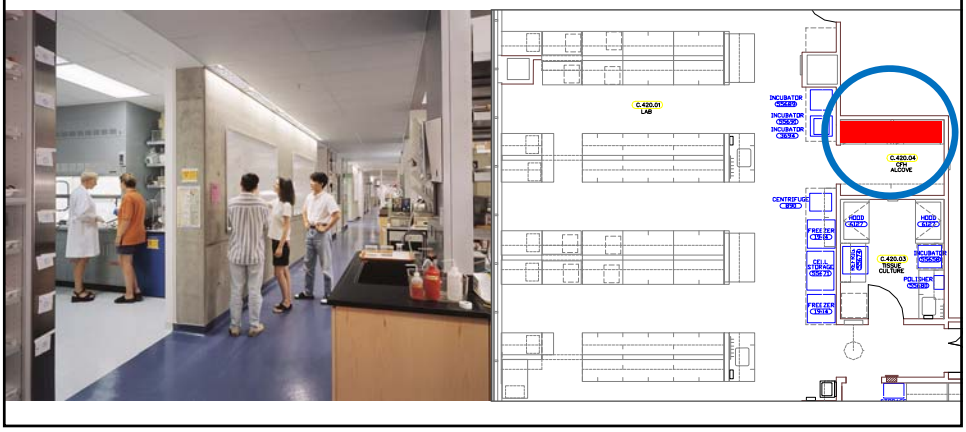
Biological Safety Cabinet (BSC)
Protects User and material
4', 5', 6',
(inside dimensions)

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



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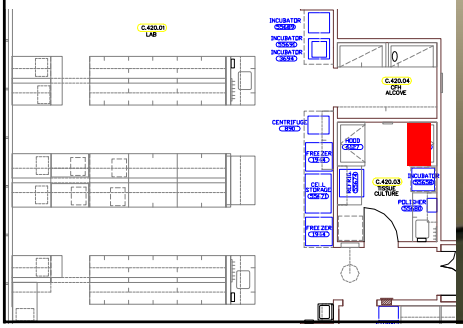
Biosafety Cabinets

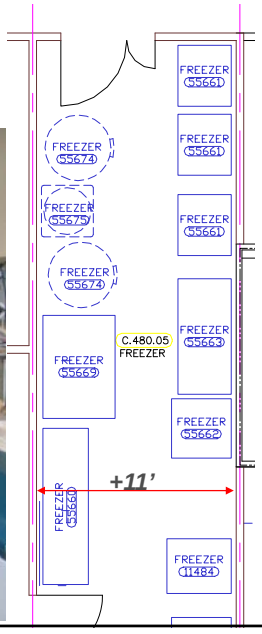
- Away from paths
- Away from exits
- Don't forget workspace
- Nominal vs. Actual Widths:
  4' Hood = 4'-6" Actual
  6' Hood = 6'-6" Actual



Equipment Rooms

Freezer Rooms Might Require More than an 11'-0" Planning Module

Floor Loading, Monitoring



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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?

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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

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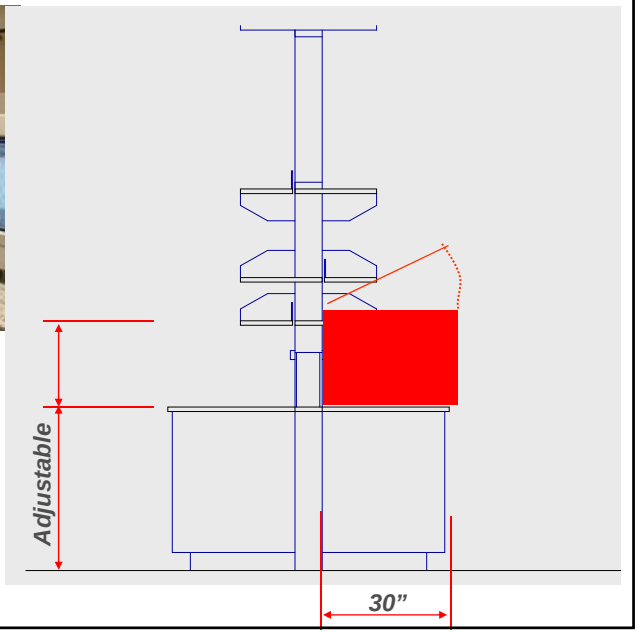
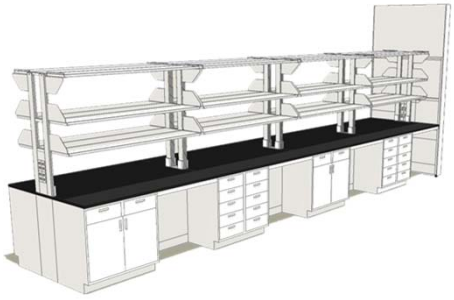
Bench



