EMERGING INFECTIOUS DISEASE LABORATORY
U.S. Centers for Disease Control and Prevention

HDR
CRITICAL SCIENCE

The Emerging Infectious Diseases Laboratory, Building 18, reflects the Centers for Disease Control’s (CDC) commitment to transforming their vision for the 21st century into a physical reality: “Healthy People in a Healthy World—Through Prevention.”

CDC’s mission is to understand, prevent, and be prepared for outbreaks of over 2,500 diseases. New diseases are constantly emerging from around the world that have no known treatment or vaccine, or are proving immune to our current arsenal of antidotes. Making CDC’s mission even more imperative is the ease with which these diseases can spread through the increase in world travel. In addition to these naturally occurring diseases, there is now an entirely new threat that the CDC must be prepared to respond to: bio-terrorism. All of this mandates that the CDC have the flexibility to predict, prepare for, and respond to surges in infection, whether they occur naturally or through terrorist events.

In order to perform their mission, CDC must be prepared to handle the most lethal pathogens, such as Ebola, avian flu and SARS in completely contained and safe environments. However, scientists working with these pathogens have needs beyond the requisite safety and security. They also require a work environment that is conducive both to working the long hours necessary to fulfill their mission, and to promoting collaboration among their peers.

The Centers for Disease Control and Prevention is dedicated to the prevention and control of disease and the promotion of health. In order to combat infectious diseases, the leading cause of death worldwide, the CDC has created the National Center for Infectious Diseases (NCID) headquartered on their Roybal Campus in Atlanta, Georgia.
THE EMERGING INFECTIOUS DISEASES LABORATORY

The Emerging Infectious Diseases Laboratory expands mission critical space, provides greatly improved working conditions and collocates formerly disparate groups into one cohesive unit, creating a foundation for scientific collaboration and inspiration. The laboratories in this building support the CDC’s Bioterrorism Program, the Division of Viral and Rickettsial Diseases, the Special Pathogens Branch, the Division of AIDS, STD and TB Laboratory Research, and the Division of Bacterial and Mycotic Diseases.

In designing the CDC’s new Emerging Infectious Diseases Laboratory located on their Roybal Campus in Atlanta, Georgia, the question became how to provide ultimate safety and security while still creating an inspiring work environment. How to take buildings designed as blast resistant bunkers and humanize them? How to induce collaboration in the midst of the isolation required by containment? The strict containment and security requirements seemed at first to be in conflict with the other equally important aspiration that the facility be open, airy, light filled and provide a collaborative work environment. By thoroughly understanding the science, potential security risks and safety hazards, the design team was able to methodically dissect each of these issues to design innovative layered solutions leading to the creation of a state-of-the-art facility; a facility that restates the paradigm for containment facilities of the future.

The new facility includes Bio-Safety Level (BSL)-4 laboratories capable of handling life-threatening and exotic pathogens for which there are no treatments or vaccines. Working with these pathogens requires an intense focus on safety. A first for the Centers for Disease Control, the Emerging Infectious Diseases Laboratory also includes BSL-3(Ag) animal holding designed to meet USDA standards for handling high-consequence agents that pose a severe risk to our agricultural economy.
BUILDING 18

The project has many “firsts.”

- It is the first BSL-4 facility to employ fast-track construction, progressing from the start of schematic design to GMP and construction in less than nine months
- It is the first to utilize a new management and delivery model to expedite mock-ups, coordination documents, and BSL-4 parametric cost modeling
- It is the first to include flexible AAALAC accredited animal holding space capable of either BSL-3 or BSL-4 operation
- It is the first to provide multiple combinations of BSL-3 and BSL-4 modules and shared specimen support space

The new facility, the largest in the world dedicated to human health, is open and bright, extremely flexible and contains the highest-level bio-safety laboratories in the world. In CDC’s own words, it is “the most advanced laboratory facility in the world.”
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Science</td>
<td></td>
</tr>
<tr>
<td>Table of Contents</td>
<td>7</td>
</tr>
<tr>
<td>Collaboration</td>
<td>8</td>
</tr>
<tr>
<td>Flexibility</td>
<td>14</td>
</tr>
<tr>
<td>Safety and Security</td>
<td>20</td>
</tr>
<tr>
<td>Sustainability</td>
<td>28</td>
</tr>
<tr>
<td>Value</td>
<td>34</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>44</td>
</tr>
<tr>
<td>Appendix</td>
<td>54</td>
</tr>
</tbody>
</table>
"Nature may have the power to create a pandemic, but together we have the power to prevent it, to stop it, to overcome it, to cure it."

