University of Hawaii at Manoa
Building Design and Performance Standards

VOL. 2/
DESIGN+
CONSTRUCTION

Additional for Labs
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**These are additional Requirements for Laboratory buildings that supplement the ones for Design + Construction of all Project Groups. This document is intended to be used in combination with the other Design+ Construction Sections for requirements to be added to the project’s checklist depending on the scope of work.
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<td>1. WATER USE REDUCTION</td>
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**INTEGRATION DESIGN**

- **Does it require performance modeling?**
  - **Yes**
  - **No**

**VERIFICATION**

- **Does it require performance model input?**
  - **Yes**
  - **No**
2/B. BUILDING PERFORMANCE

2/B.1. INTEGRATED DESIGN

2/B.1.2+ Commissioning: Laboratory Buildings

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS

   add. Equipment Commissioning

   Equivalent to the requirements in Labs21 Environmental Performance Criteria Version 3.0, Indoor Environmental Quality Credit 2:: “Containment Device Commissioning”

   DESCRIPTION AND IMPLEMENTATION

   Please refer to “Labs21 Environmental Performance Criteria Version 3.0” and “Labs21 Best Practice Guide:: Commissioning Ventilated Containment Systems in the Laboratory”.

2. INTEGRATED DESIGN

   Same as other building types

3. VERIFICATION

   Same as other building types

4. DELIVERABLES

   Same as other building types, including the additional systems and devices specific to laboratory buildings. (See 2/A.1.2.a Integrated Design:: Commissioning :: All Buildings)

5. RESOURCES

   • LEED Reference Guides (http://www.usgbc.org/leed)
   • Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)
   • Labs21- Best Practice Guide on Exhaust Devices Commissioning (http://www.i2sl.org/documents/toolkit/bp_commissioning_508.pdf)
2/B. BUILDING PERFORMANCE

2/B.3 INDOOR ENVIRONMENTAL QUALITY

2/B.3.1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS:

Add. Task Illuminance In Laboratory Spaces

| Specimen collecting: 50 fc (horizontal), 10 fc (vertical) |
| Science laboratory: 50 fc (horizontal), 30 fc (vertical) |

Values higher than 50 fc should be carefully reviewed and justified by special functional requirements and should be restricted to the areas where the task is being performed.

DESCRIPTION AND IMPLEMENTATION

Please refer to “Labs 21 Best Practice Guide:: Efficient Electric Lighting in Laboratories” and “Labs 21 Best Practice Guide:: Daylighting in Laboratories”.

2. INTEGRATED DESIGN

Same as other building types

3. VERIFICATION

Same as other building types

4. DELIVERABLES

Same as other building types

5. RESOURCES

- Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)
- Labs 21 Best Practice Guide:: Daylighting in Laboratories (http://www.i2sl.org/documents/toolkit/bp_daylight_508.pdf)
2/B.4. ENERGY

2/B.4.1+ Energy Use Reduction:: Lab Buildings

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS

   add. Labs21 Modeling Guidelines

   For UHM laboratory projects, targets should be set based on the range of energy use intensity across the UHM laboratory portfolio. Design teams to demonstrate, via energy modeling, a minimum 30% reduction below those benchmarks (same as other building types), following Labs 21 modeling guidelines as needed.

DESCRIPTION AND IMPLEMENTATION

Please refer to “Labs 21 Best Practice Guide:: Metrics And Benchmarks For Energy Efficiency In Laboratories” and “Laboratory Modeling Guideline using ASHRAE 90.1-2007 Appendix G”.

Labs21 Modeling Guidelines: These guidelines were developed to clarify or modify selected sections of the ASHRAE 90.1 standard in order to make them more applicable to systems serving laboratory spaces. Table 1 summarizes the modifications in the Labs21 guidelines.

While the Labs21 guidelines are designed to be used in conjunction with Appendix G of the ASHRAE 90.1 Standard, they were developed by Labs21 and are not officially a part of the standard. To the extent that other elements in the guidelines are not yet part of the standard, it is recommended that they be followed when modeling laboratory buildings.

2. INTEGRATED DESIGN

   Same as other building types

3. VERIFICATION

   Same as other building types

4. DELIVERABLES

   Same as other building types
5. **RESOURCES**

- Labs 21 Environmental Performance Criteria ([http://www.i2sl.org/resources/toolkit/epc.html](http://www.i2sl.org/resources/toolkit/epc.html))
2/B. BUILDING PERFORMANCE

2/B.4. ENERGY

2/B.4.2+ HVAC Selection and Control: Lab Buildings

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS

add.1 Ventilation Rates

1. Air-change rates should be benchmarked with two metrics:
   • Air changes per hour (ACH): Values higher than 6 ACH (when occupied) and 4 ACH (unoccupied) should be explicitly justified as being required for health and safety.