Floor Mounted, Adjustable Shelving



- Traditional
- Some flexibility

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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

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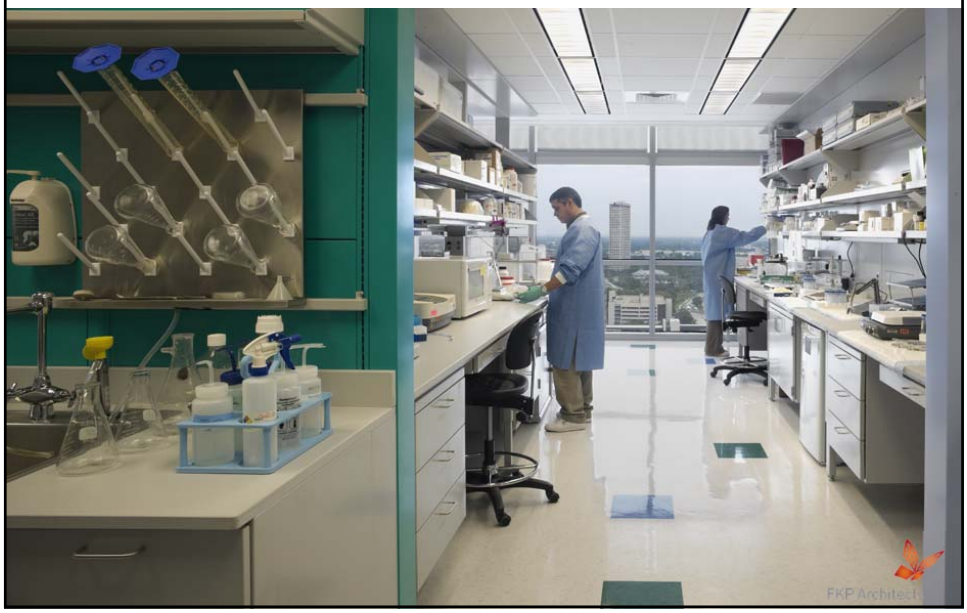
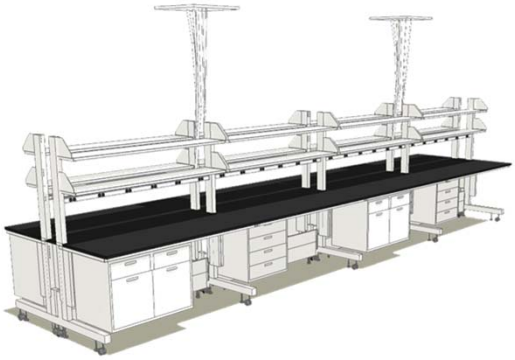
Demountable Casework/Walls



Mobile Instrument Carts



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

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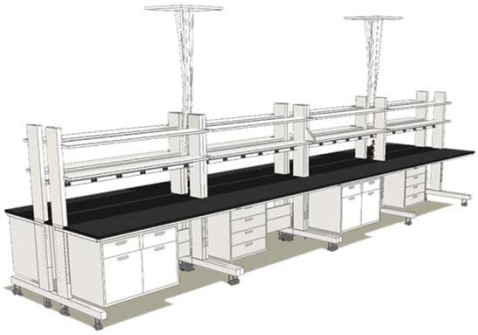
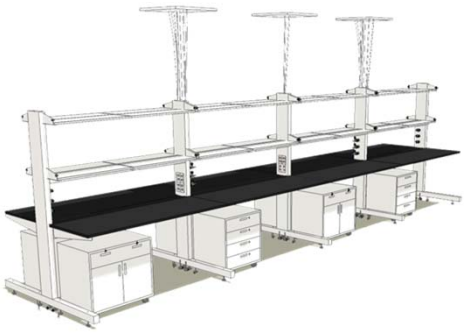
Mobile Heavy-Duty Equipment Racks



