Design Laboratories for Accessible Environment

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AGENDA: Accessible Laboratory Environment

Improving Safety for Disabled Persons

Introduction

- Why these topics are important
- Sources of Information

Topics: Building Codes & Standards

- Hazardous Materials
- Emergency Egress

Accessibility in the Laboratory

- Egress & Entry
- Lab Furniture and Equipment

INTRODUCTION: Accessible Laboratory Environment

Improving Safety for Disabled Persons

Why are these topics important to building owners, facility managers and operators, faculty, staff and students, those persons who enter and use laboratory buildings, laboratory spaces?

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Improving Safety for Disabled Persons

U.S. CHEMICAL SAFETY & HAZARD INVESTIGATION BOARD, Aug. 16, 2018,

"Laboratory Incidents from January 2001- July 2018"

Includes:

- Incident date
- Organization
- Location: City, State
- Fatalities
- Injuries

Accessed August 27, 2018

https://www.csb.gov/assets/1/17/csb_laboratory_incident_data.pfd?16376

LABORATORY INCIDENTS
JANUARY 2001–JULY 2018

U.S. Chemical Safety and Hazard Investigation Board

Incident Date	Organization	City	State	Fatalities	Injuries
2008-12-29	University of California, Los Angeles	Los Angeles	California	1	0
2009-02-28	Boise State University	Boise	Idaho	0	1
2009-03-09	Florida Medical Clinic	Zephyrhills	Florida	0	0
2009-07-27	Wasatch Labs	Ogden	Utah	0	3
2009-08-29	Eurand America, Inc.	Vandalia	Florida	0	2
2009-09-08	Indiana University-Purdue University Indianapolis	Fort Wayne	Indiana	0	1
2010-01-07	Texas Tech University*	Lubbock	Texas	0	1
2010-05-11	Texas A&M University	College Station	Texas	0	2
2010-06-02	Southern Illinois University	Carbondale	Illinois	0	1
2010-06-28	University of Missouri	Columbia	Missouri	0	4
2010-12-03	Northwestern University	Evanston	Illinois	0	1
2011-01-17	Spectrum Microwave	Marlborough	Massachusetts	0	20
2011-02-08	SynQuest Laboratories	Alachua	Florida	0	1
2011-02-17	Oregon Health and Science University	Portland	Oregon	0	4
2011-03-08	Southfield Lathrup High School	Lathrup Village	Michigan	0	3
2011-03-10	Louisiana State University	Baton Rouge	Louisiana	0	1
2011-03-16	Choice Dental Laboratory	St. Joseph	Michigan	0	1
2011-04-26	Agilent Technologies	Santa Rosa	California	0	1
2011-04-30	Aberdeen Proving Ground Laboratory	Aberdeen	Maryland	1	0
2011-04-30	Front Range Community College	Longmont	Colorado	0	1
2011-05-02	IMANNA Laboratory, Inc.	Rockledge	Florida	0	1
2011-05-09	University of California, Berkeley	Berkeley	California	0	1
2011-05-12	Clarkson University	Potsdam	New York	0	1
2011-05-18	Louisiana State University	Baton Rouge	Louisiana	0	0
2011-06-20	Purdue University	West Lafayette	Indiana	0	6
2011-06-25	Boston College	Chestnut Hill	Massachusetts	0	1
2011-07-12	University of West Florida	Pensacola	Florida	0	2
2011-07-20	New Life Worship Center	Smithfield	Rhode Island	0	4
2011-08-02	Bradley University	Peoria	Illinois	0	0
2011-08-17	University of Pittsburgh	Pittsburgh	Pennsylvania	0	1
2011-09-02	Membrane Technology and Research, Inc.	Menlo Park	California	1	1
2011-09-12	Geomet Technologies, LLC	Gaithersburg	Maryland	0	1
2011-09-19	Harold L. Richards High School	Oak Lawn	Illinois	0	1
2011-09-21	West Charlotte High School	Charlotte	North Carolina	0	1

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Improving Safety for Persons with Disabilities

U. S. CHEMICAL SAFETY & HAZARD INVESTIGATION BOARD

"LABORATORY INCIDENTS YEARS 2001 to JULY 2018"

INCIDENTS **150**

INJURIES **265**

FATALITIES **12**

Data are available for Biological Hazard Incidents from American BioSafety Association (www.ABSA.org)

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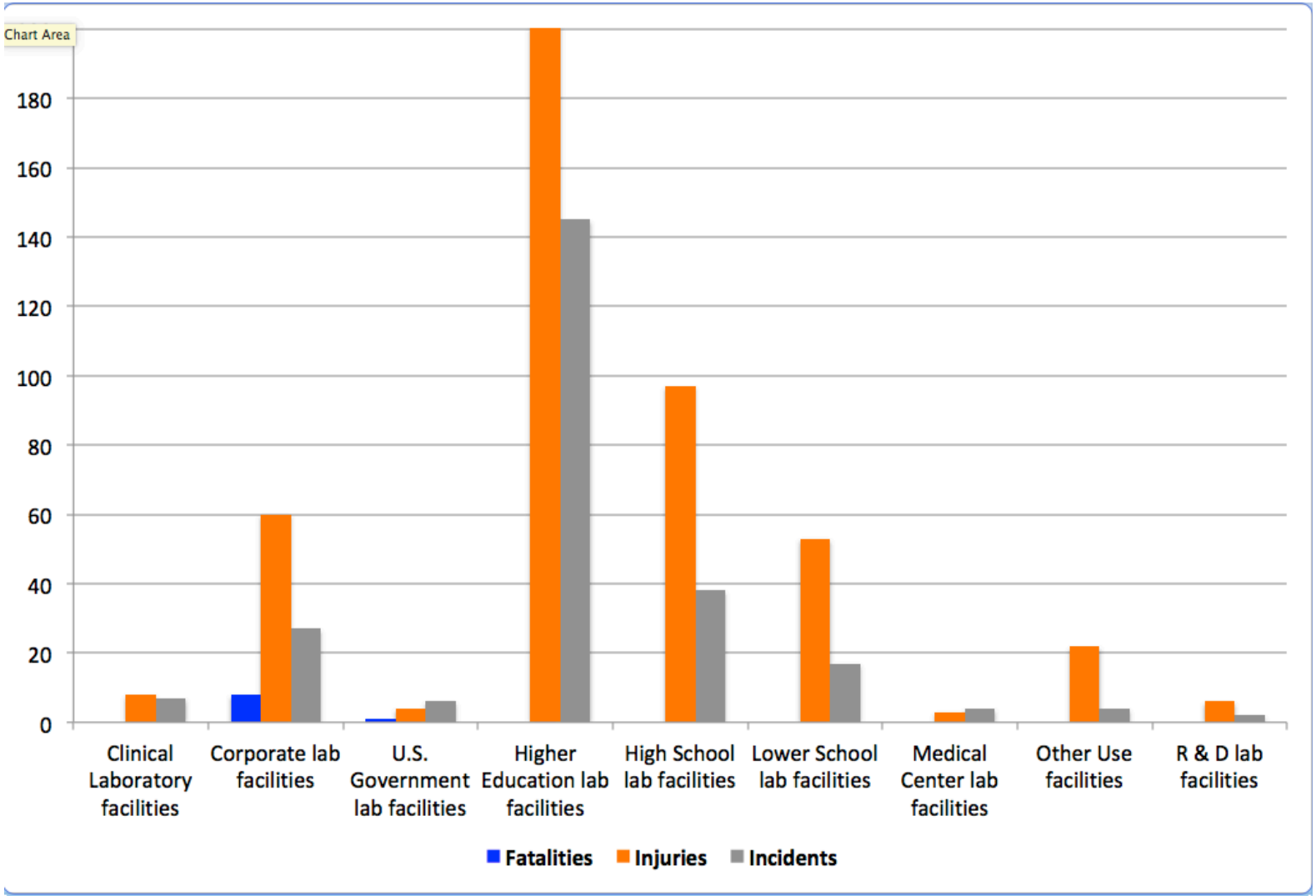
CSB – Incident, Fatality, & Injury by Facility Type



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Guide to the ADA Standards. https://www.access-board.gov/guidelines-and-standards/building-and-sites-about-the-standards/guide-to-the-ada-standards

REFERENCES & SOURCES of INFORMATION

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International Fire Code (IFC): Ch. 5 "Fire Service Features", Ch. 9, "Fire Protection Systems", 2018.

International Mechanical Code (IMC): Ch. 5, "Exhaust Systems", 2012.

Health and Safety Standards: 29 CFR 1910.34, Ch. 17, Subpart E, "Means of Egress" Occupational Safety & Health Administration (OSHA), 2011

NFPA 101: Life Safety Code, Sections 1.1.3 "Egress Facilities" and 1.12 "Danger to Life from Fire", National Fire Protection Association, 2018.

NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals, Section 5.4.2, "Laboratory Egress", National Fire Protection Association, 2015.

Prevalence of Obesity Among Adults and Youth: 2015-2016", Hales, Carrol, Fryar, Ogden, U.S. Center for Disease Control, NCHS Data Brief #288, October, 2017. https://www.cdc.gov/nchs/data/databriefs/db288.pdf

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, 2011, National Research Council.

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BUILDING CODE USE: by Laboratory Building Owners, Facility Managers and Operators, Faculty and Staff

1. Guide leaders in educational organizations to:
   - Understand key code requirements.
   - Understand key user requirements in Program Doc.
   - Quality Control (QC) during owner & user reviews.
   - Insist on code compliance.
2. Communicate with Building Officials, as needed, to explain owner's requirements.

WHY?

To facilitate code reviews by the jurisdiction(s) having authority (JHA)

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BUILDING CODE KEY TOPICS:

for Laboratory the Building Owner, Facility Managers, Operators, Faculty, and Staff

Following information is based on *International Building Code* (2009)

Occupancy Type

Hazardous Materials

Construction Types & Fire Protection

Egress

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OCCUPANCY TYPES

A	Assembly	A-1, A-2, A-3, A-4, A-5
B	Business	
E	Educational	*(day care, pre-school to 12th Grade)*
F	Factory,	F-1, F-2
H	High-hazard	H-1, H-2, H-3, H-4, H-5
I	Institutional,	I-1, I-2, I-3, 1-4
M	Mercantile	
R	Residential	R-1, R-2, R-3, R-4
S	Storage	S-1, S-2
U	Utility and Miscellaneous	

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OCCUPANCY TYPES

Scientific Education Laboratories are ALLOWED in:

B **Business** *(institutions of higher education & training)*

E **Educational** *(day care, pre-school to 12th Grade)*

Scientific Research Laboratories are Allowed in:

H High-hazard, H-1, H-2, H-3, H-4, H-5

F Factory *(only as an incidental use within factory)*

I Institutional *(only as an incidental use within hospital)*

U Utility and Miscellaneous *(only ancillary laboratory uses such as compressed gas tank storage shed)*

All other Occupancy Types do not allow scientific laboratories.
Exceptions: Scientific computer and data facilities and use are allowed.

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HAZARDOUS MATERIALS CODE REQUIREMENTS:
for Owners, Facility Managers, Operators, Faculty, and Staff

Identify risks, evaluate hazards, and recommend appropriate design features, materials, and responses to the design team.

Understand and Maintain building systems that protect laboratory buildings from damaging events and unsafe conditions.

Identify professional design standards that will meet the level of physical Containment required for hazardous materials, based on risks identified by faculty and staff, facility engineer, environmental health & safety.

Owner may bear liability for **accidents** that cause failure of building systems designed to contain release of hazardous materials.

