

# HVAC SYSTEM FOR ANIMAL LABORATORY

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## HVAC UNIQUENESS

- The animal research facility is a specially designed in order to controll environments for *the experimental animals care*.
- HVAC is the dominant system in this kind of facility.
- The facilities are complex, and expensive to design and to operate effectively.
- Design a facility like this requires team work among users, architect, engineer in order to address and solve space and operational issues.

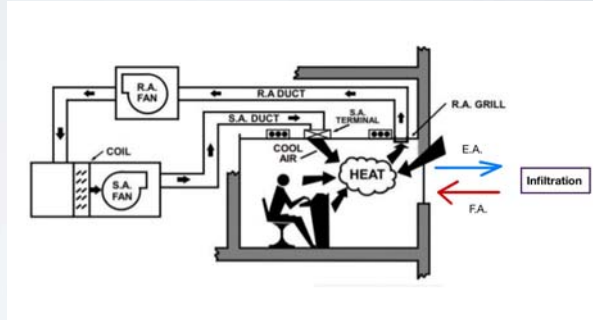


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# HVAC CONCEPT

## Typical Residence

- T 25°C
- RH <60%
- ACH 2-6



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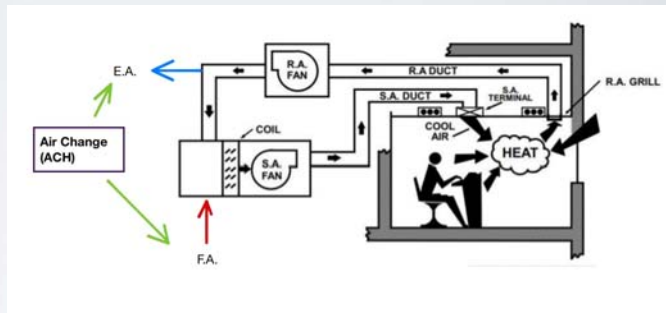
# HVAC CONCEPT

## Commercial or Large Building

- T 25°C
- RH 40-60%

## Hospital

- ACH 4-15
- T 25°C
- RH 40-60%
- ACH 6-15
- Static pressure different & Flow direction
- 100% Fresh air and HEPA filtration (in some area)

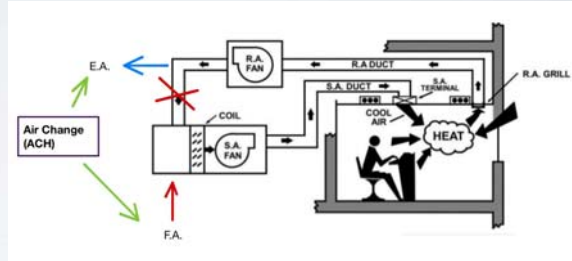


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# HVAC CONCEPT

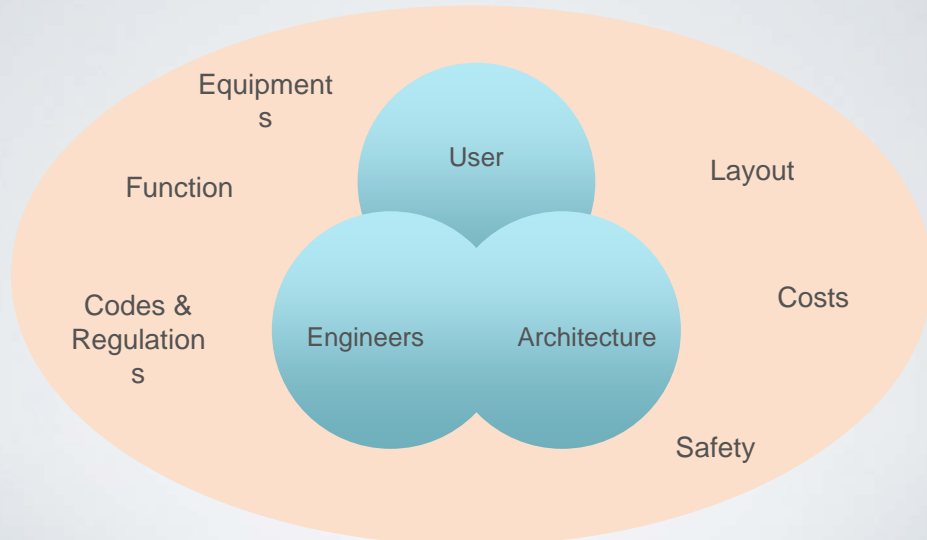
## Animal Laboratory

- T 20-25°C (controlled)
- RH 40-60% (controlled)
- ACH 15
- Static pressure different
- Flow direction
- 100% Fresh air & HEPA filtration (in most area)



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# ANIMAL LAB. DESIGN



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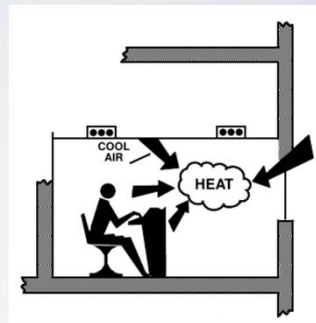
# CODES & STANDARDS

