

Closed-System Caging · Exhaust Ventilated Rack

A Better Mouse Cage at Low Cost of Ownership

M.I.C.E.[®] System

ACS-Animal Care Systems, Inc. (www.AnimalCareSystems.com) was founded in 1997 by a Veterinarian, Director of animal facilities, who was concerned about reproducibility of data and quality of life in and out of rodent cages used in biomedical research, testing, and education.

The Certex Corporation acquired ACS in 2001. Certex is a manufacturing company founded in 1950. In 2002, ACS was approved by the U.S. Government for GSA contracts (https://www.gsaadvantage.gov/advgsa/advantage/main/start_page.do).

ACS manufactures and markets a Closed-System Cage on an Exhaust Ventilated Rack called the M.I.C.E.[®] system. M.I.C.E. is for Mi(a)croenvironmental comfort, Isolation, Containment, and Enrichment. Instead of using blower-driven forced-air to ventilate the cages, it operates by exhaust ventilation, i.e. HVAC-assist and thermodynamic ventilation.

The M.I.C.E.[®] system achieves barrier-at-cage level with adequate exhaust ventilation that provides **Flexibility / High Density - Occupational Health & Safety - Costs Containment Productivity / Low-Maintenance - Animal Welfare - Valid Data**

ACS applies science through design and R&D to build a better rodent cage. Our core technologies include:

- **Source control of contaminants**
- **Exhaust ventilation**
- **Low-stress environment**
- **Ergonomics.**

These technologies implicit four valuable benefits:

1. **Protect animals, users, and environment**
2. **Maximize care, personnel, and space**
3. **Improve breeding performances, welfare, data quality, and standardization**
4. **Save time, space, energy, and money**

Because ACS likes to meet users' needs and expectations, we make the M.I.C.E. system with one primary goal:

Quality of Life

Protect (Barrier-at-Cage level)

1. Animals (*Mice, Rats, Guinea pigs, Hamsters*)

- **Micro-Environmental Comfort**
 - Oversized air supply and exhaust vent ports of properly designed cages
 - Negative low-pressure (0.15 in. of H₂O) and low-velocity (max. 5 fpm) of air
 - One-pass cage airflow (adjustable from 15 to 30 ACH-air changes/hour)
 - Contaminant-free caging (no body heat, moisture, waste gases accumulations)
- **Health: Isolation & Containment**
 - Closed-System design with interlocking and self-closing parts
 - Vent filtration with 0.3 μ absolute pore size rating filters at air supply/exhaust
- **Well-Being**
 - Enrichment structures and devices in spacious universal size cage (84 in²)
- **Fail-Safe**
 - Source control of contaminants with cage air supply/exhaust filters
 - Safety clips for occupied cage assembly transportation
 - Constant thermodynamics of convection that induce natural airflow
 - 8 ACH (convection) in occupied cages of static D8-112 cages rack

2. Users (*Occupational Health & Safety Protection*)

- **Macro-Environmental Comfort**
 - Closed-System design with interlocking and self-closing parts that prevents leakage in or out of both cage and rack
- **Health & Safety**
 - Building HVAC-assist exhaust ventilation with direct connections
 - Negative pressure relative to room provides 'clean room' environment
 - Contaminant-free work zone including odors and allergens
- **Simple**
 - All cage and rack parts have easy-to-clean smooth surfaces
 - No mechanical or electrical components
- **Ergonomic**
 - User-friendly two-part, cavity-shape cage assembly
 - Easy and safe cage loading and docking on rack
 - Twist-free bottle-cap with ribbed silicone seal
 - Modular, lightweight, easy-to-move racks

3. Environment (*Green Building Technology*)

- **Green Building Strategy**
 - Electricity-free powered ventilation
 - Reduced Waste (no blowers' additional heat load, pre-filters and HEPA-filters)
 - **Save Energy**
 - Low Exhaust HVAC-assist requirements (8 cfm/module)
 - 64 cfm exhaust air volume per D8-112 cages Rack for 20 ACH at cage level
 - **Reduce Utility Consumption**
 - Reduced room HVAC requirements
 - Direct exhausting of body heat, moisture, and odors to outside
 - Will allow you to reduce room ACH up to 50%
 - Extended Changing Period Decreases Frequency of Washing/Autoclaving
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Maximize