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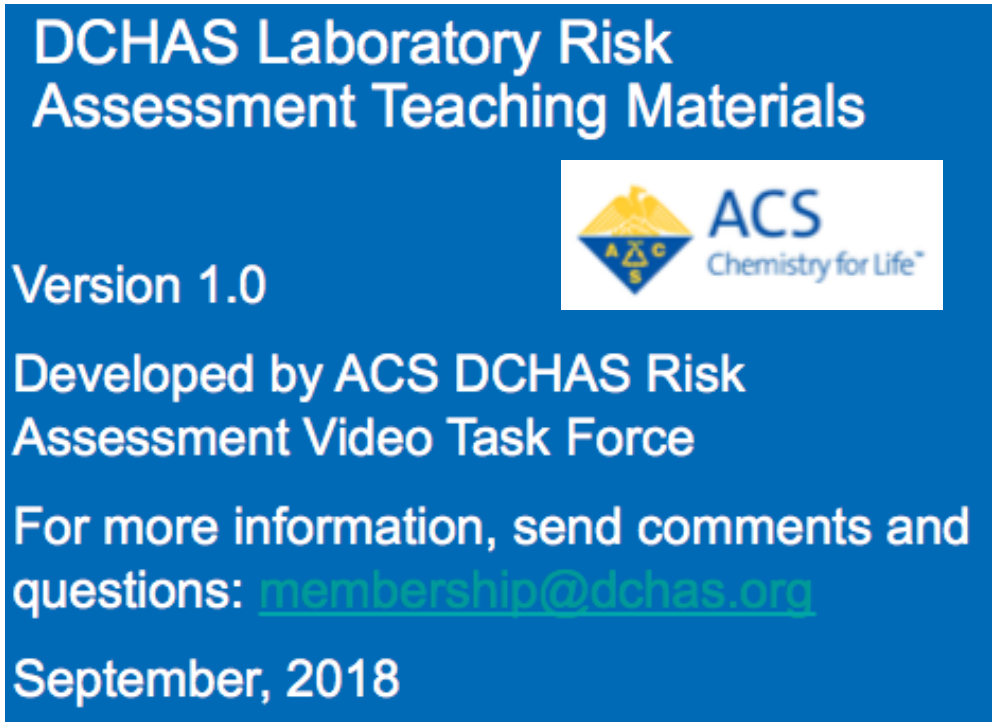
IDENTIFY & ASSESS RISK - Hazardous Materials & Processes



"Reducing the Risk of Liability in the Laboratory", by Kenneth Roy, National Science Teachers Association, NSTA blog, Oct. 17, 2018
http://nstacommunities.org/blog/2018/10/17/reducing-the-risk-of-liability-in-the-lab/

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"*Hazard Rating per Control Area* of Hazardous Materials *Posing a PHYSICAL HAZARD*" (adapted from Table 307.1(1))

Materials are used under these conditions:

- In Storage of solid, liquid and gaseous materials
- In Use-Closed Systems for solid, liquid and gaseous materials
- In Use-Open Systems solid, liquid and gaseous materials

Combustible, Cryogenic,
Explosive, Flammable,
Organic Peroxide, Oxidizer,
Pyrophoric, Unstable,
Water Reactive

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"*Hazard Rating per Control Area* of Hazardous Materials *Posing a HEALTH HAZARD*" (adapted from Table 307.1(2))

Materials are used under these conditions:

- In Storage of solid, liquid and gaseous materials
- In Use-Closed Systems for solid, liquid and gaseous materials
- In Use-Open Systems solid, liquid and gaseous materials

Corrosive

Highly Toxic

Toxic

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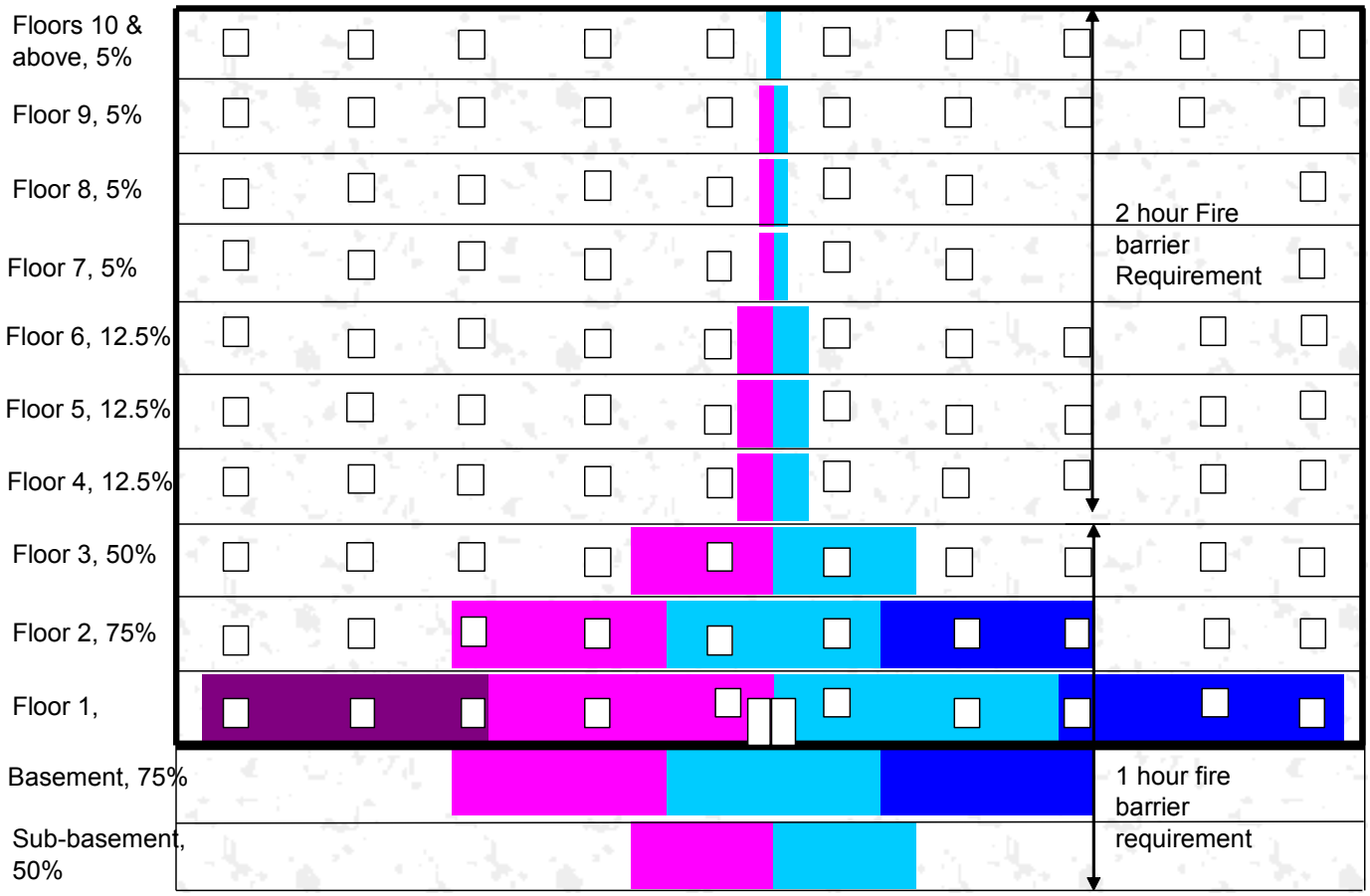
SPECIAL DETAILED REQUIREMENTS

IBC Exempt Quantities of Hazardous Materials Per Floor



Notes:

1. Storage limits = Total quantities for entire building.
2. Building must be equipped with automatic sprinkler system for quantities shown.
3. Materials must be stored in approved manner.

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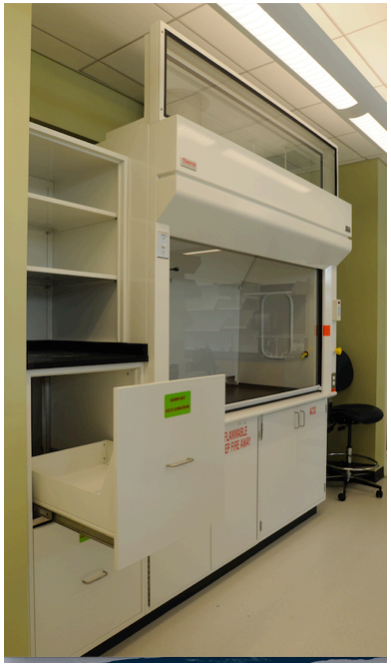
HAZARDOUS MATERIALS: Use & Storage in Safety Equipment

Toxic Gas Cylinders in Vented Toxic Gas Cabinets

Flammable Liquids in Laboratory Safe Refrigerator



Chemicals Stored in Vented Storage Cabinet at Side of Chemical Fume Hood

Chemical Fume Hood with Under-counter Flammable Liquid & Corrosive Storage Cabinets

Photos provided with permission by Louis DiBerardinis, Director of EHS, M.I.T., Cambridge, MA

CONSTRUCTION TYPE & FIRE PROTECTION

Description of Construction Type (IBC, 2009)

Type I and II – **Noncombustible** building elements listed in Table 601 with fire-resistance rating shown.

Type III – **Noncombustible building exterior walls**. Interior elements are of any material permitted by this code.

Type IV (HT) – **Noncombustible building exterior walls**. Fire-retardant-treated wood framing permitted within exterior wall assemblies of ≤ 2 hour rating. Interior elements are solid or laminated wood without concealed spaces. Minimum solid sawn nominal dimensions are required for structures.

Type V – Structural elements, exterior walls, and interior walls are of any materials permitted by this code.

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FIRE PROTECTION

Fire Detection Control Panel in a Fire Department Control Center

Automated Water Sprinkler System on Ceiling

Photos provided with permission by Janet Baum, AIA, Program Co-Director, Harvard SPH, Boston, MA

ADA Design Guide: Accessible Laboratory Environment

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BUILDING ACCESSIBILITY REQUIREMENTS:

Building Codes, ADA, OSHA: for Building Owners, Facility Managers, Operators, Faculty, and Staff

Compliance with accessibility laws and regulations that are applicable to the use, occupancy, and ownership of the facility.

Compliance to standards the owner, manager, & building users require.

Communicate to the design team about the extent and level of accessibility and compliance the owner, facility manager, faculty, staff and students require in specific laboratories, classroom, general assembly, and community facilities.

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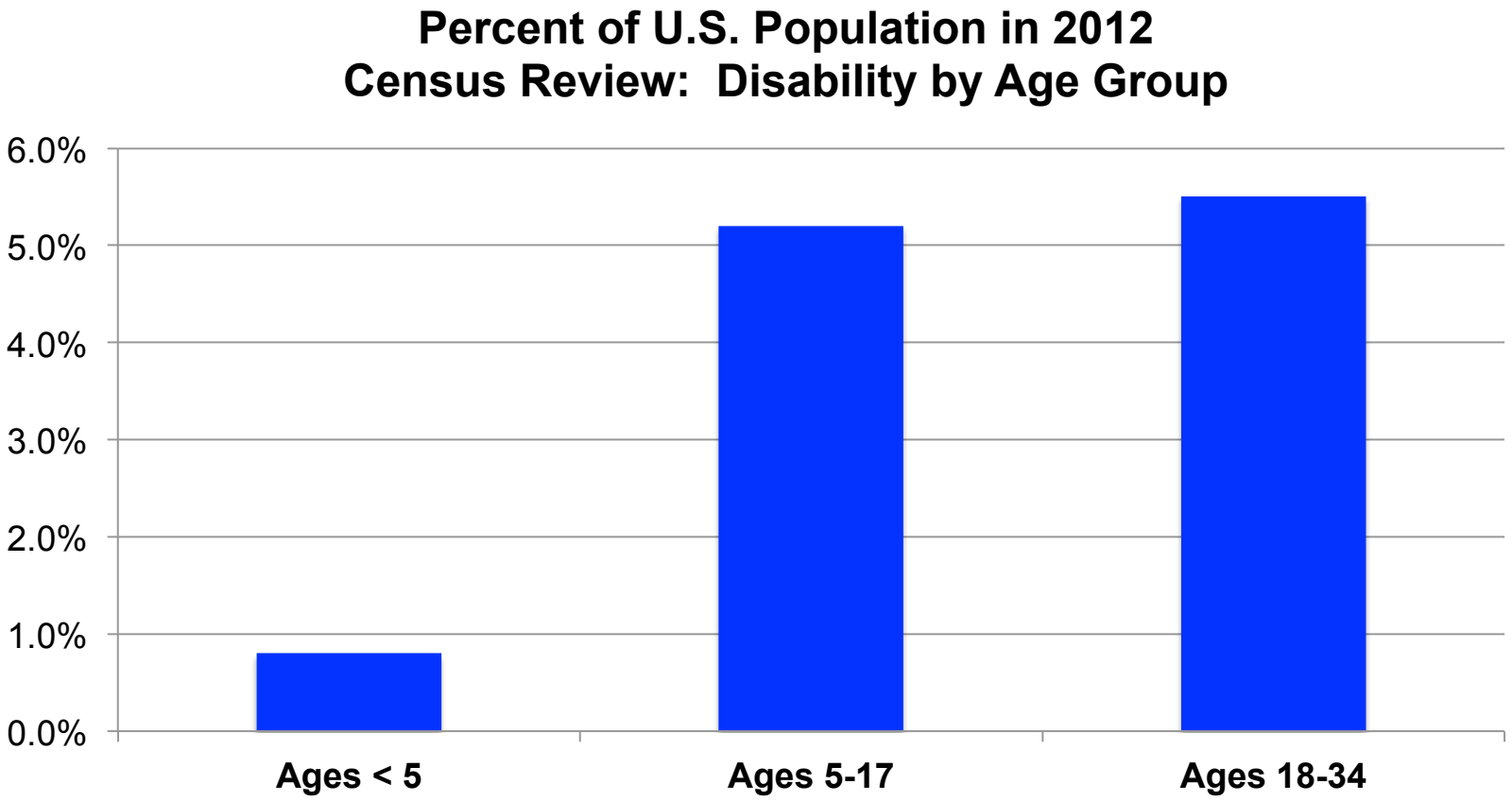
ADA COMPLIANCE: School Age Demographics