- Donna Shalala,
  Former U.S. Secretary of Health and Human Services,
  “Collaboration in the Fight Against Infectious Diseases”
A physical symbol of the CDC’s critical role in the health, safety and quality of life of our nation’s citizens, the Emerging Infectious Diseases Laboratory unifies the campus as a beacon to their life-saving work. Research involving exotic and deadly viruses requires complete containment for obvious safety reasons; a requirement that is diametrically opposed to the connectivity required to stimulate intellectual energy. By identifying and celebrating those points where the safety and security requirements of research can align with the open and inspiring environment required to promote creativity, these seemingly contradictory components are united. United by the powerful image recognizing the very real importance of their work, the facility provides researchers, epidemiologists, laboratorians and diagnosticians places to gather, both in time and in space, fostering casual exchanges that can eventually lead to the prevention and cure of diseases such as Ebola, AIDS, or avian flu.
**interaction**

The Emerging Infectious Diseases Laboratory breaks the paradigm of the high containment laboratory as an isolated bunker. The design includes light-filled hallways with views into and from the maximum containment laboratories. The adjacency of labs to associated offices also encourages interaction. Within the high-containment block, space was provided for scientists to congregate after removing their pressurized suits, a natural time and place for casual interaction. These spaces were all designed as a means to cross both physical and psychological boundaries that can prevent interaction within the CDC community.

**new site orientation**

With the development of the CDC masterplan just prior to the Building 18 project inception, CDC reoriented their headquarter campus in Atlanta from the existing northern entry along Clifton Road to the west with a new visitor’s center and the security enhancements required for a governmental campus with a critical mission.

Laboratory buildings are placed at the center of the campus with office and support buildings forming the perimeter. With this new orientation, the Emerging Infectious Diseases Laboratory becomes both the heart of the campus and the symbolic entry to the laboratory core. The collection of the laboratory facilities at the center of the campus facilitates the working relationships and collaboration between programs and support functions.
Building 18 is organized with offices to the south that attach to each level of CDC’s existing maximum containment laboratory, Building 15, to provide much needed office space for occupants of that facility. Levels 2 through five have additional office space to support Building 15, from the sixth level to the eleventh level, the office component supports only Building 18.

Due to the unique nature of the CDC laboratory mission, CDC internal design standards require the offices to be separated from the laboratories. Each person has a laboratory work area and an office work area. The laboratory block which contains BSL-2 and BSL-3 biocontainment laboratories is directly adjacent to the office areas and forms the laboratory tower with the office block.

Adjacent to the laboratory tower on the north end of the site is the six story high containment block. This block is composed of a central glassware facility, a floor of BSL-3 vivarium space, interstitial floors over the vivarium and below the BSL3-Ag and BSL-4 space and two mechanical floors serving the high-containment block. The adjacency to the laboratory tower provides easy access between the high-containment laboratory where live highly pathogenic organisms are used and the BSL-2 molecular biology laboratories where extracted RNA and DNA of the same organisms are analyzed.

Service for both blocks are provided from a service component located between the blocks that connect to a tunnel system to serve the laboratory core of the campus.
relief and informal communication

Because of the intense focus necessary to work in a high-containment laboratory, CDC also required that “restful” spaces be designed to provide relief for the scientists from the demands of their intense scientific mission. One response was the design of an enclosed and protected garden. Scientists are able to break from their work and meet informally in a serene environment created between buildings: a space that maximizes day-lighting and views within the high-containment areas. The location of the garden between two maximum containment laboratories required a high degree of security; the amenity is accessible only from within the facility, and use is restricted to the occupants of the buildings.

The laboratory spaces within the lab and office tower have orienting views to the outdoors. Communication is favorable in these light-filled, comfortable spaces. Scientists meet at points of intersection created both within and outside of the laboratory block. Lessons learned from other recent CDC laboratory facilities were used to assure that the design would foster connectivity within the unique CDC environment.

research campus

As a shared resource, located in the lowest level of the building, the glass wash facility includes fully automated washing and drying systems to serve the entire campus.

building

The enclosed garden is designed as a place where scientists can relax and retreat from the intense focus required by their work. Completely secure, it is accessible only from inside the building.

labs

With windows throughout, communication is easy in the light-filled corridors within the BSL-2 laboratory floors. Views are oriented into the labs and outside to the surrounding campus.
“We have the largest and most modern BSL-4 laboratory capability in the world.”

- Dr. Julie L. Gerberding
  Director, CDC
CDC’s mission mandates rapid response to emerging threats to human health. These threats fall into BSL-2, BSL-3 and BSL-4 (highest risk) categories. Some of the infectious agents pose a high risk to the agricultural economy as well as posing a risk for human disease. Special environmental containment in BSL-3 labs, and protection from infection, are required for these high-consequence agricultural pathogens.

Work with viable infectious organisms classified as BSL-3 and BSL-4 agents must be executed in labs of corresponding bio-safety level. Work with parts of organisms, such as extracted DNA, RNA or proteins, can be safely carried out in a BSL-2 molecular biology laboratory. Since outbreaks are unpredictable, the flexibility to convert lower-level BSL-2 space into BSL-3 or BSL-4 is essential. Also, adjacent procedure rooms can be converted to BSL-3 when additional surge capacity is required.