1- Care (*Animal Welfare*)

- **Adequate, Quiet, and Reliable Ventilation**
Thermodynamic Cage & Rack Design (no noise or vibration)
Adequate (15 to 30 ACH) low-velocity/one-pass airflow HVAC-assist ventilation
- **Enriched and Low-Stress Environment**
Resting shelf with adjacent sipper tube, central wire-bar feeder, frosted bottom
Optional tunnel-trough
Cage compartments: nesting, marking, hiding, playing, feeding, wasting, grooming etc.
- **Refinement**
Cage environment appropriate to the species = Expression of Normal Behavior
Simple and easy husbandry practices = Docile Occupants

2- Personnel (*Productivity / Low-Maintenance*)

- **Ease of Handling/Changing/Stacking Cages**
- **Ease of Cleaning/Moving/Storing Cages & Racks**
Two-Part, cavity-shape cage assembly with external bottle and feeder access
Closed-system design with interlocking & self-closing parts is fast & fail-safe
Twist-free bottle cap and drop-in external bottle and feeder
Direct access to animals without wire-bar lid
Quick connect/disconnect vent hose connections
Simple SOPs for streamline and fast operations
- **Extended Cage Changing Period**
Research/Testing: up to three weeks
Trio breeding: up to two weeks
- **High Visibility**
Integrated molded cage card holder for fewer parts and high animal visibility
- **Increase Employee Retention**
'Clean' air contribute in 45% reduction of absenteeism, and an increase of 16% in productivity

3- Space (*Flexibility / High Population Density*)

- **Universal Cage Size** according to *Guide* and CCAC guidelines
Standard cage: 84 in² / Double-wide cage: 182 in²
6 mice (25g), 2 rats (300g) / 15 mice (25g), 6 rats (300g)
5 hamsters (100g), 1 g. pigs (350g) /
- **Modular Rack**
Single-sided: S1-14 cages, S2-28 cages, S3-42 cages, S4-56 cages, S5-70 cages
Double-sided: D2-28 cages, D4-56 cages, D6-64 cages, D8-112 cages, D5-140 cages
- **One-Inventory Caging Design**
Multispecies and Multiuse (Toxicology, Physiology, Inhalation, Behavioral Phenotyping)
Conventional, Testing
Quarantine, BSL-2, BSL-3
Barrier for Tg, K/O, NUDE, SCID, etc.
Production (trio-breeding)
- **High Population Density**
D8 rack (112 cages): max. 672 mice, 45 mice/sf; average 560 mice, 35 mice/sf
Modular racks for 'library' or 'paper wall' configuration: up to 10-mice/room sf

Improve

1- Breeding Performances (*Health & Well-Being*)

- **Universal Cage Size**
 - Trio breeding including 1 stud, 2 dams, and 2 litters
 - Gang caging (available in double-wide cage)
 - Breeder pooling (females and males)
- **Good Air Quality**
 - 20 to 30 adjustable (with valve or damper) total-volumes ACH at cage level
 - Waste gas evacuation at each air exchange
- **Minimal Disturbances**
 - Adequate & Comfortable ventilation without blower-related noise and vibration
 - Two-week cage changing period
 - Two-part cage with direct access to animals
 - High animal visibility
 - External bottle and feeder access, No wire-bar lid
 - Frosted cage bottom, optional tunnel-trough for nesting and avoidance behaviors
 - Cage compartments: nesting, marking, hiding, playing, feeding, wasting, etc.
- **High Breeding Performances**
 - More litters, pups per litter, and weaned pups
 - Higher pups survival, healthier and stronger pups, faster weaning period (18 days)

2- Animal Welfare (*Refinement / Better Science*)

- **Refinement**
 - Adequate exhaust ventilation that avoids high turnover of dry air, noise, and vibration
 - Quiet, Comfortable, and Enriched Micro-Environment
 - Extended cage changing period
- **Expression of Normal Behaviors**
 - Environmental Enrichment Structures and Devices for Behavioral Phenotyping