from 2010 U.S. Census - Enrolled in School = **89,939,002**



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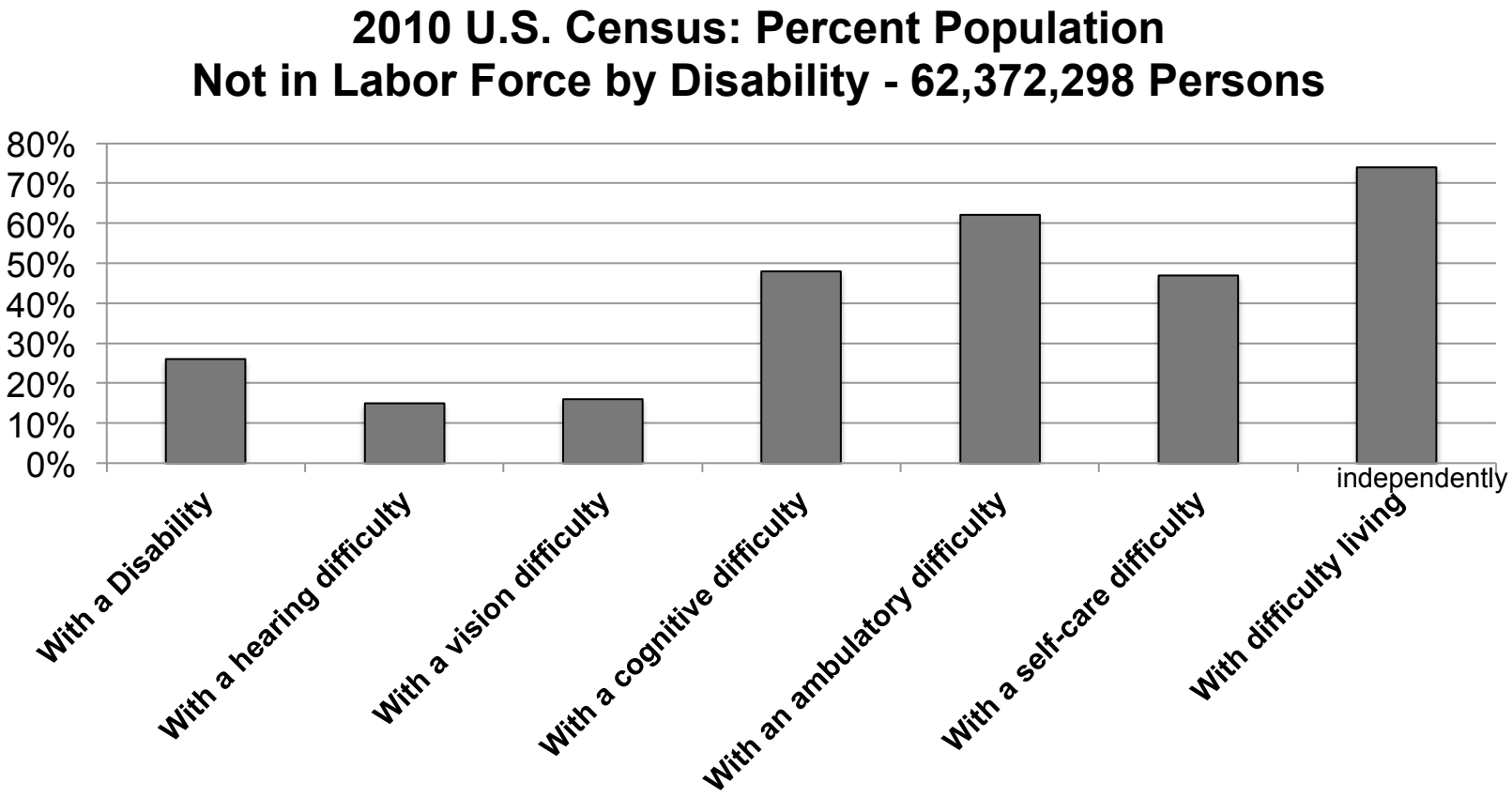
ADA COMPLIANCE: Labor Force Demographics



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ACCESSIBILITY STANDARDS: ADA

U.S. Americans with Disabilities Law 1990: amended 2003

*U.S. Percent Total Population with Disabilities: **18.36%**

*U.S. Percent Workforce Age with Disabilities: **4.96%**

- Applies to Government-owned laboratory buildings
- Public Institution-owned laboratory buildings
- Private Institution-owned laboratory buildings when institution accepts government funding of research programs.
- Commercial and Industry-owned laboratory buildings that permit public access.

* 2010 U.S.A. Census

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ADA COMPLIANCE: Layout Requirements

Access to and Egress from Laboratories

- Wheelchair Clearance on both sides of Exit and Entry doors.
- Wheelchair Clearance at Emergency Eyewash & Safety Shower
- Wheelchair Clearance in front of wall benches, sinks, equipment
- Wheelchair Clearance in front of chemical fume hoods
- Wheelchair Clearance at chalk/marker board
- Wheelchair Clearances between benches
  - Aisles that lead to Primary Exits, back to front
  - Aisles that allow passage side to side in lab

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LABORATORY EGRESS: Recommendations

1) Perform **Risk Assessment** to identify hazards in each lab.
2) Building and lab spaces are **E or B** occupancy and Type **I** or Type **II A** construction rating
3) Laboratories are **fully fire-protected** by an approved automatic sprinkler system (Exception: labs using water-reactive chemicals).
4) Minimum **2 Exits** for labs ≥500 sf (150 sm) net area.
5) Minimum **2 Exits** for labs using chemical fume hoods or glove box
6) Minimum **2 Exits** for labs using flammable and combustible: liquids, gases, cryogenics, dusts and solids.
7) Minimum **2 Exits** for labs using oxidizers, unstable reactives, water reactives, organic peroxides, highly toxics, corrosives.
8) **Risk Assessment** determines numbers of exits for Biosafety Levels **2, 3** and **4**.

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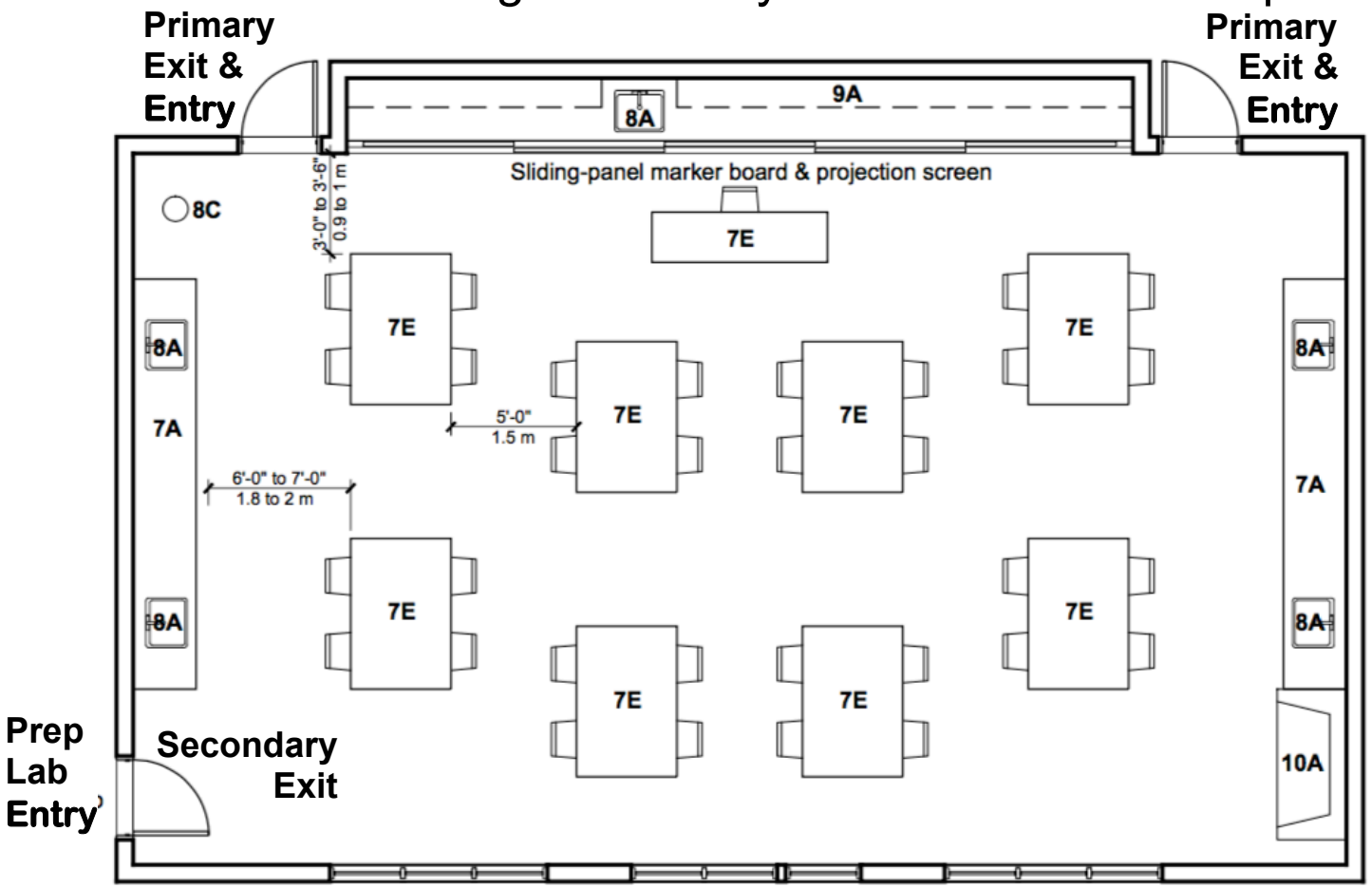
LABORATORY EGRESS: Recommendation

Teaching Laboratory: Student Teams – 4 persons



KEY

7A Lab Wall Bench
7E Lab Table or Bench with utilities
8A Lab Sink with EEW
8C Emergency eye wash fountain and safety shower
10A chemical fume hood

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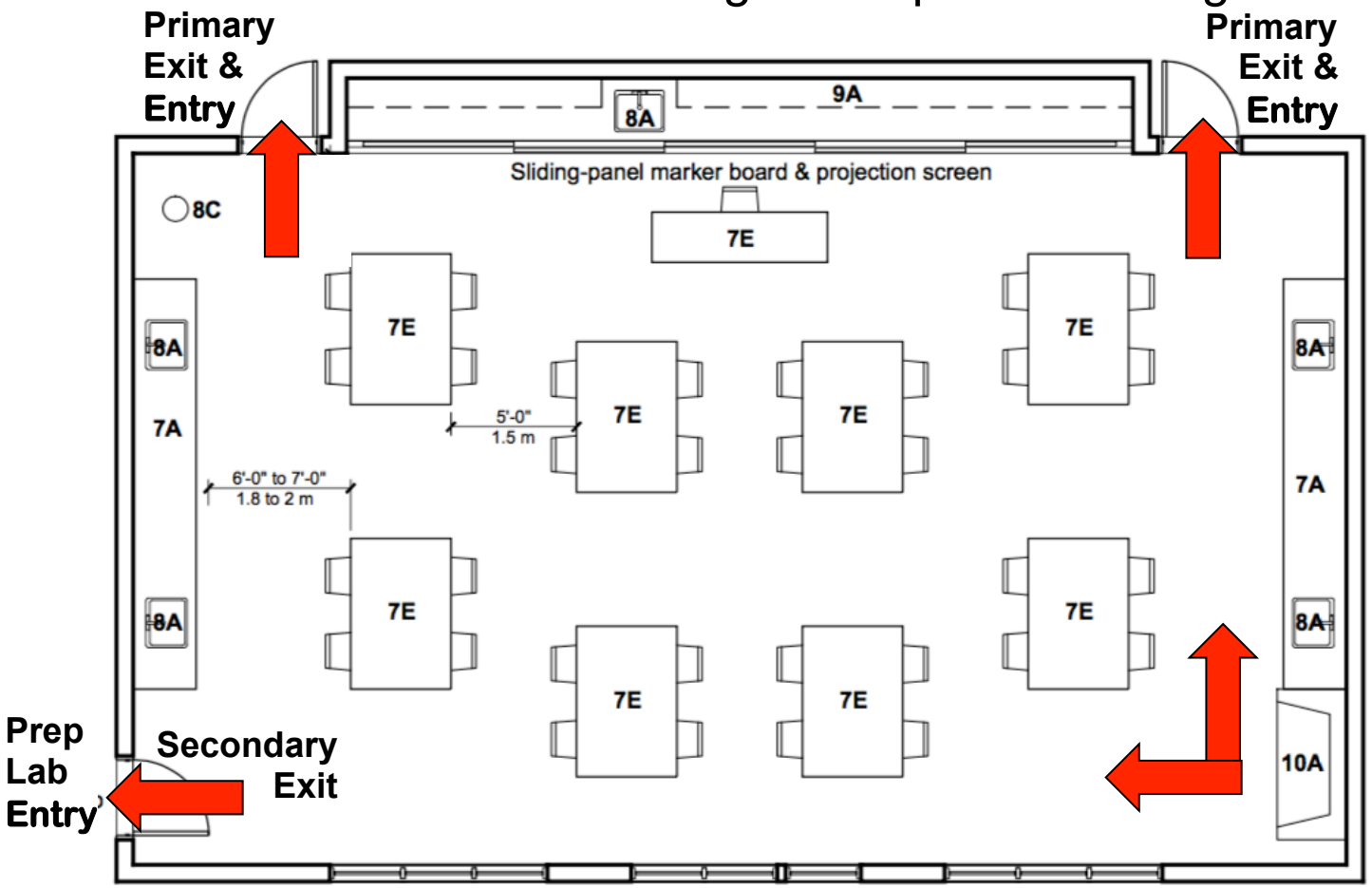
LABORATORY EGRESS: Recommendation