Safety and productivity concerns led to innovative design within BSL-3Ag (agricultural) and BSL-4 labs, as well. For example, BSL-3 and BSL-4 labs are collocated, sharing entry-changing and shower-out facilities. This not only reduces space requirements and operating costs, it also allows workers to spend part of their day in a BSL-3 environment; an important consideration due to the dehydrating effects of breathing air in the protective suits worn in the BSL-4 labs.

Locating the BSL-3 and BSL-4 labs adjacent to each other allows a Class III bio-safety cabinet (glove box) to be stationed between the two labs to handle suspicious samples of unknown origin, even if the sample turns out to be a BSL-4 agent. The sample is placed in the cabinet and split. One part is taken into the BSL-4 lab for testing; the other half remains in the cabinet. If the sample is identified as a BSL-4 agent, the remainder is brought into the BSL-4 lab. If the sample is identified as a BSL-3 agent, the sample in the BSL-4 lab is destroyed. (No viable material from a BSL-4 lab can be taken to a lower-level lab). The half of the sample remaining in the cabinet can be taken into the BSL-3 lab for evaluation.
**FLEXIBILITY**

**high-containment**

The design of the high-containment block addresses a particularly frustrating problem of the previous generation of labs of this type. In the past, only one BSL-4 lab would be in operation at any given time. The other would be shut down for maintenance, since it took six months to decontaminate, update, setup, re-commission and startup the lab. In the event of multiple outbreaks—which have occurred—scientists were not able to process specimens from every outbreak at the same time. The new high-containment lab is designed to handle **multiple outbreaks simultaneously**. Four quadrants comprised of four BSL-3Ag and four BSL-4 labs provide the **highest capacity** of high-containment labs in the world.

**BSL-4 challenge & response**

**Multiple program size**
- BSL-4 labs can be joined together
- Centralized specimen storage

**Ability to work a full day**
- Work area allow suits to be taken off without final shower
- Toilet and sustenance are available

**Varied animal usage**
- Animal rooms and necropsy can be increased by 100% for any of the 8 labs
- Animal rooms can be BSL-3Ag or BSL-4

**BSL-3Ag/BSL-4 animal holding**

Another important design decision was locating **animal holding rooms adjacent to one another** with air-tight doors between them. These rooms can operate completely independently for each high-containment lab if need be. Since scientists and technicians must be inoculated against any disease to which they might be exposed, shared animal holding space requires that they be inoculated against diseases being studied in both labs. The inoculation process can be lengthy and requires that a project be shut down while gearing up for another, which greatly disrupts the science. Animal holding facilities here are designed so they can **serve each lab independently** or can be combined to **serve multiple labs** for larger projects.

**glove boxes**

Glove boxes stationed between BSL-3 and BSL-4 laboratories safely contain high-hazard specimens as well as specimens of unknown origin.
Experimentation on animals with highly pathogenic acute infectious diseases is short-term and intermittent. A wide variety of species including rodents, ferrets, birds, fowl, rabbits, pigs, sheep, and non-human primates may be required as models depending on the agent in question. Not only are the animal rooms flexible to handle these many species, but the Emerging Infectious Diseases Laboratory is the first facility to provide the ability to change animal holding rooms from BSL-3 to BSL-4 (or vice versa). This allows any of the eight laboratories in the high containment block to double the animal space dedicated to the laboratory to meet the requirements of any agent-specific protocol.

The innovative layout and flow in the BSL-3 animal facility are particularly important in providing flexibility, safety and increased productivity in this multi-agent and multi-species vivarium. Distinctly important attributes of infectious disease work addressed in the design of this animal facility are:

- A one-to-one relationship of animal holding to procedure rooms, so that animals can be taken to procedure rooms without risking cross-contamination or loss of containment
- A clean corridor entrance to the procedure room, so that research personnel are not exposed to other agents being used in other rooms in the facility
- An internal corridor in which potentially contaminated cages can be safely taken to autoclaves for decontamination, to processing and to cage washing
BSL-2 and BSL-3 labs

Standard BSL-2 molecular biology laboratories provide maximum flexibility for both clean and contaminated infectious disease work. Three BSL-2 labs are supported by procedure rooms and other support space. Each laboratory contains five 11 x 11 sq ft alcoves that can accommodate up to two people and two biological safety cabinets per alcove. The alcove model maximizes the number of biological safety cabinets and collocates them for work with BSL-2 infectious organisms. The biological safety cabinets provide a Class 100 clean environment for working with molecular diagnostics to eliminate cross-contamination that can lead to false-positive diagnostic results. Each generic lab can have from one to ten biological safety cabinets.

In addition to a highly flexible overall layout, laboratory casework is completely interchangeable in any lab in the building. Adjustable, removable countertops and shelves are all the same width to maximize flexibility, while rolling base cabinets provide multiple storage options. Shelves and countertops can be removed for installation of large bench or floor-mounted equipment. Each lab has a mobile sink with quick-disconnect connections.