- The Guide for the Care and Use of Laboratory Animal (NRC 2011) is the primary standard used by AAALAC International
- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5<sup>th</sup> edition
- National Institutes of Health – 2008 Design Requirements Manual for Biomedical Laboratories and Animal Research Facilities
- ASHRAE Handbook
- Local codes & regulations

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# SPECIAL REQUIREMENT

- Provide healthy air quality for staffs , animal, and cage environments.
- Supply fresh air
- Remove thermal loads (sensible & latent) and control temperature (+/- 2°F)
- Remove airborne and particulate contaminants (filtration)
- Control humidity (40-60%RH +/- 5% )
- Create static-pressure differentials -/o/+

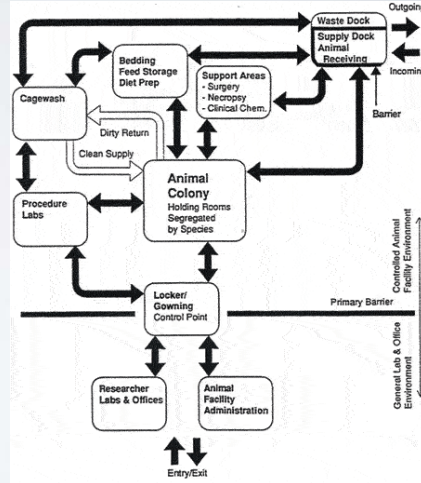


Species	Weight, lb	Heat Generation, Btu/h per Normally Active Animal		
		Sensible	Latent	Total
Mouse	0.046	1.11	0.54	1.65
Hamster	0.260	4.02	1.98	6.00
Rat	0.62	7.77	3.83	11.6
Guinea pig	0.90	10.2	5.03	15.2
Rabbit	5.41	39.2	19.3	58.5
Cat	6.61	45.6	22.5	68.1
Nonhuman primate	12.0	71.3	35.1	106.0
Dog	22.7	105.0	56.4	161.0
Dog	50.0	231.0	124.0	355.0

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# SPECIAL REQUIREMENT

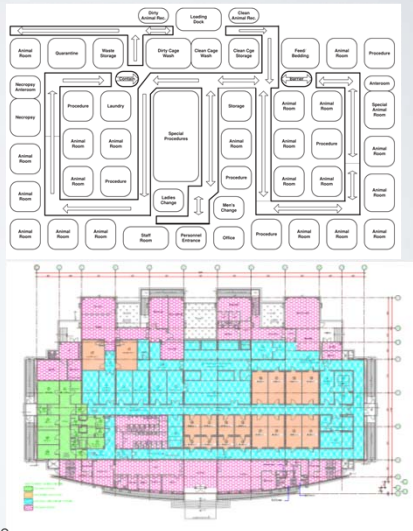
- Animal procedures - vivarium or laboratories
- Surgical or diagnostic radiography suites
- Zone separation
- Sizing of major equipment
- Impact of design on operation costs
- Neighboring
- Commissioning/validation



Animal Facility Diagrammatic Model Showing Basic Flows and Spatial Relationships (WBDG Animal Research Facility 2010)

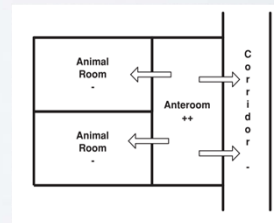
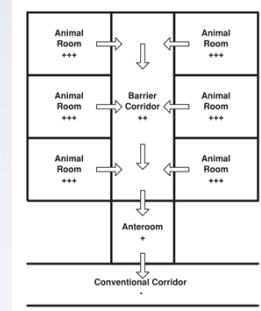
# SPECIAL REQUIREMENT

- Traffic flow, room, and facility design
- Containment/contamination control
- Safety and security
- Species conflicts/incompatibilities
- Noise
- Cage storage/cage staging
- Macroenvironment or Microenvironment
- Mechanical systems distribution



# DESIGN PARAMETERS

- Air exchange rate
  - 10-15 ach – AAALAC
  - 15-20 ach – Canadian Standard
- Relative humidity levels - through condensation at low temp. and reheat up to working temp
- Air recirculation/filtration
  - No recirculation (100% FA)
  - HEPA filtration @ supply and/or exhaust
- Air pressure differentials between room/area
- Computational Fluid Dynamics may be required in some areas



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# DESIGN PARAMETERS

- HVAC systems in laboratory animal facilities must operate continuously 24 hours per day, year round.
- Mechanical Systems must be designed for worst case
  - Maintain temperature and humidity for animal well being.
  - Finish surgical operations
  - Should maintain minimum of 24 hours of fuel storage on backup generator
  - Differential pressures must be maintained
  - UPS required during generator startup?
  - Provide component redundancy