- Overheard 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

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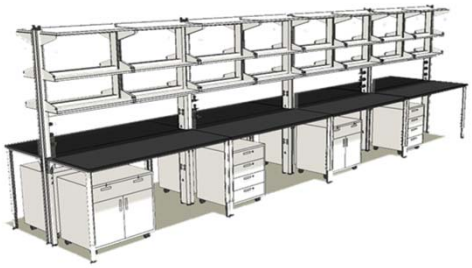
Movable Four-Leg Bench System



- 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

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Overhead Utility Costs

Pre-manufactured (Wing)
~$450 LF

Fabricated on
~$375 LF

Ceiling Panels
~$116 LF

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Utility Distribution – Ceiling Service Panels

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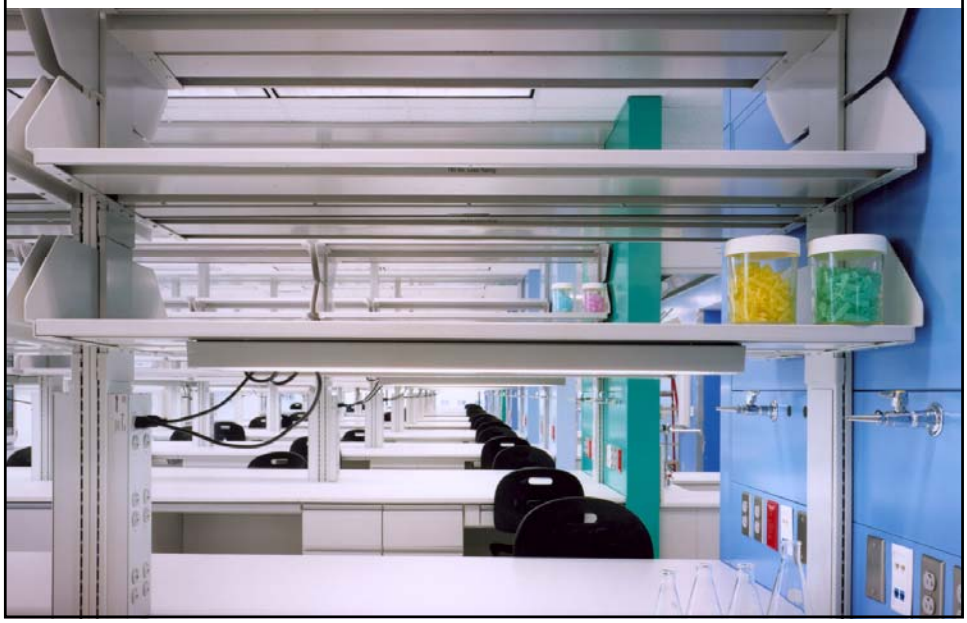
Bench Distribution – On the Upright



Bench Distribution – On the Upright

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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

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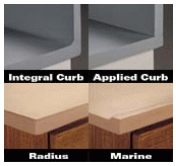
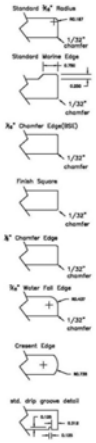
Countertops, Sinks & Fixtures

- 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

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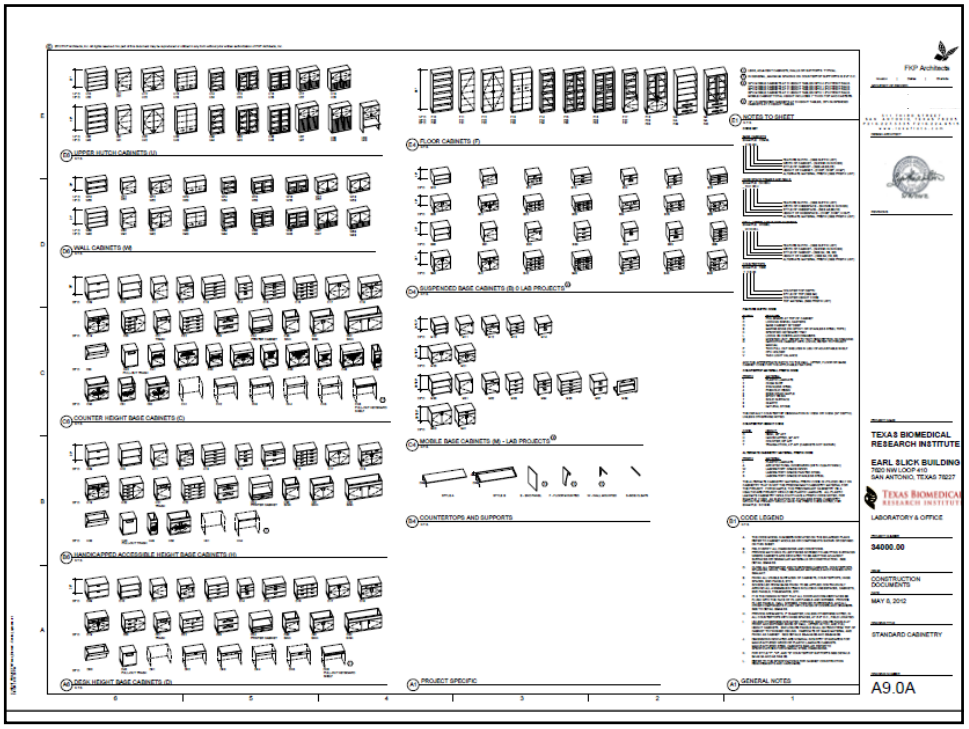