2. Fulfill the requirements described in “Labs 21 EA EPC Prerequisite 1 Assess Minimum Ventilation Requirements”.

add.2 Airflow Analysis

Fulfill the requirements described in “Labs 21 EQ EPC Credit 1 Laboratory Air Flow Analysis”.

add.3 HVAC Specifications

1. Ventilation airflow efficiency should be benchmarked by two key related metrics:
   • Pressure drop (in. w.g.): Each component in the supply and exhaust system should be optimized for low pressure drop.
   • Ventilation system W/cfm: total power of supply and exhaust fans divided by the total cfm of supply and exhaust fans: from 0.3 W/cfm to 1.9 W/cfm. The fan power limitations specified in ASHRAE 90.1 2004 provide an additional benchmark.

2. Chiller systems in labs should be designed for 5 percent minimum-turndown ratios, defined as the ratio of minimum load (with continuous compressor operation without hot gas bypass or other false loading methods) to design load.

3. Reheat energy-use factor (defined as the ratio of the reheat energy use to the total space heating energy use) should be 0 percent (i.e., complete elimination of reheat energy use for temperature control).
2/B.4.2+ Energy:: HVAC Selection and Control: Lab Buildings (Continued)

add.4 Fume-hood density and Sash Management

Optimize indoor lab airflow with proper fume hood location. Fume-hood density should be benchmarked with other labs that have similar programmatic requirements. As a reference, values higher than about 3 hoods/5000 gsf may present opportunities for optimizing the number of fume hoods.

Fume-hood sash management: use fume hood airflow management ratio (defined as the ratio of the average flow to the minimum flow) to be close to 2.

add.5 Temperature and Humidity Setpoints

Tolerances tighter than those required for human comfort (e.g., based on ASHRAE Standard 55-12), be carefully evaluated and explicitly justified.

add.6 High Energy Equipment Isolation

Examine options for co-locating equipment with high heat generation (e.g., -80 freezers) in a distinct space that permit the use of hydronic cooling loops or other means of high-efficiency heat rejection.

DESCRIPTION AND IMPLEMENTATION

The intent of this requirement is to optimize minimum ventilation and cooling system requirements in laboratories based on user requirements, health/safety protection and energy consumption.

Please refer to the following Labs21 Best Practice Guides: “Minimizing Reheat Energy Use in Laboratories”, “Low-Pressure-Drop HVAC Design for Laboratories”, “Energy Recovery in Laboratory Facilities”, “Optimizing Laboratory Ventilation Rates”.

2. INTEGRATED DESIGN

Same as other building types

3. VERIFICATION

A. DESIGN

Perform real or virtual laboratory models that permit airflow pattern simulations. These performance-based approaches evaluate a simulated environment's hazards, e.g., they determine a chemical's clearing time by calculating the lab space's "mixing factors" for a given spill scenario rather than simply applying a
universal, prescriptive air change rate. This is an iterative process that accounts for facility design features that influence one another. The following simulation methods may be applicable:

- **CFD simulations:** are useful for evaluating the dynamic effects of HVAC system features, layout, and operation. Room geometry, HVAC system equipment, diffuser placement, and laboratory equipment as well as operational procedures all influence air movement in the laboratory, particularly around the fume hood sash opening. A CFD model simulates the interaction of all of these variables—as well as the turbulence caused by a worker's movements—to provide data that can be used to understand a laboratory’s temperature, air movement, relative pressure, regions of turbulence, and contaminant concentrations.

- **Tracer gas simulations:** If a scaled or full-size mockup is built, a lab’s ventilation system can be determined by using a tracer gas test, according to the ASHRAE Laboratory Design Guide.

- **Neutrally buoyant bubble simulations:** Using neutrally buoyant helium bubbles to study airflow patterns in a laboratory space provides designers an opportunity to study a lab’s ventilation system. Helium bubbles are also useful for evaluating the efficacy and placement of supply diffusers and return air grilles; their positions can be varied during the test in order to mitigate areas of stagnant air.

### 4. DELIVERABLES

#### A. DESIGN REVIEW

Same as other building types, in addition to submitting results of performance laboratory models. Document the process and findings of the following:

- Determine the necessary fresh air ventilation rate and number of fume hoods and other exhaust devices based on applicable codes and the planned use of the laboratory over the next 5 years.

- Consider different types of fume hoods and exhaust alternatives to fume hoods, such as instrument exhausts and ventilated storage cabinets with very low flow ventilation and good ergonomic accessibility.