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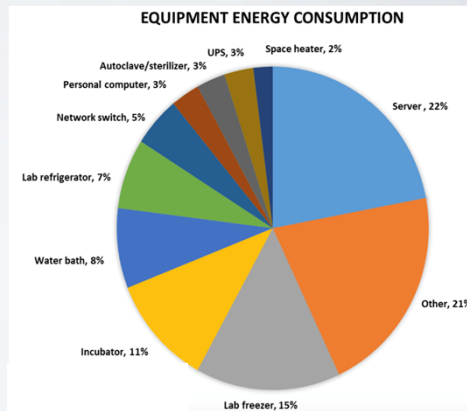
# ENERGY EFFICIENT FOR ANIMAL LABORATORY

- Animal laboratory usually has 3-8 times energy intensity of typical office buildings.
- High ACH and 100% FA requirement result in very high cooling load especially latent heat, result in conventional HVAC system size about 3 times of typical building.
- HVAC system is account for the highest energy consumption within the facility
- Mostly decision on final design is depend on building and installation cost, which mostly lead to high O&M cost.
- Several strategies can be applied to design and operate high performance and energy efficient HVAC system (approximately 30%).

# MINIMIZE COOLING LOAD

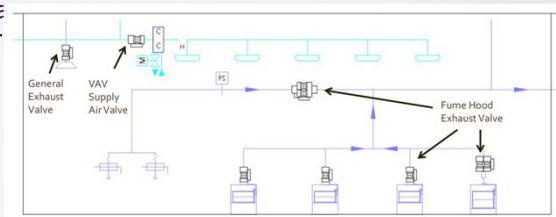
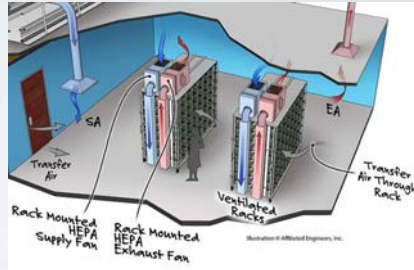
- Architectural design of facility should minimize energy consumption.
- Use energy efficient lighting and equipment to reduce cooling load
- "Research-grade" autoclaves are available that use significantly less energy and water than "medical-grade" units
- Centralize to allow equipment to be shared by the maximum number of labs

Lamp type	Lumens/W	Life hours
T-12 FL	80 L/W	24,000 HR
T-8 FL	80-100 L/W	24,000 - 30,000 HR
T-5 FL	90-100 L/W	24,000 -30,000 HR
T-8 FL ELL	85-95 L/W	46,000 -50,000 HR
LED	100-110 L/W *	50,000 HR



# MINIMIZE COOLING LOAD

- Reduce room air changes per hour for no-animal laboratory (4-12ACH)
- Use microenvironment system or ventilated cages (8-10ACH)
- Use low flow fume hood
- HVAC sometime operated below the design maximum during part load or unoccupied conditions.
- Use variable air volume devices



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# REDUCE PRESSURE DROP

- Using low pressure drop AHU and HEPA filter
- Reduce air flow velocity (larger pipe size)
- Use building management system (BMS) to control on facility demand

95% MERV 14 Filter Typical Pressure Drops	
Filter Type	Pressure Drop (Pa)*
Standard 300mm-deep (12-inch-deep) box-style rigid media filters	151.9 (0.61 inch WG)
300mm-deep (12-inch-deep) low pressure drop V-bank type mini-pleat filters	92.2 (0.37 inch WG)
Electronic filters	49.8 (0.20 inch WG)

\*Initial clean filter pressure drops @ 2.5 m/s (500 fpm)

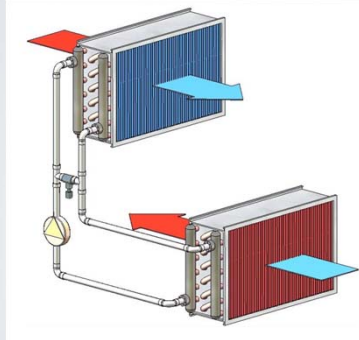


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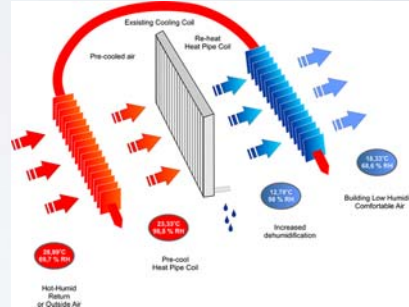


# ENERGY RECOVERY DEVICE

- Heat exchanger device



- Heat pipe



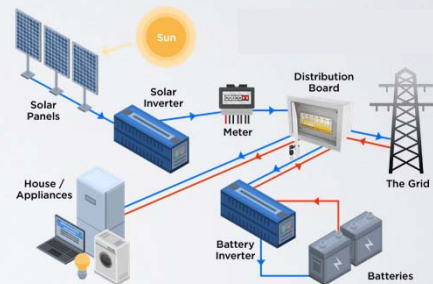
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# RENEWABLE ENERGY

- Hot water solar collector



- Solar PV with energy storage



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