In the diagram, “from BSL-2 to BSL-3,” the upper right corner is a BSL-3 lab for programs with minimal need for BSL-3 containment. For programs requiring additional BSL-3, this containment level can be easily increased by modifying the door location to the BSL-3 suite to encompass up to seven rooms to the suite.

FLEXIBILITY

customized alcoves

Each alcove can be customized to fit the scientific need. Biosafety cabinets and incubators can be interchanged within the space.

from BSL-2 to BSL-3

Typical labs need to accommodate the risk assessment of the agent to be used. For example: Hepatitis would predominately require BSL-2, while Anthrax would have significant BSL-3 components.

surge capacity

Each lab needs surge capacity at BSL-3 in the event of a significant outbreak. The innovative layout in Building 18 provides for this flexibility.
“The World Health Organization has labeled the growing threat of infectious disease a global crisis.”

- Donna Shalala, Former U.S. Secretary of Health and Human Services, “Collaboration in the Fight Against Infectious Diseases”
SAFETY AND SECURITY
Ample visibility is always essential in the design of safe laboratories. This facility enables maximum visibility. Carefully placed windows throughout the facility from the lobby, labs, and corridors, provide light and views to the outdoors even from the interior of the BSL-4 laboratory.

Due to the hazardous nature of infectious diseases, containing them within the laboratories is critical. For this reason, CDC requires that all facilities engineers and maintenance staff be kept out of the laboratories and out of harm’s way. With the design of mechanical galleries which house all mechanical equipment that requires servicing outside of the laboratories, the design team provided complete serviceability, with the added benefit of increased day-lighting. In addition to keeping facilities and maintenance personnel out of the laboratories, these mechanical galleries were designed to provide optimal clerestory lighting.
bio-safety suits

For personnel protection, before entering the BSL-4 suite, it is required that laboratorians put on positive-pressure suits. Before leaving the suite, it is required that chemical showers be taken to disinfect the suits before removing them. Oxygen hoses connect the pressurized suits to a back-up breathing-air system, as shown.

redundancy

All systems were designed with backup components that allow the building to function safely in the event of the loss of a primary system. In the event of loss of normal power, the entire facility is fully operated by backup power generation. For critical components, an uninterruptible power supply bridges the gap between loss of power and generator start-up. Containment systems were designed with a “belts and suspenders” approach with secondary containment providing protection in the event of primary containment system failure.

visibility

The laboratory corridor allows for excellent views into the labs—including views into the high-containment block—encouraging safe protocol and communication.
**communication and fire safety**

**Plasma screens** located throughout the high-containment block serve to communicate any potential problems, their location, and most importantly any action required by those inside the block. All code-required fire alarm audible and visual alarms are provided throughout the high containment block. However, when bio-hazard suits are worn, the alarms cannot easily be heard. **Strobe lighting alerts investigators to alarms.** All alarms, including security breach and HVAC/BAS alarms, are scrolled across these panel displays in 2-inch-high block lettering.

**specimen flow**

A **service corridor to move specimens** internally assures that laboratory access from offices is free of potential contamination. Off this service corridor are zones for freezers, autoclaves, cold rooms and other support facilities. CDC policy is to keep all offices and maintenance outside of the laboratories for safety and protection of the work.

**effluent decontamination system**

The BSL-4 laboratories produce significant volumes of water-borne waste, decontaminated prior to discharge to the campus and municipal sewer system. This includes waste from laboratory sinks, animal room wash-down, sterilizer waste, personnel shower and chemical showers. It is collected by a biowaste plumbing system and transported to the effluent decontamination system located in the lowest level of the building.

The biowaste piping appears similar to a normal plumbing waste and vent systems, but there are added features that are critical to prevent accidental exposure of the infectious material being carried by the piping.
SAFETY AND SECURITY

biowaste waste piping

Several design features provide reliability and protection:

- All the biowaste and biovent piping is made of welded stainless steel.
- Sanitary grade isolation valves can isolate each laboratory quadrant from the system, to allow for maintenance of the lab without affecting the other laboratory quadrants.
- All of the biowaste vents are protected by HEPA filtration prior to the atmosphere discharge.
- Dual HEPA filter skids enable the removal and testing of one HEPA filter at a time, enabling the biovent system to stay active.
- Ports are built into the biowaste, biovent and HEPA filter skids for decontamination of the system components before access to the system components is made.

Vessels were designed with several features to enhance safety and reliability of the effluent decontamination system.

- In this system design, gravity is the only means used for transporting fluids. This is critical, because the use of pumps can lead to undesirable conditions including leaks and contamination, making the equipment dangerous to repair.
- The vessels are double-walled to prevent any exposure to the waste.
- The system is interlocked with the BSL-4 laboratories. Water to the labs can be shut off if there is a problem with the effluent decontamination system, preventing more waste from being discharged into the system.
- The design team and the manufacturer modified the design of the safety relief system for the autoclaves in the BSL-3 and BSL-4 laboratories to prevent any release of infectious agents, even if the chamber’s safety relief valve were to be open.

waste removal

The effluent decontamination system includes three factory-fabricated pressure vessels. Three tanks provide reliable receiving and treatment of the waste during all modes of operation: one vessel receives waste, one vessel treats the waste and the third can be offline for maintenance.
The Emerging Infectious Diseases Laboratory defines the heart of the campus, both symbolically and physically.
“The health of communities not only depends on the health of individuals but also on whether the physical and social aspects of communities enable people to live healthy lives.”