BIM - Drawings in Revit

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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, Percloric
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

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FUME HOOD TYPES

FUME HOOD OPTIONS

Many projects require a combination of fume 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, Vectamatic, 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 Distillation
- ☐ General Purpose, Floor Mounted, Vectamatic
- ☐ Special Purpose, Research Chemical, Perchloric Acid
- ☐ Special Purpose, Research Chemical, Radioisotope
- ☐ Special Purpose, Research Chemical, Positive Sash
- ☐ Special Purpose, ADA, HOPEC IV
- ☐ Special Purpose, Education, Full View
- ☐ Special Purpose, Education, Pass/Thru Demonstration
- ☐ Special Purpose, Education, Economy
- ☐ Special Purpose, Education, Ductless
- ☐ Special Purpose, Other, Table Type
- ☐ Special Purpose, Other, Canopy
- ☐ Low Flow, Bench Type, Constant Volume, Standard Height
- ☐ Low Flow, Bench Type, Restricted Bypass, Standard Height
- ☐ Low Flow, Bench Type, Constant Volume, Extended Height
- ☐ Low Flow, Bench Type, Restricted Bypass, Extended Height
- ☐ Low Flow, Floor Mounted, Constant Volume
- ☐ Low Flow, Floor Mounted, Restricted Bypass
- ☐ High Performance, Bench Type, Restricted Bypass, Standard Height
- ☐ Other: _____
- ☐ Other: _____

FUME HOOD CONSTRUCTION FEATURES

LINER MATERIAL

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

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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


Source: Thermo Scientific Hamilton Products


Source: Kewaunee Scientific

Limit Customization

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

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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

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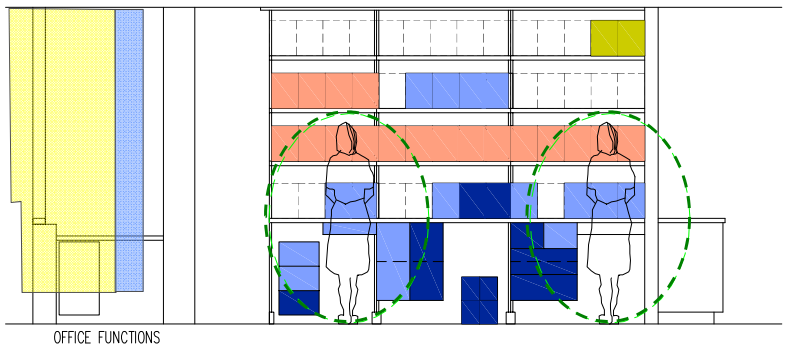
Watch How People Work