Hazard Zoning Concept in Teaching Laboratory



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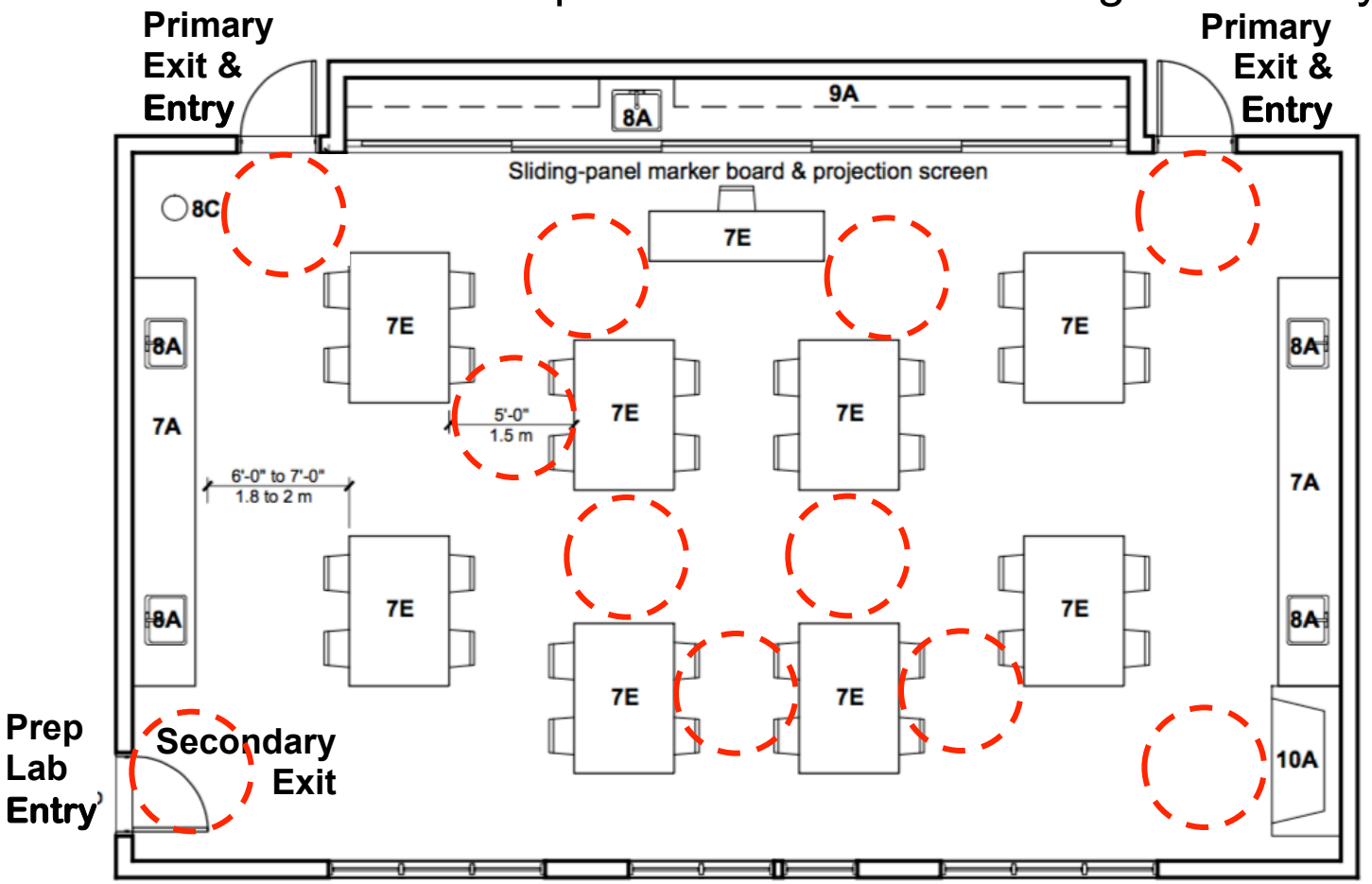
LABORATORY EGRESS: Recommendation

ADA Compliant Access in Teaching Laboratory



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Wheelchair 360° Turn 1.5 m (5 ft) Clearance

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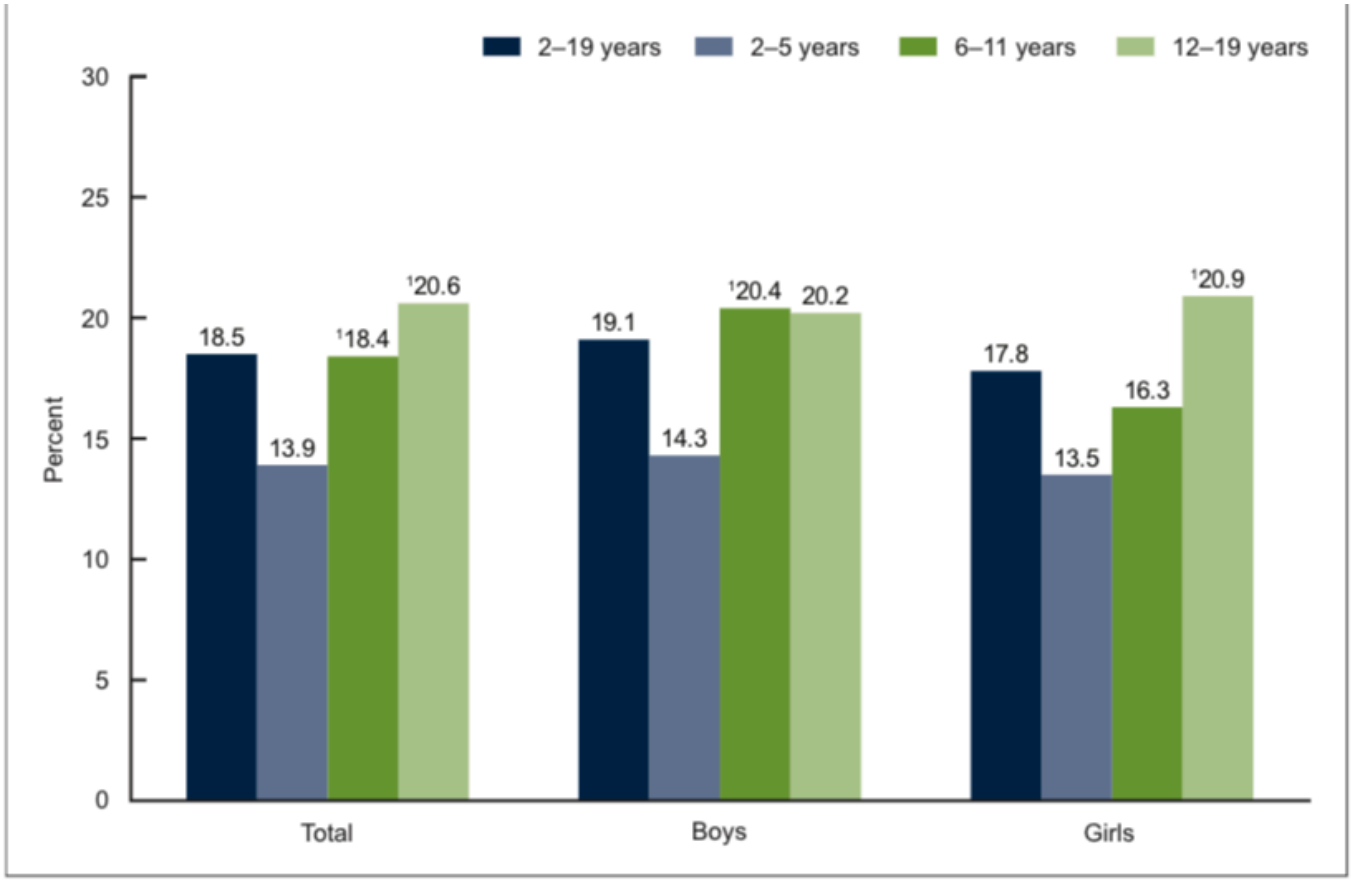
CDC Study of Obesity Among Youth 2 – 19 years

NCHS Data Brief, No. 288, October 2017



[1]Significantly different from those aged 2–5 years.
NOTE: Access data table for Figure 3 at: https://www.cdc.gov/nchs/data/databriefs/db288_table.pdf#3.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 2015–2016.

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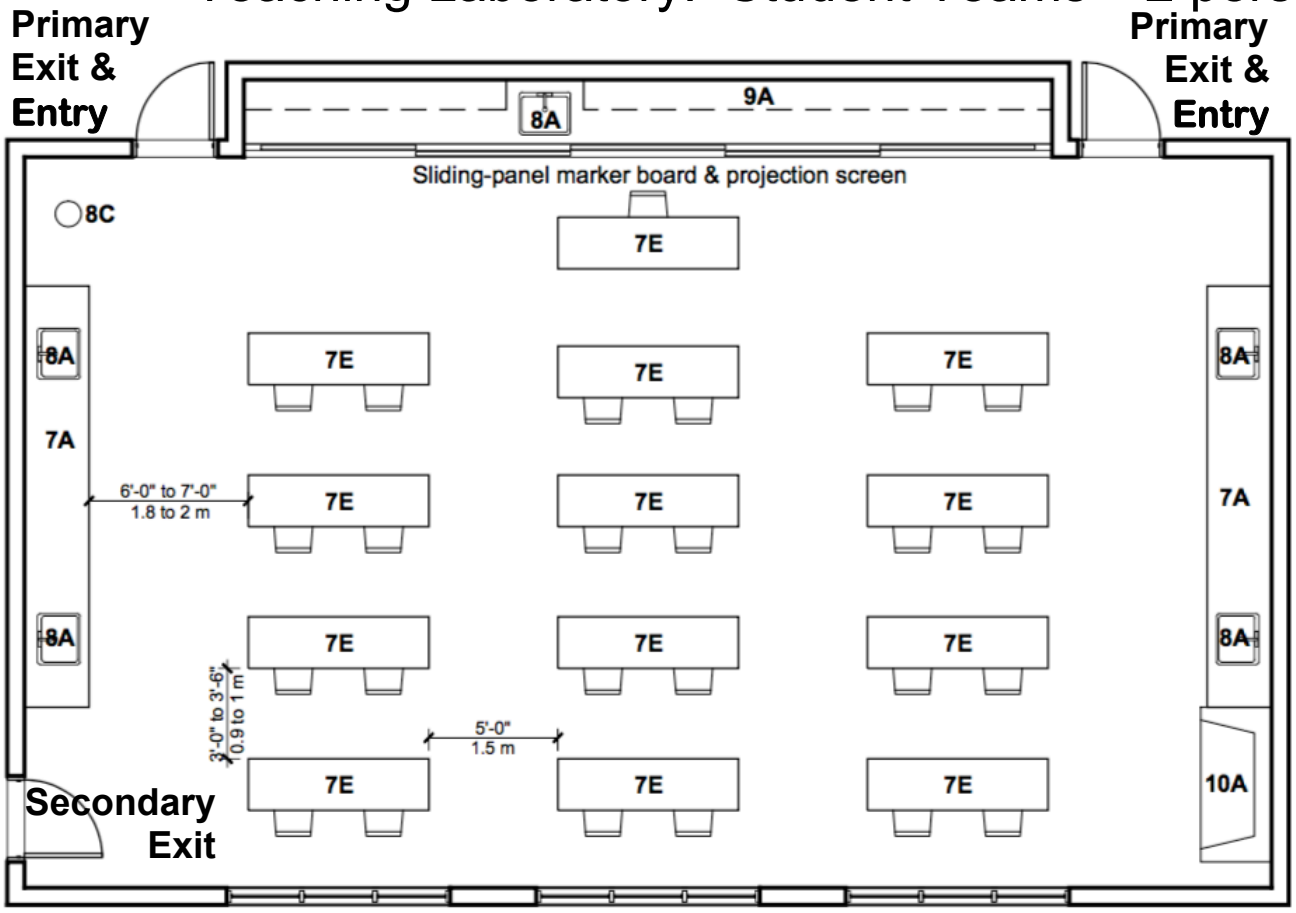
LABORATORY EGRESS: Recommendation