- U.S. Department of Health and Human Services: “Healthy People 2010” (Vol. 1, Part 7)
The Emerging Infectious Diseases Laboratory was designed to meet LEED certification criteria that aligned with the technical challenges and maintainability of a maximum containment laboratory. The high-containment laboratories and animal facilities, although responsive to energy concerns, were designed primarily to assure that the systems and materials selected would function best for these critical environments. Energy usage and day-lighting were studied extensively through computer modeling, resulting in office and laboratory spaces that rely heavily on day-lighting, task lighting, lighting control and solar control to conserve energy and to create a more productive work environment. The productive costs for lighting were reduced 40% over a baseline facility.

“right-sizing” engineering

The facility was designed to reduce energy demands by “right-sizing” the engineering systems by accurately assessing and reducing the initial energy demand, rather than through heat recovery. The concept of right-sizing of engineering systems in this laboratory is critical because of the high energy consumption required by single-pass ventilation air. Three primary right-sizing methods were incorporated into the project: air change reduction, localized cooling and reuse of outside air.

The air-change rate, typical for infectious diseases laboratories, was reduced by 20% through carefully examining the impact of air changes on the risk of infection and designing to these real risks. To address past spot cooling problems, the engineering was designed with even distribution, allowing for more air transfer and minimizing energy consumption. This was accomplished by evaluating the CDC’s existing laboratory facilities and determining the amount of reheat that was being used on a constant basis. Using this empirical data, the engineers presented this information to the CDC’s Office of Health and Safety showing that significant energy savings could be achieved without compromising safety.
High heat-producing equipment on each floor has been located in an LER (Linear Equipment Room) which is served by dedicated air handling units that recirculate the conditioned air within the space. In addition, the air required for space pressurization of the LER is transferred from the perimeter corridor through the air handling unit. This transfer of air allows conditioned outside air to be used for two purposes before being exhausted to the outside. Using both of these approaches reduces the amount of conditioned outside air required, resulting in energy savings of 20% compared to a baseline facility.

**campus sustainability**

Storm water from the Emerging Infectious Diseases Laboratory contributes to the campus’s detention basin, which is used for watering. The center of the campus, surrounding Building 18, is sloping greenscape and a stream filled with artificial rocks. Rainwater is collected from the site, then delivered down the stream to a pond where it is recycled to the top and sent down again. The water from this system is distributed to all of the sprinklers on the campus.

For the life of the building, 55% of the project site, 2.7 acres, has been designated for preservation and restoration to a pre-development state with native and adaptive vegetation. Due to a 9% total potable water consumption reduction over the baseline design, the CDC will save over 100,000 gallons of water per year. 30% of non-roof impervious surfaces will be shaded within the next 5 years, and high albedo materials and finishes were used on impervious surfaces to decrease the heat island effect generally associated with buildings of this magnitude. These efforts will lower energy demands and utility costs.
The commitment to day-lighting dictated extremely high ceilings. The project achieved an 11'-6" ceiling height throughout the office areas and at the perimeter laboratory corridor, in order to maximize the daylight penetrating the innermost offices and laboratories. The ceiling height was achieved even with the restriction of matching an existing building’s floor-to-floor height of 15'-6." In the office areas, the higher ceilings were achieved by minimizing plenum congestion. Additional coordination developed a concept that allows for a single layer of ductwork and for all crossovers to occur within the depth of the structural framing. Mini optical light shelves reflect daylight deep into the space, and create a brightness and interest on the ceiling surface. Corridors in the office block terminate with day-lighted interaction areas. Solar control of communal windows is provided by solar activated mechanical shades. The laboratory ceiling height was achieved by concentrating the horizontal ductwork run-outs toward the middle of the laboratory floors, over the smaller enclosed laboratories. This enabled the perimeter ceilings to be as high as practical for day-lighting penetration. The perimeter ceilings curve down to a height of 10' throughout the balance of the open lab. Over 95% of the spaces that functionally could have day-lighting and views were provided with these amenities.

Regionally, available materials such as precast concrete and stacked stone are the predominant exterior materials. Low-VOC paint and carpet, and highly sustainable materials such as linoleum, carpet tiles and wood from renewable sources were the major interior finishes in the basic laboratories and offices. Materials in the maximum containment laboratories were chosen for long-term performance as containment barriers, and for resistance to decontaminants utilized in the facility.

**day-lighting**

High ceilings from the corridor into the labs optimize the use of day-lighting and admit light far into the laboratories.

**office and training areas**

Daylight pours far into the office and training areas.