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



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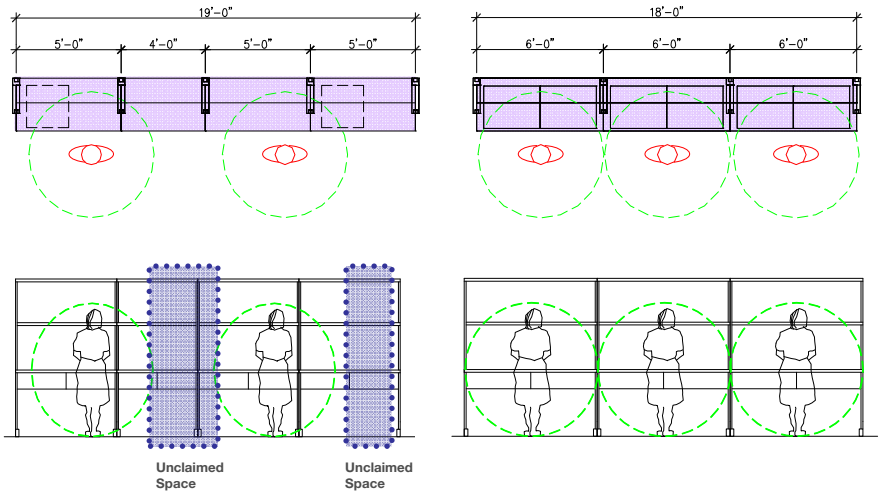
Bench Size and Usage



Provide Other Spaces for Storage

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Office Functions in Labs

Limit Lab Furniture

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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?**

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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

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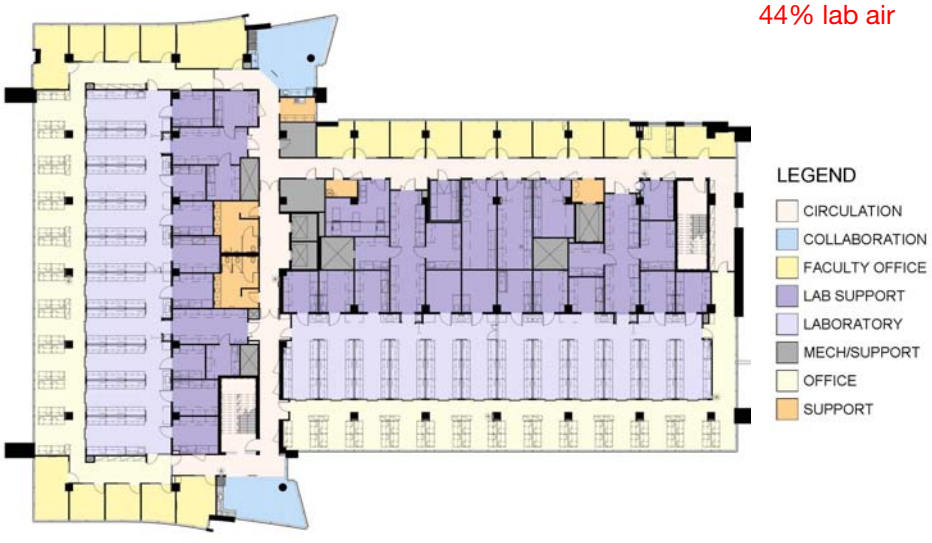
Existing Lab
13,840 SF

Proposed Lab
11,000 SF

~$300,000 savings in construction cost of build-out per floor
~ $12,000 savings in cost of air/year per floor

UTMB Building *Texas*
FKP Architects/Shah Smith Engineers

44% lab air



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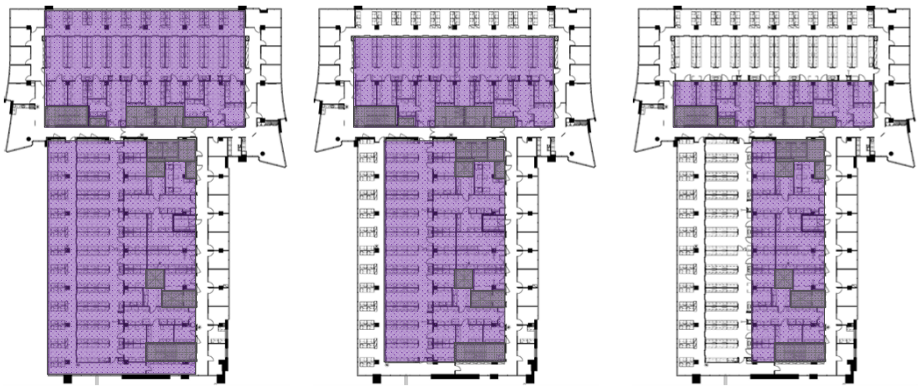
The cost of Air Changes (3 floors)