Teaching Laboratory: Student Teams – 2 persons



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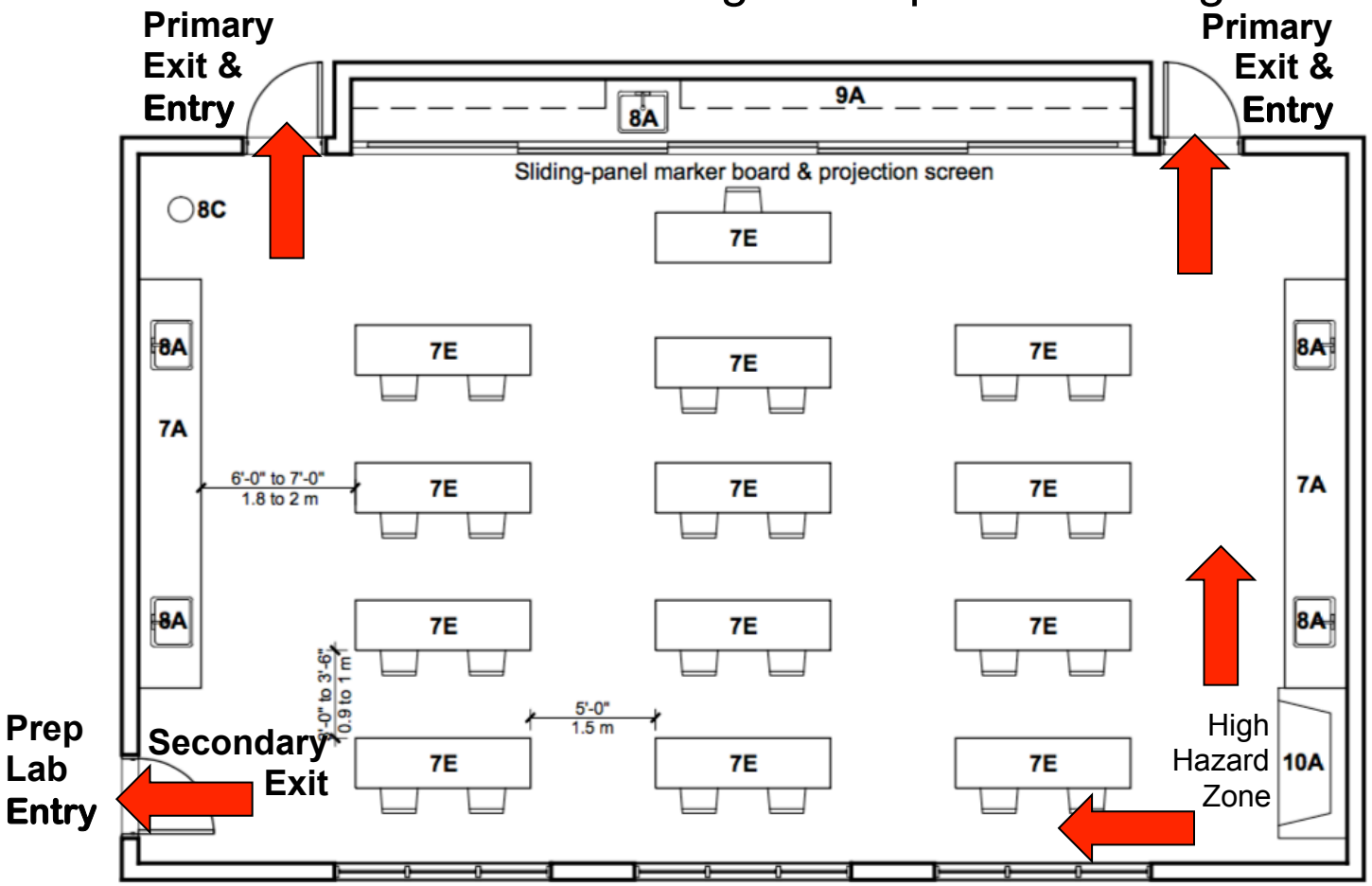

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LABORATORY EGRESS: Recommendation

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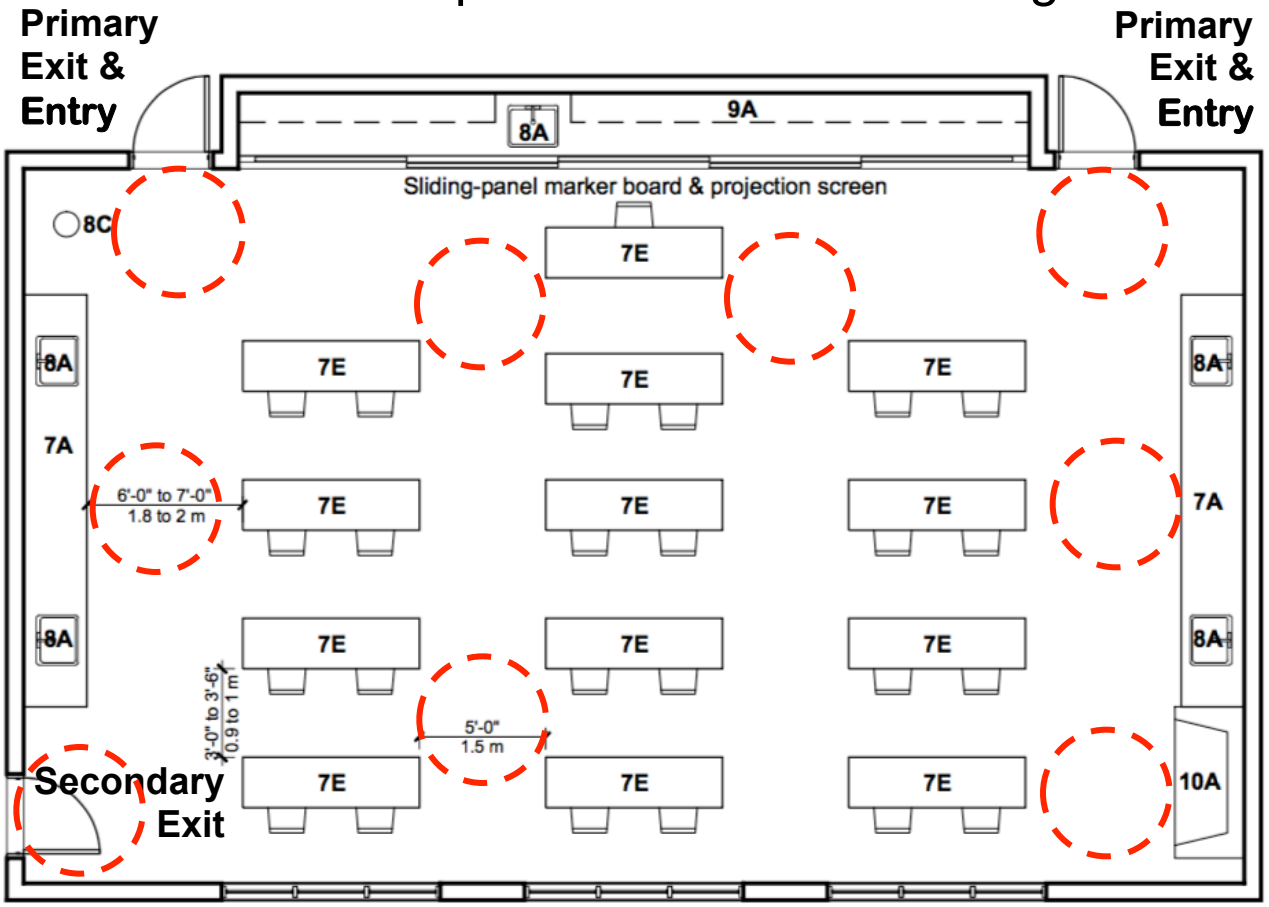

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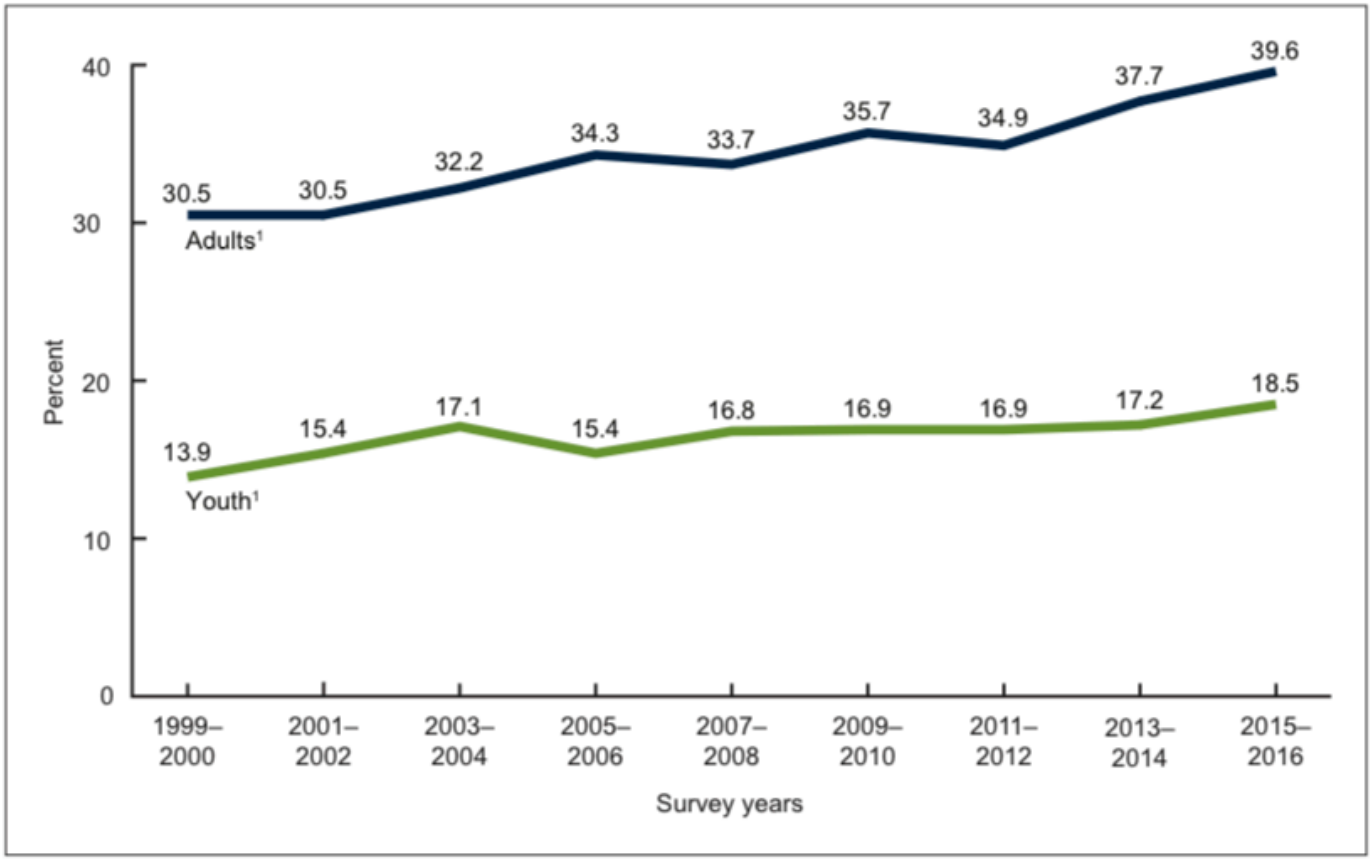
CDC Study of Obesity Rates Adult vs Youth 1999 – 2016

NCHS Data Brief, No. 288, October 2017



[1]Significant increasing linear trend from 1999–2000 through 2015–2016.
NOTES: All estimates for adults are age adjusted by the direct method to the 2000 U.S. census population using the age groups 20–39, 40–59, and 60 and over.
Access data table for Figure 5 at: https://www.cdc.gov/nchs/data/databriefs/db288_table.pdf#5.
SOURCE: NCHS, National Health and Nutrition Examination Survey, 1999–2016.

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Guide to ADA Standards: Building Entry Conditions

Accessible Route Elements from Site Arrival Points to Interior Circulation Pathways