**materials**

High ceilings from the corridor into the labs optimize the use of day-lighting and admit light far into the laboratories.
Operating costs were evaluated to identify potential targets for reduction.

**solar control**
Computer modeling to study day-lighting and solar control assured the design made the best use of solar energy.
“The public health infrastructure is the underlying foundation that supports the planning, delivery, and evaluation of public health activities and practices.”

-“Preventing Emerging Infectious Diseases: A Strategy for the 21st Century,”
U.S. Department of Health & Human Services,
Centers for Disease Control and Prevention
This project symbolizes the United States government’s acknowledgment of an important investment to modernize and upgrade critical buildings at the Centers for Disease Control. This building is replacing 40 to 50-year-old facilities at the CDC’s Roybal Campus. The Emerging Infectious Diseases Laboratory will greatly improve CDC’s ability to work with, study and advance the knowledge of emerging infectious diseases, existing infectious diseases and health threats, and environmental hazards and threats.

### Technical Achievement

Few laboratory facilities are **100% commissioned and verified** with everything in good working order prior to occupancy; this one is. Rigorously applied technical criteria assure that containment barriers are not breached, airflows are balanced to as low as 12 pascals, and decontamination systems are integrated to enhance productivity and safety.

The story of CDC’s Emerging Infectious Diseases Laboratory begins in October of 2000, when CDC challenged the design team to **break ground within one year**, by the end of September of 2001 (the end of the federal fiscal year), or risk losing CDC funding through congressional rescission. An ambitious plan: less than one year from the start of programming to the start of construction of one of the most technologically advanced laboratory facilities in the world. Not only that, the facility is a highly specialized facility, one that exists nowhere else in the world, so there would be no “cookie-cutter” solutions.
To provide CDC with a world-class facility at the best price, the design team adopted a continuous value management process that examined every detail of the design.

The design of the exterior wall system is a solid example of the impact of the value management process. Interspersing precast concrete panels at critical locations, instead of a full curtain wall system, resulted in a fenestrated wall system that still met the blast performance criteria and reduced the cost by approximately one half. The addition of the stacked stone base (one of Atlanta’s great values at $14 per square foot) made the exterior wall a low-cost, high-impact component of the project. Similar exercises were repeated for every component of the building to ensure the best possible value.

So, the first high-containment facility planned on a fast-track schedule with staged documents began construction on an expedited schedule.

### Exterior Wall System

A fenestrated wall system reduced the cost by approximately one half.
Then, everything changed. Construction had just begun in October of 2001, when letters containing weaponized anthrax were mailed to various locations along the East Coast. CDC went into crisis management mode, stopping laboratory programs to create capacity for the huge surge in demand for anthrax diagnostics. For the Emerging Infectious Diseases Laboratory, the answer was simple: add two floors of laboratories to provide needed surge capacity for the future. The team responded quickly with an entirely new foundation and structural frame design for the lab tower, delaying construction by only six weeks. Concurrently, security requirements on the campus changed due to new federal standards based on the events of September 11, 2001. The new facility’s security systems were completely redesigned as a result.

50 year investment
Since this facility will serve CDC for 50 years—as their previous building has—it was imperative that design decisions provide solid value, in addition to being reliable and flexible. Special attention was paid to the mechanical systems, which account for close to 30% of a laboratory building’s initial costs as well as for the major part of its operating expenses.

Innovation
This next-generation high-containment laboratory pushed the envelope on lessons learned from previous design, construction and operating experience by first thoroughly testing and then incorporating many technical innovations to improve safety and productivity.

Integrated lightweight air pressure resistant (APR) doors: Previous APR doors had been bulky and difficult to operate. The design team worked with a German manufacturing firm to develop lightweight doors with all appropriate services integrated into the door and frame.
Mist spray, self-cleaning, chemical shower nozzles: Nozzles used to decontaminate pressurized suits when exiting the BSL-4 laboratory often become clogged. The design team integrated a plunger to unclog the nozzle with a low-flow spray head to reduce clogging as well as chemical use and maintenance.

Integrated service delivery chase: Highly integrated and modular steel service chases organize and streamline exposed services without taking valuable space away from the laboratories.

Scuba Tank Breathing Air Compressors: As the world’s largest facility with an integral breathing air system, Building 18 was a challenge to the design team. Emergency backup to breathing air compressors is normally provided by bottled air tanks. Regulations require that the air in these tanks be changed yearly at a minimum, if not used. Several hundred bottles of air created quite a maintenance headache. The design team developed a unique system utilizing a scuba tank compressor and two large storage tanks to provide the backup required along with the ability to purge and refill the tanks at CDC’s convenience.