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

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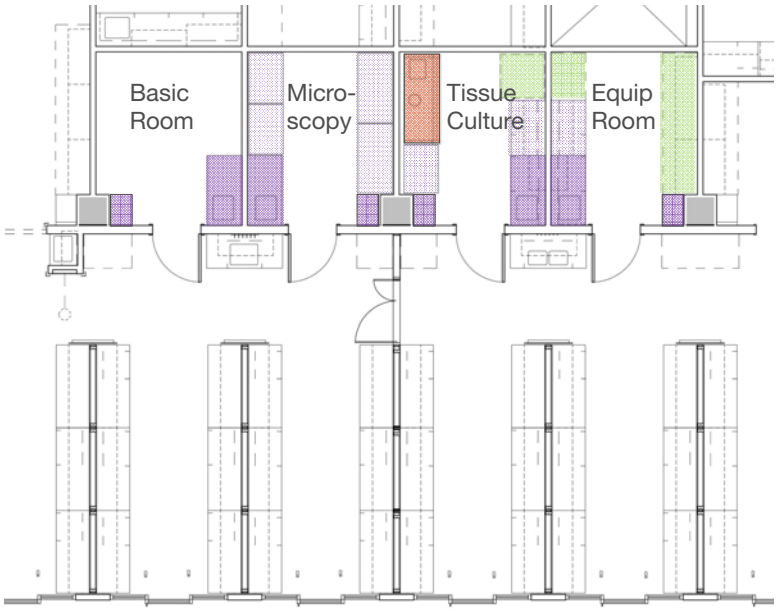
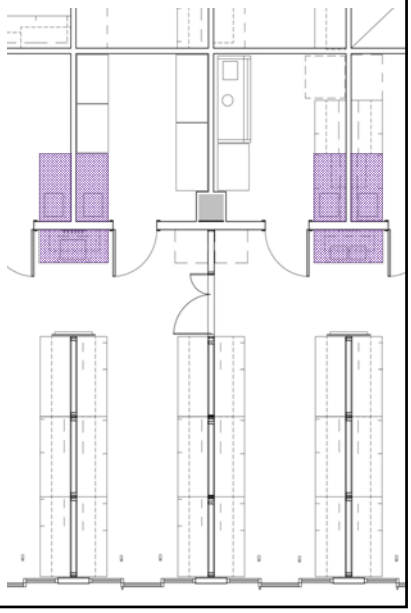
Modular Design



Clustered Plumbing



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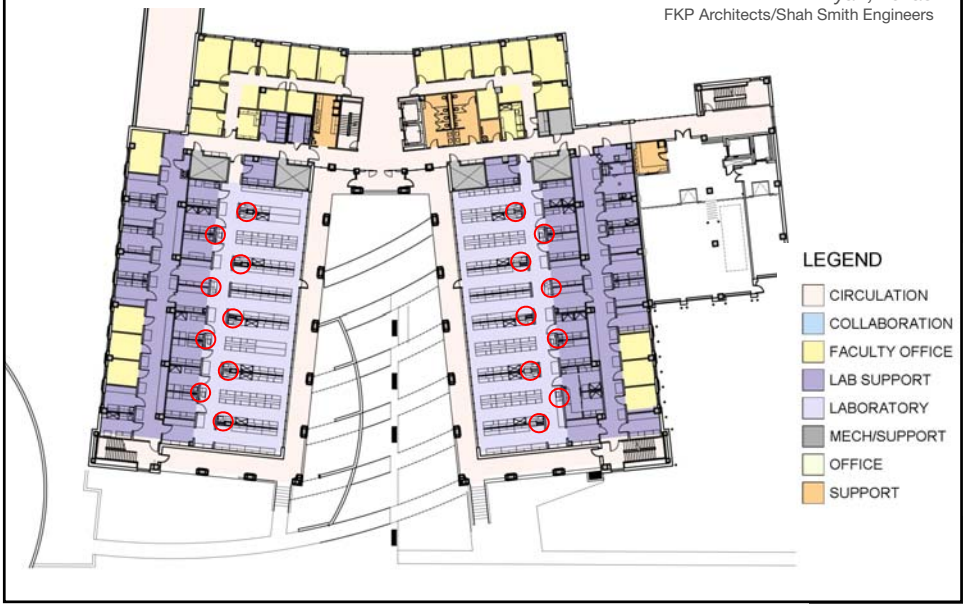
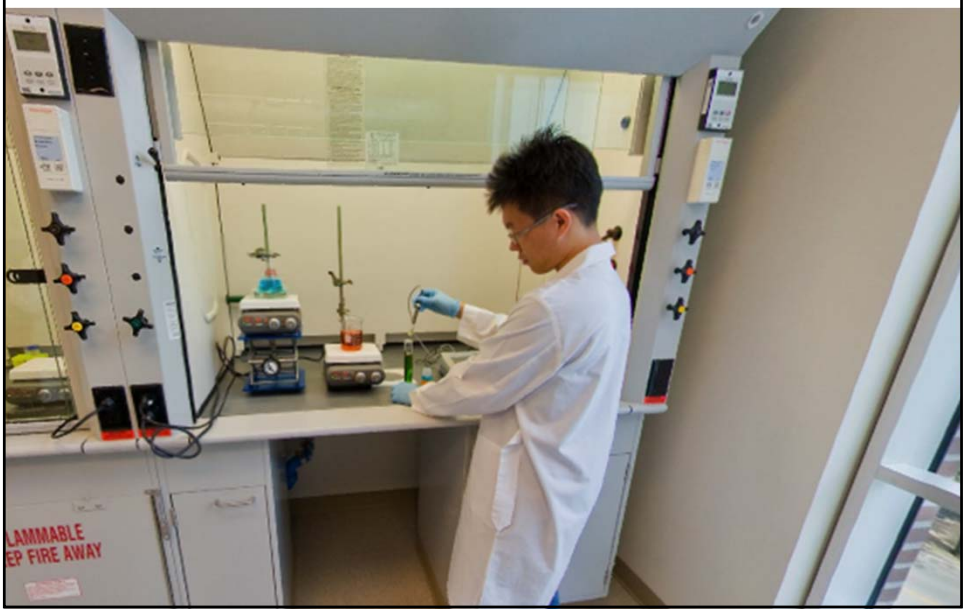
Texas A&M Health Science Center
Medical Research and Education Building
Bryan, Texas
FKP Architects/Shah Smith Engineers