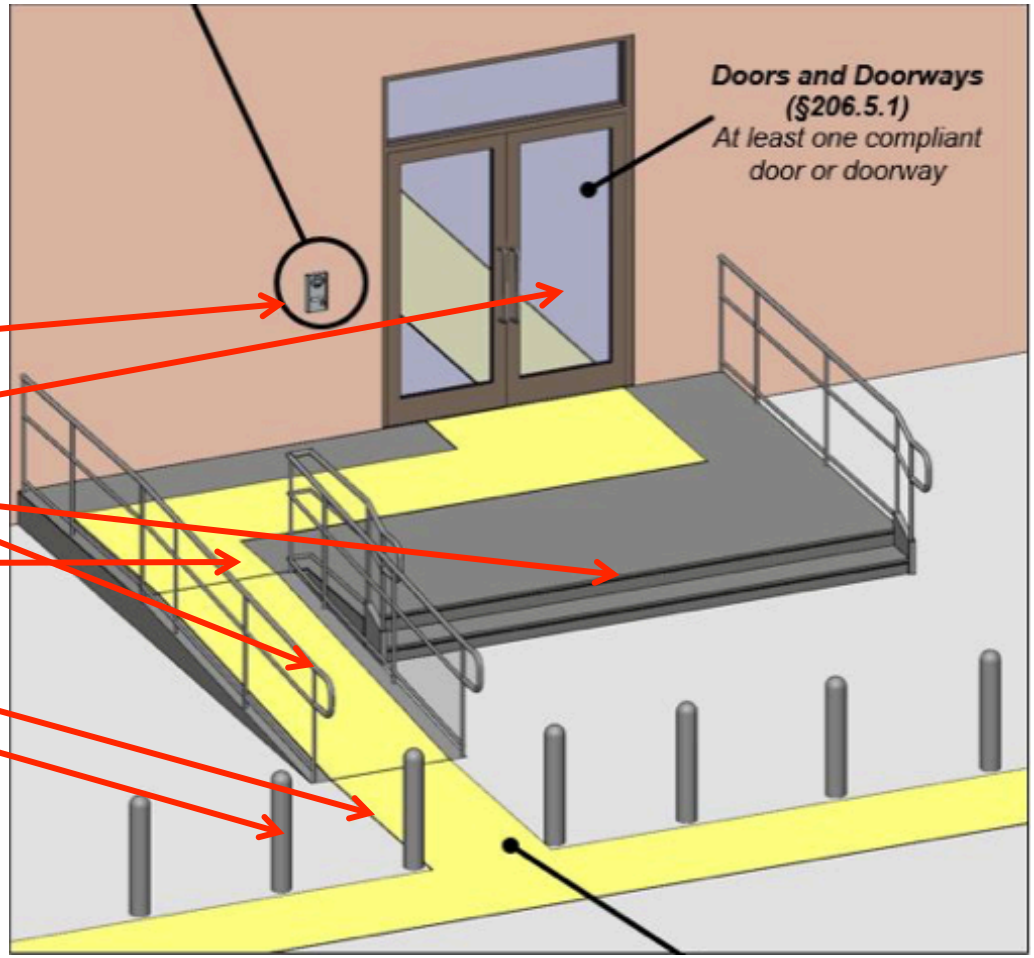
Communications Systems

Designation of Accessibility

Stairs and Accessible Ramp

Landings

Security Barrier



Drawing from *Guide to the ADA Standards*

ADA Design Guide: Accessible Laboratory Environment

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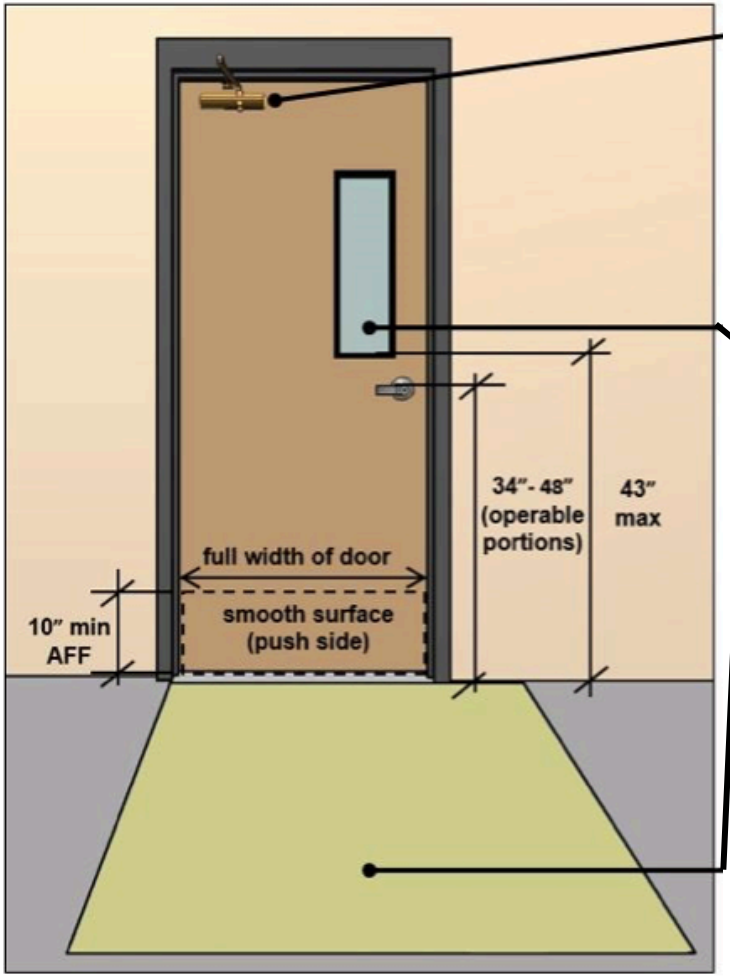
Guide to ADA Standards: Building Entry Conditions - DOOR



Drawing from *Guide to the ADA Standards*

Clear Width minimum 81.2 cm (32 in.)

Recommended Lab Building Entry Door 191.4 – 125 cm, (36 – 42 in.)

Manual Door opening force – 5 lb max.

Vision Panel 112 cm, (43 in) accessible viewing height

Hardware height 86.4 – 125 cm, (34 – 48 in.)

Smooth Surface at bottom on the push side

Thresholds 19.7 cm, (½ in.), beveled if >9.9 cm (¼ in.)

Maneuvering Clearances required on both sides unless door or gate is used in one direction

Double Leaf Doors- One active leaf is required to meet criteria for clear width & maneuvering clearance

ADA Design Guide: Accessible Laboratory Environment

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Guide to ADA Standards: Building Entry Conditions - RAMP

Recommended Ramp Minimum: Clear Width 91.4 cm (36 in.)

Maximum Rise 76.2 cm (30 in.), Running Slope 3.9:30.5 cm (1:12 in.)

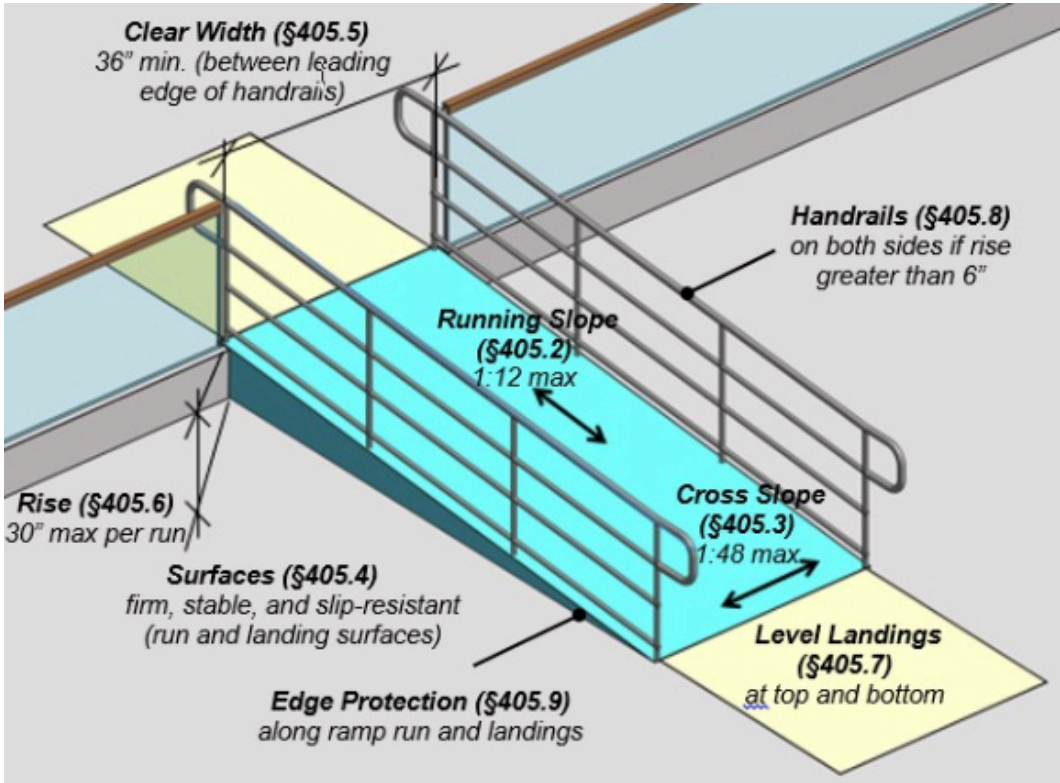
Other requirements:

Cross Slope 4:125 cm (1:48 in.)

Handrails on both sides

Edge Protection 30.5 cm (12 in.) on both sides & landings

Level Landings designed to prevent pooling of rain or snow-melt



Drawing from *Guide to the ADA Standards*

ADA Design Guide: Accessible Laboratory Environment

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Guide to ADA Standards: Building Entry Conditions - RAMP

Recommended Ramp Minimum Landing where Ramp **Changes Direction**:
Clear Width 1.5 m (60 in.) in each direction at Landings

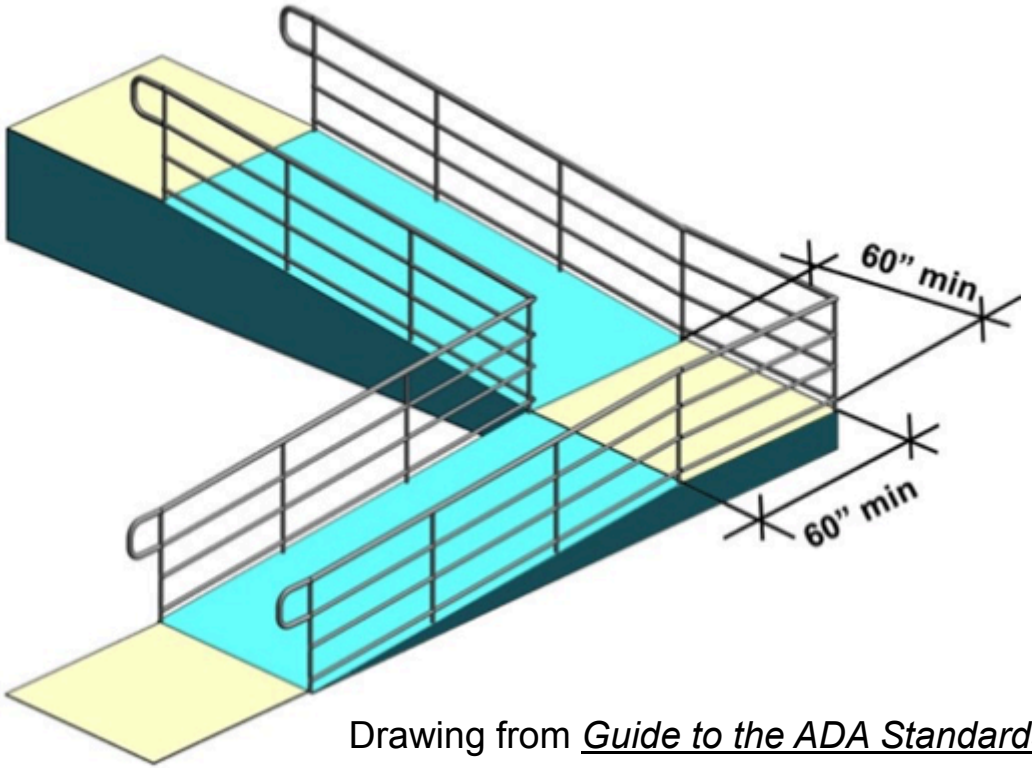
Other requirements:

Cross Slope 4:125 cm (1:

Handrails on both sides

Edge Protection 30.5 cm on both sides & landings

Level Landings designed pooling of rain or snow-m



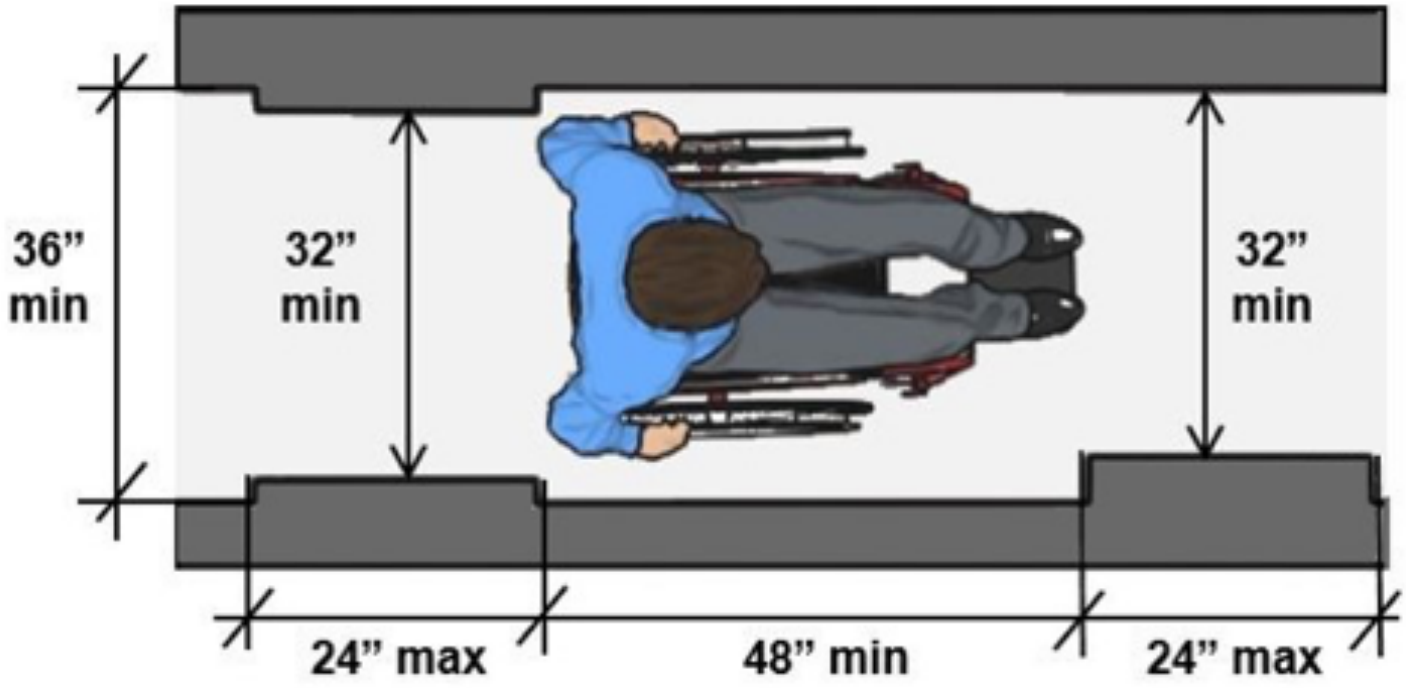
Drawing from *Guide to the ADA Standards*

ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

Guide to ADA Standards: Hall, Corridor, Aisle **minimum** width

Recommended **minimum** Hall or Corridor width 91.4 cm (36 in.) can be reduced to 81.3 cm (32 in.) in certain conditions, for a distance 61 cm (24 in.)