In designing and executing maximum containment spaces, the devil is in the details. These examples illustrate how the smallest details were considered to improve the facility’s performance. In addition to the innovative solutions highlighted above, every system was improved by lessons learned from extensive benchmarking tours of previously constructed facilities.

chemical showers
The chemical shower developed for this project is such that a scientist will be misted rather than showered with the disinfecting chemicals.

breathing air
A unique back-up system for scientists wearing pressurized suits was developed utilizing a scuba tank compressor and two large storage tanks.
construction achievements

High-containment construction, designed to be airtight over a long period of time, involves a rigorous process integrating design and construction. Testing and verification by mock-up of low-shrinkage concrete mixes, coordination of all utilities to penetrate the concrete barrier including the smallest control and security system conduits, and pre-installation performance testing of coatings combined to make the development of the containment barrier a close coordination process between the design and construction team.

Construction of high-containment barriers requires coordination, installation, inspection and verification to be repeated layer by layer until the shell and then the coatings are complete. The substrate and the coatings are verified by visual inspection covering every inch of the floors, walls and ceilings. If cracks develop in a high-containment facility during operation, it will shut down and be out of commission until repairs can be made. The intent is to create a barrier, utilizing normal construction materials, which will maintain its integrity over a long period of harsh use. The first step in achieving this goal involves “communication and sub-contractor “buy-in” which includes:

- Pre-bid Conference with major sub-trades
- Mock-ups and validation of specialized components prior to final installation
- Clear and complete final testing criteria and quality control audits
Pre-testing and mock-ups that were completed on Building 18 include:

- Air-pressure resistant door seals
- Sterilizer seals and door seals
- Bio-seal dampers (cycle tested)
- Air-pressure resistant windows
- Epoxy sealed conduits
- Concrete mixture
- Epoxy coatings
- Recipe experimentation and pull tests

The sequence of construction for high containment facilities is very different from the normal construction process. All coordination must be completed prior to pouring the high containment concrete. The sequencing of construction:

1. Create cast-in-place penetrations for lights, services, ductwork, bio-seal doors, electrical conduits, etc.
2. Allow a 6 month concrete curing period prior to coatings application
3. Install and complete HEPA and biowaste distribution systems in floors above and below
4. Pull electrical and data cables prior to epoxy filling
5. Install integral through-wall equipment
6. Apply epoxy coatings (pre-tested) to floors, walls and ceilings
7. Install stand-off services such as plumbing services, breathing air lines, gases, etc.
8. Perform pressure decay testing.

One of the challenges of high-containment construction is the intensive coordination that must occur before the concrete is poured. All services entering the high-containment block must be precisely located in advance to ensure that concrete and reinforcing can work around them without cracks forming in the slab.

The barrier uses standard construction materials to maintain its integrity over a long period of hard use.

All services entering the high-containment block must be identified with precise location. This includes final coordination of control and security conduit locations. Electrical conduits that enter the space, like the one directly below, are epoxy filled to seal the high-containment barrier.
The mechanical systems were installed providing properly directed airflow from areas of low hazard to areas of higher hazard. As previously mentioned in the description of flexibility, a unique aspect of the high-containment component in this facility is having animal rooms capable of functioning as either BSL-4 or BSL-3Ag. This required that the pressure systems dynamically respond to allow different pressure relationships to occur in either of these conditions. Over three hundred HEPA filters, with the ability to be decontaminated in place, serve the high-containment floor from an interstitial mezzanine. All are easily accessible for certification, decontamination and replacement.

**commissioning and validation**

With a BSL3-Ag or BSL-4 laboratory you have to be certain that it performs both as designed and required; **100% commissioning and validation is how the performance is proven.** The critical steps toward commissioning and validation include having architects and engineers resident on site for continual monitoring of the quality of the construction. During this time, sequential component systems and integrated systems were tested. **Systems testing** included: structural, superstructure-walls, air pressure resistant doors and windows, coatings application and wall preparation, bio-seal dampers, sterilizers, HVAC systems, electronic hardware, chemical disinfectant system, breathing air system, effluent decontamination systems, HEPA filter housings, domestic water backflow, controls, UPS, emergency power, medical lab gases, fire detection systems, and architectural barriers and finishes. One of the systems commissioned and validated was the integrity of the entire containment boundary including seals of all equipment, components and services penetrating the barrier. The facility passed the pressure decay test for the containment barrier with flying colors. This test verified the integrity of room tightness through physical testing. The challenge was .05 w.g. loss/min at 2" w.g. (500 pa) for 20 minutes (tested under negative pressure).
A delivery of value both to the government and to the taxpayer:

The Emerging Infectious Diseases Laboratory is the most technically advanced high-containment laboratory in the world, exceeding the CDC’s expectations.
“This is a world-class facility for world-class scientists.”