- Develop a fume hood sash management plan, to be incorporated in the Chemical Hygiene Plan for the laboratory, that includes:
  - a) Informational placards for hoods;
  - b) Awareness and Use Training.
2/B.4.2+ Energy:: HVAC Selection and Control:: Lab Buildings (Continued)

B. CONSTRUCTION REVIEW
Same as other building types, including specific additional systems for laboratory buildings.

C. PERFORMANCE REVIEW
Same as other building types, including specific additional systems for laboratory buildings.

5. RESOURCES
• Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)
• Labs21 Best Practice Guide Minimizing Reheat Energy Use in Laboratories. (http://www.i2sl.org/documents/toolkit/bp_reheat_508.pdf)
• Labs 21 Best Practice Guide:: Low-Pressure-Drop HVAC Design for Laboratories (http://www.i2sl.org/documents/toolkit/bp_lowpressure_508.pdf)
• Labs 21 Best Practice Guide:: Energy Recovery in Laboratory Facilities (http://www.i2sl.org/documents/toolkit/bp_recovery_508.pdf)
• Labs 21 Best Practice Guide:: Optimizing Laboratory Ventilation Rates (http://www.i2sl.org/documents/toolkit/bp_opt_vent_508.pdf)
2/B. BUILDING PERFORMANCE

2/B.4. ENERGY

2/B.4.3+ Electric Lighting Energy:: Lab Buildings

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS
   add. Laboratory Lighting Power Allowance and Guidelines
   Laboratory Lighting Power Allowance (Building Area Method) is 1W/sqft.

   DESCRIPTION AND IMPLEMENTATION

   Lighting designed for laboratories has many things in common with lighting designed for classrooms, offices or other places where mixed visual tasks are performed. One significant difference is that the work surfaces in labs are typically at various heights, hence most tasks are of a three-dimensional nature, involving multiple horizontal and vertical work surfaces. Lighting for good visual acuity necessarily includes a balance between horizontal work surface illumination and the brightness of other surfaces near and distant in the field of view. Minimizing dramatic contrast in the entire field of view will help to reduce eyestrain and visual fatigue, although some contrast is essential to prevent visual dullness, which can also cause fatigue.

   Please refer to “Labs 21 Best Practice Guide: Efficient Electric Lighting in Laboratories”.

2. INTEGRATED DESIGN

   Same as other building types

3. VERIFICATION

   Same as other building types

4. DELIVERABLES

   Same as other building types

5. RESOURCES

   • Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)
   • Labs 21 Best Practice Guide on Efficient Electric Lighting In Laboratories. (http://www.i2sl.org/documents/toolkit/bp_lighting_508.pdf)
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2/B. BUILDING PERFORMANCE

2/B.4. ENERGY

2/B.4.5+ Plug Load Reduction:: Lab Buildings

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS
   
   add.1 Equipment Efficiency
   
   Fulfill the requirements described in “Labs 21 EA EPC Credit 1.2: Improve Laboratory Equipment Efficiency by 20%”

   add.2 Right Size Equipment Load
   
   Fulfill the requirements described in “Labs 21 EA EPC Credit 2: Right Size Laboratory Equipment Load”.

   DESCRIPTION AND IMPLEMENTATION

   The intent of this requirement is two-fold: first, to save energy with efficient laboratory equipment. Second, to “right-size” mechanical equipment by improving estimates of heat-gain from laboratory and process equipment.

   Please refer to “Labs 21 Best Practice Guide: Right-sizing Laboratory Equipment Loads” and the “Labs 21 Energy Efficient Laboratory Equipment Wiki”.

2. INTEGRATED DESIGN

   Same as other building types

3. VERIFICATION

   Same as other building types

4. DELIVERABLES

   Same as other building types

5. RESOURCES

   • Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)
   
   • Labs21 Best Practice Guide on Right-sizing Laboratory Equipment Loads (http://www.i2sl.org/documents/toolkit/bp_rightsizing_508.pdf)
2/B.4.5.+ Energy:: Plug Load Reduction:: Lab Buildings (Continued)

2/C. WATER

2/C.1. WATER USE REDUCTION

1. ADDITIONAL REQUIREMENTS FOR LABORATORY BUILDINGS

Designs should fulfill the following requirements that are specifically critical for the Hawaiian Climate:

*add. Equipment And Process Water Use Reduction*

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>“Labs 21 WE EPC Prerequisite 1 Laboratory Equipment Water Use”</td>
<td>Fulfill the requirements described in “Labs 21 WE EPC Prerequisite 1 Laboratory Equipment Water Use”.</td>
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<tr>
<td>“Labs 21 WE EPC Credit 1.1 and 1.2 Process Water Efficiency”</td>
<td>Fulfill the requirements described in “Labs 21 WE EPC Credit 1.1 and 1.2 Process Water Efficiency”.</td>
</tr>
</tbody>
</table>

DESCRIPTION AND IMPLEMENTATION

The intent of this requirements is to reduce process water use, including water use for laboratory equipment. Process water is defined as any water that is used in the laboratory. Design teams should follow the recommendations described in the “Best Practices” Guidelines for Water Efficiencies Guide for Laboratories.

2. INTEGRATED DESIGN

Same as other building types

3. VERIFICATION

Same as other building types

4. DELIVERABLES

Same as other building types

5. RESOURCES

- Labs 21 Environmental Performance Criteria (http://www.i2sl.org/resources/toolkit/epc.html)