3- Data Quality (*Reduction*)

- **Barrier-Cage with Low-Stress Environment**
 - Source control of contaminants by closed-system caging and exhaust ventilation
 - Adequate ventilation (20 ACH) with GAQ and enrichment structures
- **Stable Micro-Environmental Conditions**
 - Rack air plenums with maximal 'chimney' effect designed to extract even air
 - Temperature at a constant ave. 0.5 °C above room temperature
 - Relative humidity at a constant ave. 15%RH above room humidity
 - Waste gases such as ammonia at a constant ave. 5 ppm
 - Elimination of variables = Reduction of nb. of animals for statistical significance

4- Standardization (*Reproducibility*)

- **Validatable**
 - Reliable & Fail-Safe airborne contaminant-free environment and ventilation
 - Adjustable & Controllable HVAC-assist exhaust ventilation
 - **Minimal Variables**
 - Integrated and fixed enrichment structures and devices
 - Elimination of body heat, moisture, and waste gases accumulations
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Save

1- Time (*Productivity*)

- **Two-Part, Cavity-Shape, & External Bottle / Feeder Access Cage Assembly**
Faster animal handling and cage handling /washing (clean & dirty sides)
High animal visibility / Direct access to docile animals / Drop-in bottle w/twist-free cap
More mice (25%) in fewer cages (25%) for faster husbandry
- **Modular Rack Assembly**
Self-closing (spring-loaded) exhaust vent port
Self-docking (lip-retained) of cages on smooth shelf system
Push-in (spring-loaded) module cap with vent hose quick-connect/disconnect fittings
Clip-on (spring-loaded) module drain door
Clip-on shelves could be easily disassembled
All smooth surface components for fast, safe, and easy cleaning
- **Extended Cage Changing Period**
Research: up to 3 weeks / Trio Breeding: up to 2 weeks
- **Free of Service, Maintenance, and Calibration**
Absence of electrical and mechanical parts
Magnehelic gauge for Operational Visibility
Manually operated valve/damper exhaust ventilation device (optional)

2- Space (*Flexibility / High Population Density*)

- **Multiuse:** Bio-Exclusion and Containment
Quarantine, Conventional, Barrier, ABSL-2 & 3, Production, Testing
- **Multispecies:** Mice, Rats, Hamsters, Guinea pigs on same rack

• Optimal Facility Layout	M.I.C.E. D8-112 cages	IVC-140 cages
Cage Density: Mice (up to 25 g)	6 max., 5 ave.	5 max., 3 ave.
Rats (up to 300 g)	2	N/A
Hamsters (100 g), G..pigs (up to 350g)	5, 1	N/A, N/A
Rack Density:	7 cages/sf - 35 mice/sf	9 cages/sf - 27 mice/sf
Room Density (365 sf):	672 cages	840 cages
6 racks/room	3,360 mice/room (10 mice/sf)	2,520 mice/room (7 mice/sf)
Breeding Facility (3,000 mice):	Trio Breeding	1 litter/cage
Number of Cages on Inventory	600 occupied - 200 change-out	1,000 occupied - 1,000 change-out
Nb. Of Cages Washed per day	60	200

3- Energy (*Environmentally Friendly Building*)

- **Low HVAC-assist Exhaust Ventilation (cfm) Requirements**
Recommend 8 cfm (cubic feet per minute) per module of 14 cages for 20 ACH
D8-112 cages requires 12 watts/h compared to 420 watts/h for IVC-140 cages
- **Reduce Room-ACH when direct exhaust of heat and odor loads**
Minimize Dilution Ventilation, Filtration, and Pressurization Control needs
- **Reduce Building's Utility Consumption = Green Building Strategy**

4- Money (*Cost Containment*)

- **Inventory of Occupied and Change-Out Cages Cut by at least 50%**
- **Reduce Waste Disposal Costs** (Extended Cage Changing Period)
- **Ownership Costs Cut by at least 66%**

Less and faster cage changes due to better cage & rack design and system performances
D8-112 cages costs ~\$2,500/yr compared to ~\$9,600/yr for IVC-140 cages or ~\$11,800 for 140 static cages