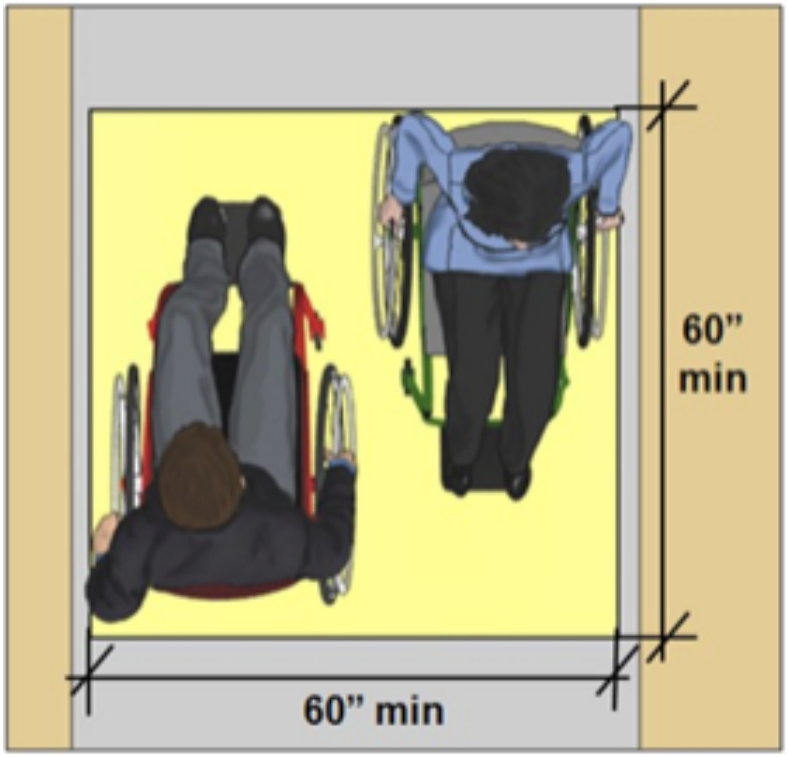
Drawing from *Guide to the ADA Standards*

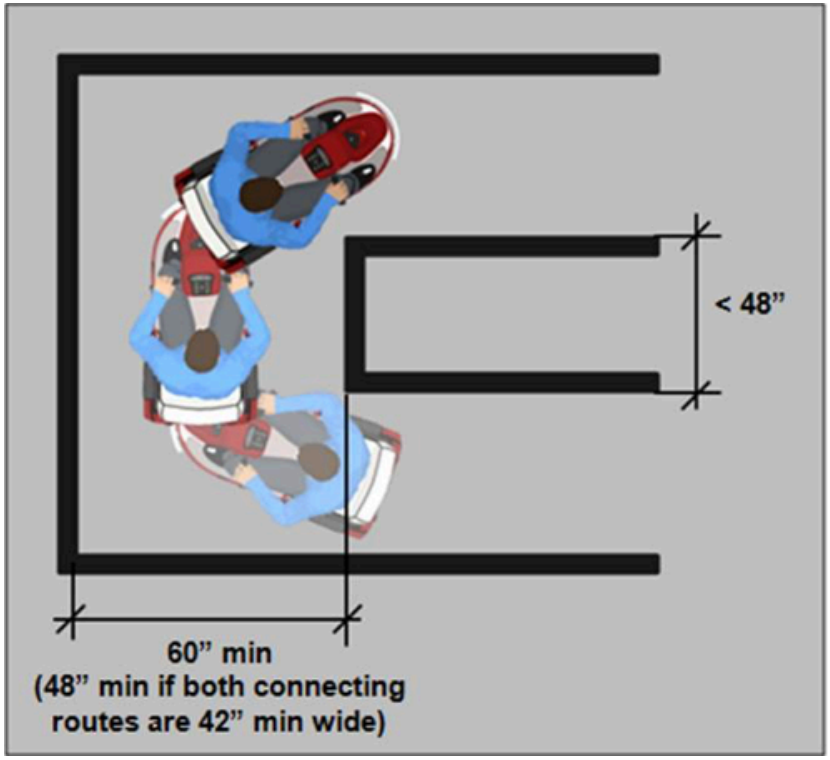
ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

Guide to ADA Standards: Hall, Corridor, Aisle minimum widths

Recommended **minimum** Hall or Corridor width of 1.5 m (60 in) with passing space for 2 persons in wheelchairs is applicable to laboratory aisle minimum.





Drawings from *Guide to the ADA Standards*

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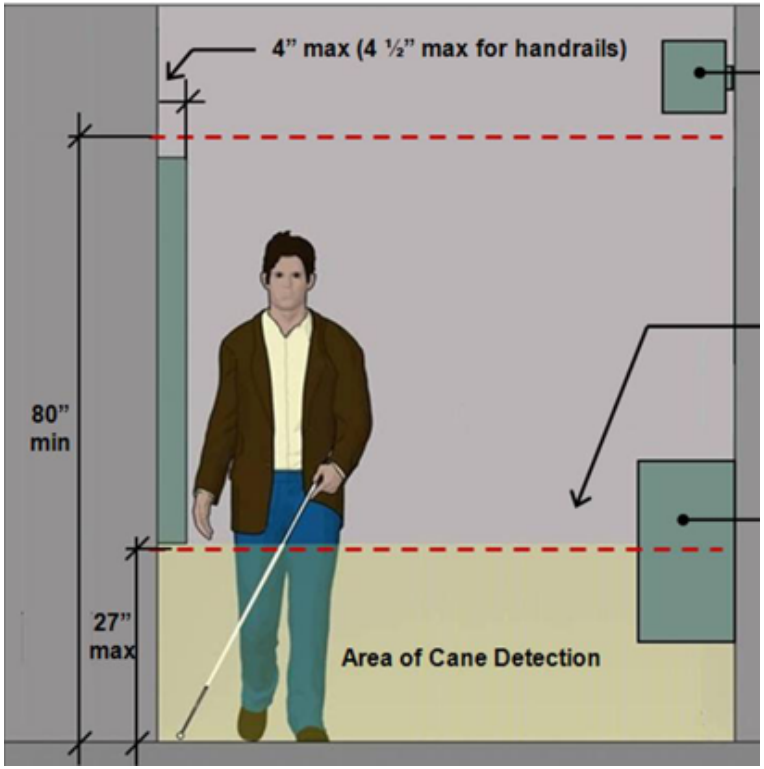


Objects above headroom clearance can protrude any amount

Protruding objects cannot reduce the minimum width of accessible routes.

Objects with leading edges within cane sweep can protrude any amount.

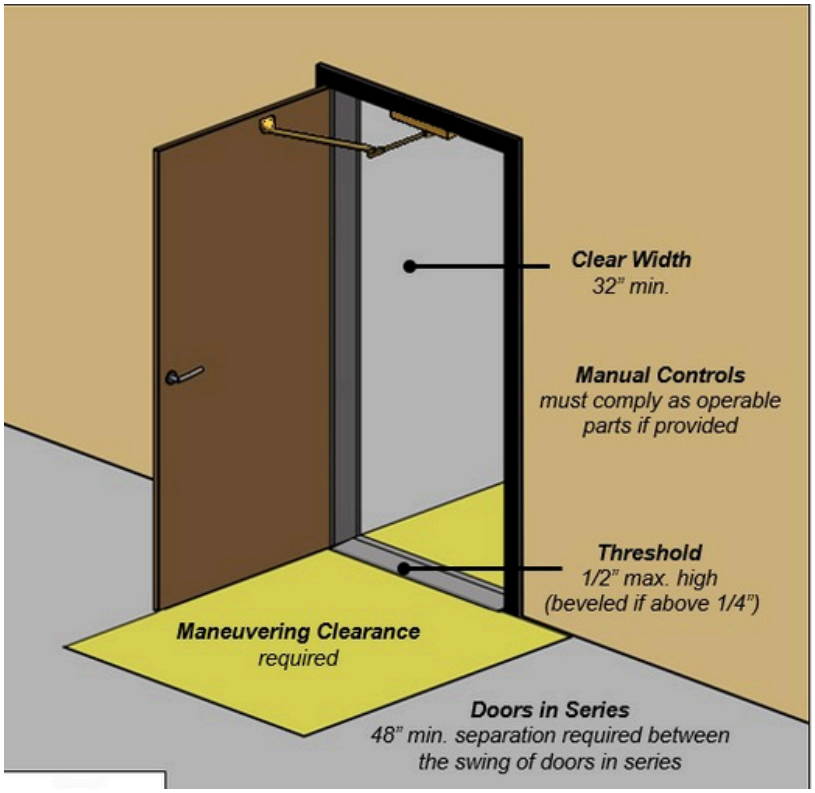
Drawing from *Guide to the ADA Standards*

ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

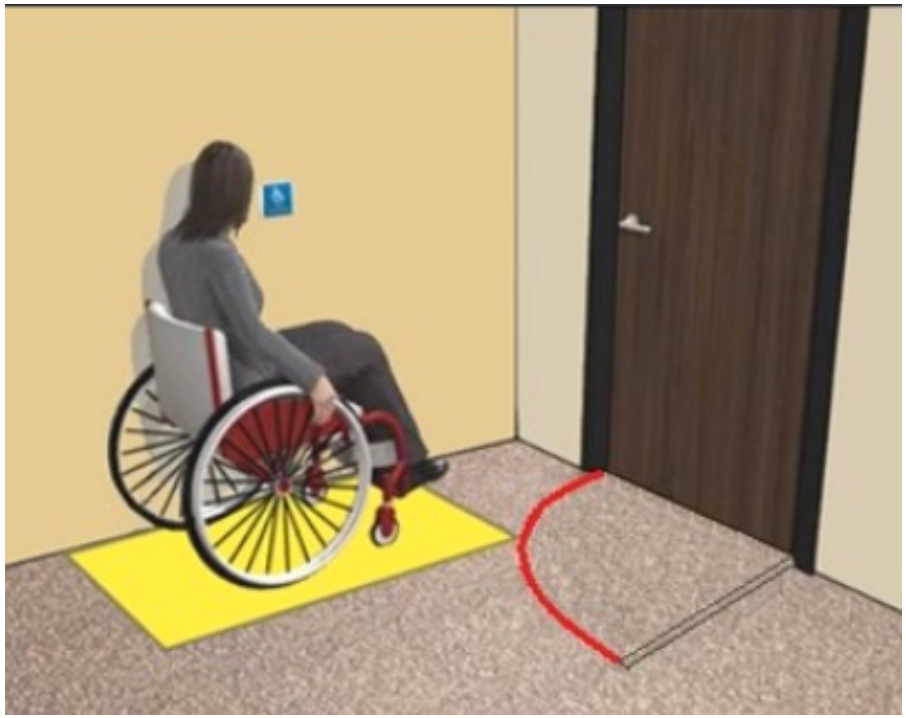
Guide to ADA Standards **-** Door Opening Requirements

Recommended **minimum** width for laboratory doors 0.91 m (36 in)
Preferred width 1.0 m (40 in)