Improve Chemical Fume Hood Efficiencies



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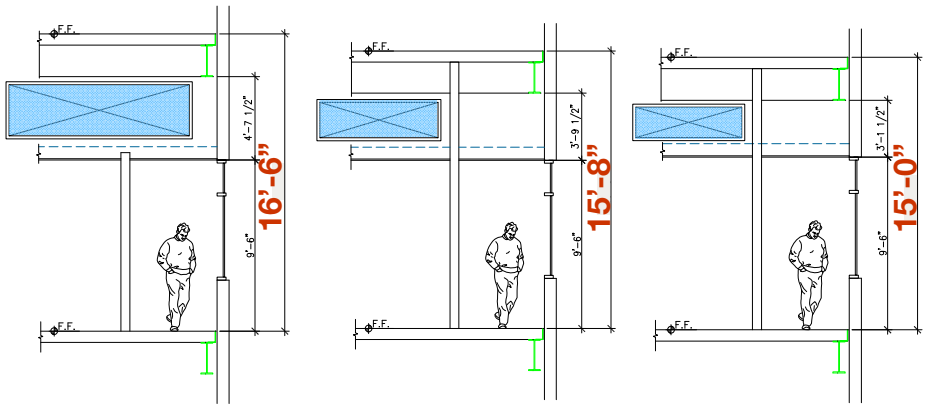
Duct Sizing



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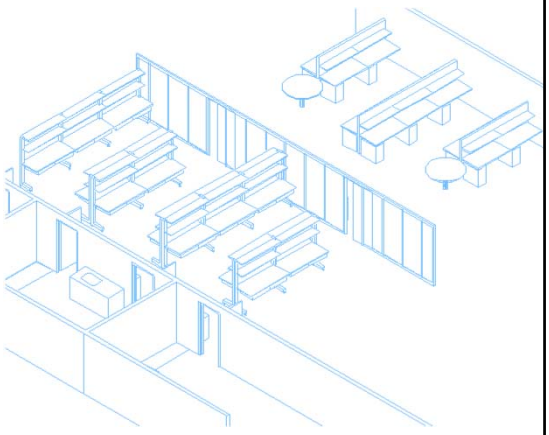
Toolbox for cost reductions
(without quality reductions)

Architecture:	First Cost	Operating Cost
•Program/Build appropriate to functions	✓	✓
•Design with modularity	✓	✓
•Use Flexible/adaptable casework		✓
Mechanical / Electrical / Plumbing		
•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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ASSOCIATION OF Texas College & University Facilities PROFESSIONALS

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!

CONTINUING EDUCATION AIA