Drawings from *Guide to the ADA Standards*

Clearances for door with automatic opener

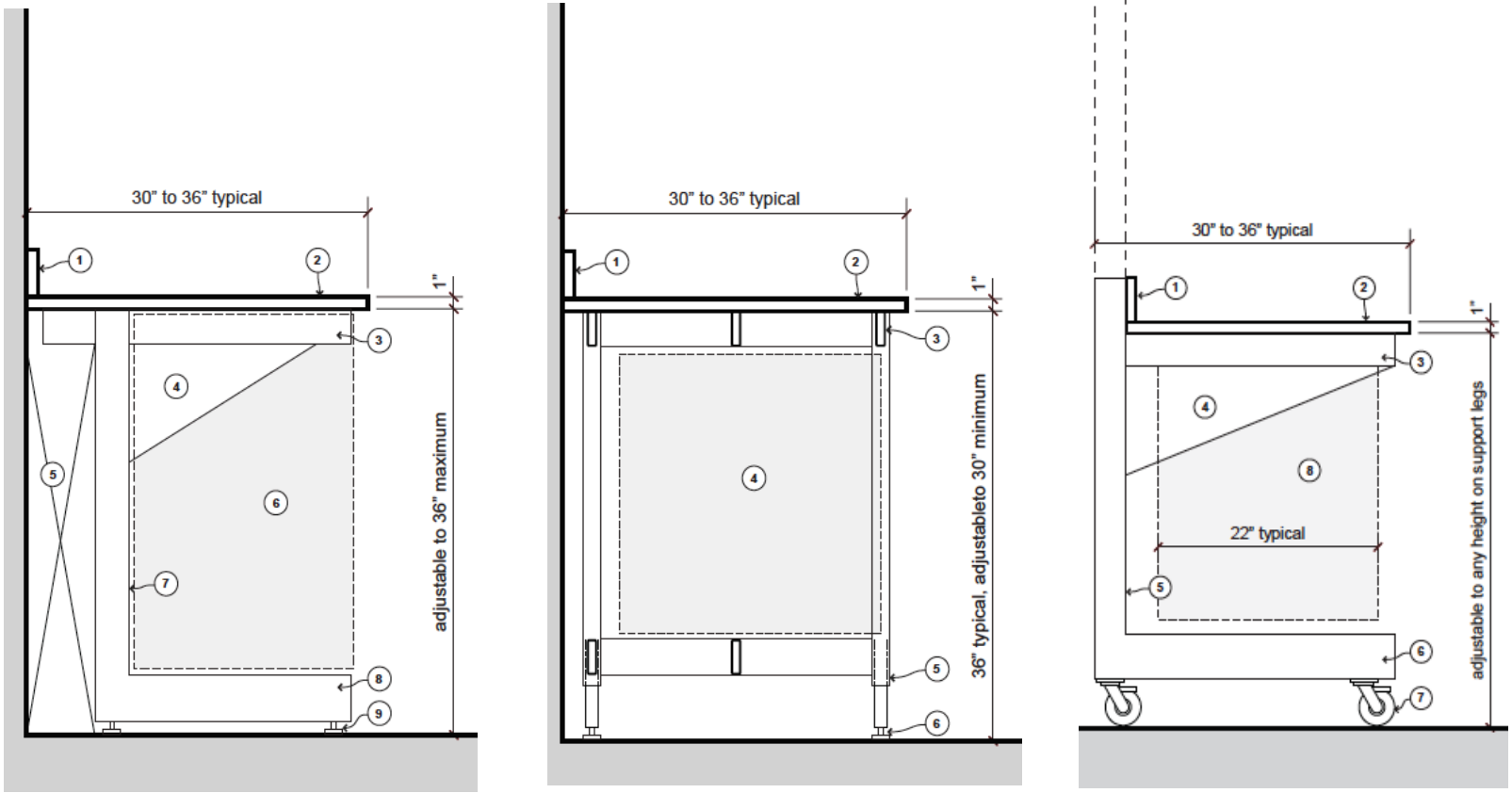


ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

LAB FURNITURE, FIXTURES, FITTINGS

- These bench systems have flexible, adjustable heights
- And moveable knee spaces

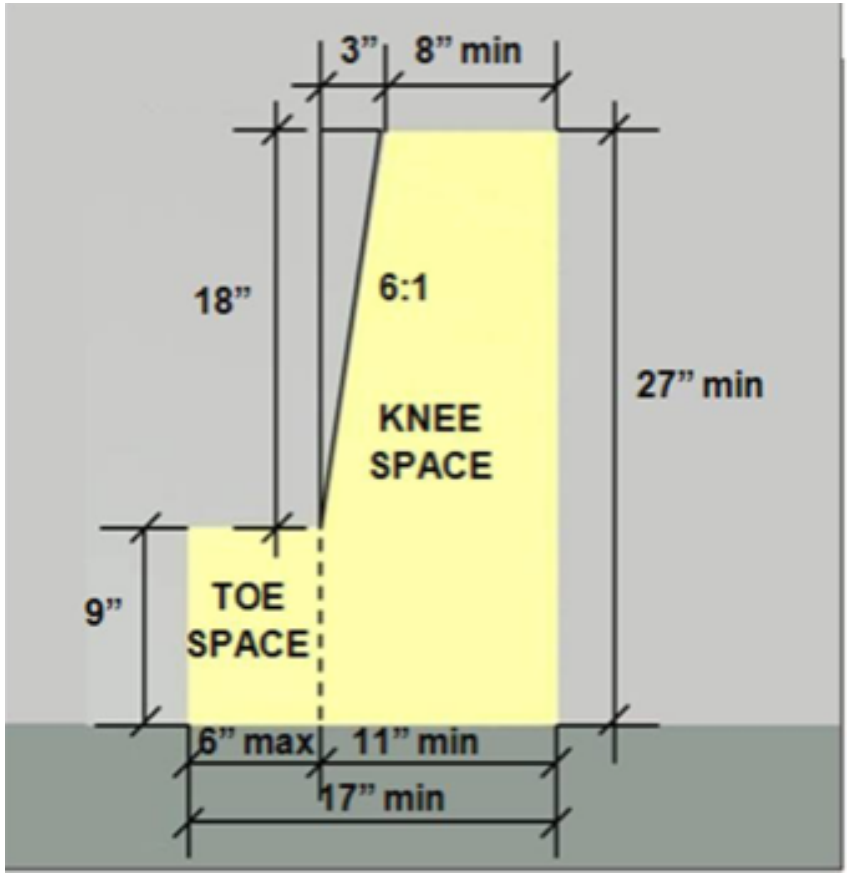


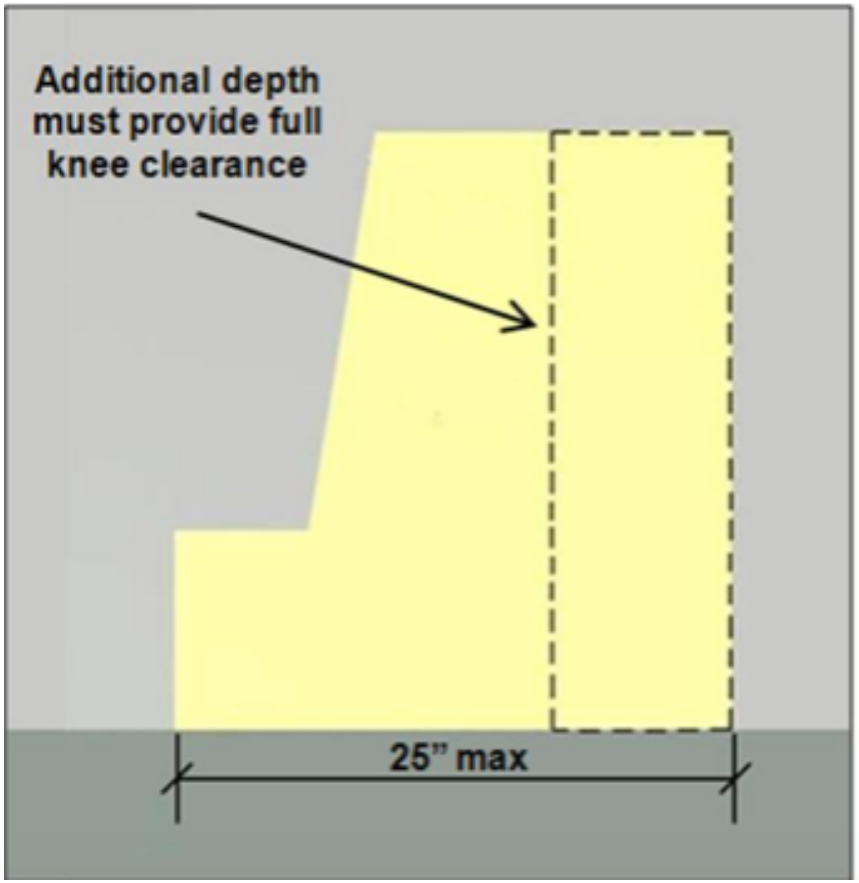
ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

LAB FURNITURE, FIXTURES, FITTINGS

Knee spaces ADA Criteria: Height, depth. Width required 91.4 cm (36 in.)





Drawings from *Guide to the ADA Standards*

ADA Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

LAB FURNITURE, FIXTURES, FITTINGS

- These table systems have flexible, adjustable heights
- Open knee spaces

Accessibility in the Laboratory, 2018
Assessing the Lab Environment, CH 3
(Photo published with Permission from RESNA)

Environmental Quality & Protection

Compliance of the design with environmental protection laws, regulations, and professional standards.

Provide safety in laboratories for occupants' breathing zone during use of hazardous chemicals.

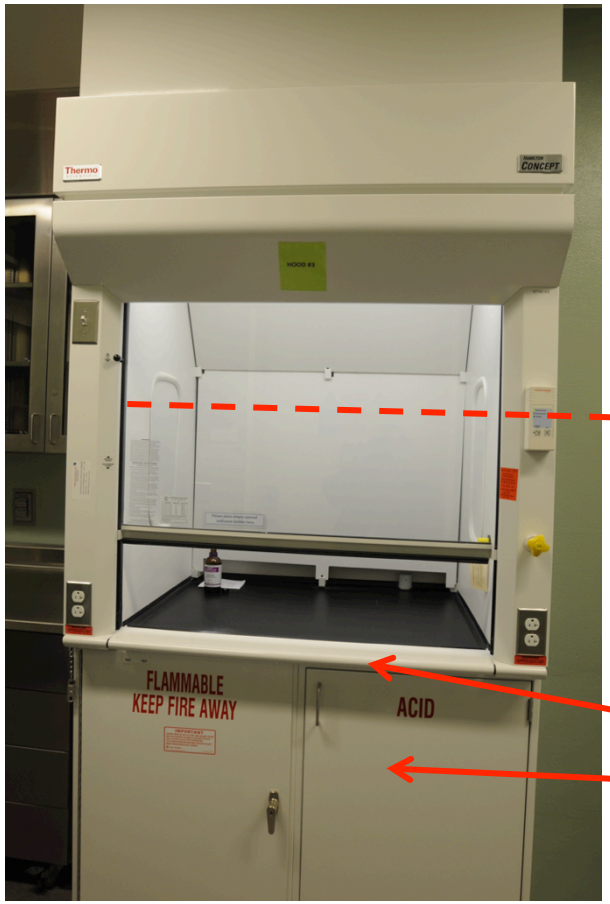
Liability for poor performance, pollution, and building damage due to building's ventilation, plumbing, and electrical systems design's maintenance and operation

Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

- Exhaust Air Containment − Std Chemical Fume Hood

Work Surface Height: Not Adjustable



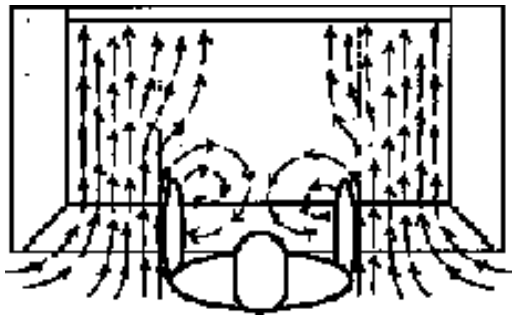


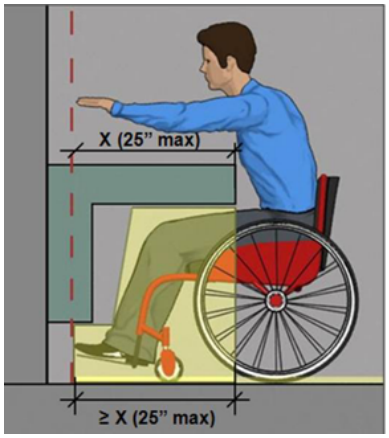
Diagram of airflow at CFH

Knee space obstructions limit seated persons' reach

Nose level of 5'-10" tall manikin used in ANSI Std-110 test

Standard CFH has knee space obstructions

- CFH frame
- Chemical stg



Photos provided with permission by Louis DiBerardinis

Drawings from *Guide to the ADA Standards*

Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

- Exhaust Air Containment

Chemical Fume Hood (ADA-CFH)

Current design ADA chemical hoods meet most ADA requirements:

1. Work surface height is adjustable
2. Area beneath work surface is unobstructed.
3. Height for wheelchair to move forward under work surface.
4. Utility outlets are in reach.
5. Alarm control are visible.
6. ADA-CFH may or may not protect operator. Breathing zone of seated operator is within the sash opening where leakage of fumes & aerosols within hood **increases risk**.

Observe proximity of operator's face in relation to work surface level of CFH and top of open beaker.

Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

- Exhaust Air Containment
Biological Safety Cabinets (BSC)

Currently BSCs are the best containment equipment that can adjust to meet ADA requirements:

1. Work surface height is adjustable
2. Area beneath work surface is unobstructed.
3. Height for wheelchair to move forward under work surface.
4. Utility outlets are in reach.
5. Alarm control are visible.

AND

Operation of BSC **protects operator of BSC** as well as work products within chamber and good ergonomic design for operator.

Design Guide: Accessible Laboratory Environment

Improving Safety for Persons with Disabilities

Exhaust Air Capture Systems at Laboratory Benches

Local Exhaust System with Multiple Snorkels

Local Slot Exhausts at Student Benches

Photos provided with permission by Louis DiBerardinis, Director of EHS, M.I.T., Cambridge, MA

Design Laboratories for Accessible Environment

THANK YOU FOR YOUR ATTENTION

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