- Dr. Julie Gerberding, Director of the Centers for Disease Control and Prevention
The central location, function and design of the Emerging Infectious Diseases Laboratory celebrates the significance of CDC’s science and establishes the interconnectivity among various groups on campus that is crucial to CDC’s vision for the future. Promoting collaboration among researchers, diagnosticians, laboratorians and epidemiologists is central to the design. Given the severe constraints of a BSL-4 laboratory, creating a collaborative, pleasant and inspiring work environment required a new rigorous approach, in which often the solution lay in the rethinking of the smallest detail.
Scientists were involved in the design of the colorful break-room “bio-art” which is displayed through the glass. Using electron micrographs, they were able to enlarge various specimens for use as graphics, integrated into the glass panes of these informal meeting areas.
Collaboration on a larger scale was addressed through a careful analysis of circulation patterns through the site, the building, and into the labs and offices. Each point where people naturally gathered was celebrated through the architectural design: the welcoming light-filled entrance lobby; the high-ceiling fenestrated corridors with orienting views to the outside; and break areas carefully woven into the scheme at appropriate points, including areas within the high-containment block.
In the garden, scientists break from their work and meet informally in a serene environment created between buildings. This space maximizes day-lighting and views within the high-containment areas.
With over 300 HEPA filters containing the world’s most dangerous pathogens, quality of life is critical for the maintenance staff as well. Easily accessible mechanical and electrical systems, outside of the laboratories that can be safely and effectively maintained, are a key component of Building 18.
Within the high-containment block, wearing a pressurized suit is uncomfortable and creates hardship for the scientist. The design thoughtfully addresses this immutable reality through discreet but effective solutions. Typically, scientists wear a pressurized suit for 4 hours at a stretch, although some programs require longer stints up to 12 hours in duration. Previously, scientists in the high containment block had to take a body shower (after decontaminating their suit in a chemical shower) every time they had to use the rest room, eat, or get a drink of water or even record notes. Scientists would refrain from drinking water, eating or doing anything that would require them to remove their suits, shower and then suit up again. Not only is this a time-consuming process, but frequent showering dries the skin, causing cracks which increases the risk of infection.

To minimize these concerns, these high-containment labs are designed with an internal work area so that a scientist can get out of his or her suit and work at a desk, use the bathroom, or take a break, even eat or drink, without having to take a personal shower. This gathering space is provided at the very heart of the containment block where the scientists remove their suits; a natural time and place for relaxation and casual conversation away from the intensity of the BSL-4 laboratory.
Closed offices are provided with task lighting, solar control through mini-optical light shelves on the upper windows and user controlled blinds on the lower windows.
Throughout, the work environment is bright, open and filled with light. Exterior corridors are designed with generous full-height fenestration allowing daylight to penetrate through to the innermost laboratories. (The ceiling height is lowered in the laboratories to accommodate mechanical systems without decreasing the amount of daylight filtering through to these areas.) The generous use of glass combined with the open design of the flexible lab and office areas creates a pleasant ambience and highlights the important work and stature of the CDC’s scientists.
QUALITY OF LIFE

The Center for Emerging Infectious Diseases is a cornerstone building for the CDC’s Atlanta campus, and a landmark that proudly proclaims the CDC’s leadership role in the preservation and protection of our nation’s health and quality of life. The Emerging Infectious Diseases Laboratory provides an identity and recognition for the National Center for Infectious Diseases that reflects the values and importance of their mission.

As the heart of CDC’s core pursuit, the Emerging Infectious Diseases Laboratory is an up-to-date enriched laboratory facility that satisfies the need for high-containment research and response to emerging infectious diseases. Light-filled throughout, with daylight radiating into the atrium and extending into the labs and offices, the highest-level containment labs are no longer designed as bunkers hidden from the world. The National Center for Infectious Diseases now has an identity and a home. Infectious diseases, the leading cause of death worldwide, will be battled here along with bioterrorist threats, in the most advanced laboratory in the world.
A delivery of value both to the government and to the taxpayer:

*The Emerging Infectious Diseases Laboratory is the most technically advanced high-containment laboratory in the world, exceeding the CDC’s expectations.*
Total Construction Cost: $130.7 Million
$335/Square Foot

Construction Breakdown Costs:
- Misc. Site work: $11.32/gsf
- Foundations/Superstructure: $34.94/gsf
- Roofing and Exterior Skin: $30.89/gsf
- Interior Construction: $35.14/gsf
- Laboratory Casework/Fume Hoods: $30.00/gsf
- HVAC: $76.47/gsf
- Electrical: $50.88/gsf
- Plumbing/Fire Protection: $20.17/gsf
- General Considerations, Insurance, Permits, etc.: $45.30/gsf

**TOTAL** $335.11/gsf

Project Site: 2.5 Acres

Building Area:
- Office/Amenities: 86,000 GSF
- Laboratory: BSL-2: 142,000 GSF
- Laboratory: BSL-3: 24,000 GSF
- Vivarium: BSL-3: 41,000 GSF
- Laboratory: Enhanced BSL-3/BSL-4: 79,000 GSF
- Glassware: 18,000 GSF

**TOTAL** 390,000 GSF
Lead Architectural and Engineering Firm:
Jon Crane, AIA
Principal, Project Director, and BioContainment Specialist
HDR
1201 Peachtree Street, NE
400 Colony Square, Suite 600
Atlanta
Georgia
30361-6316
United States of America
Phone: 404-815-8601
Fax: 404-815-3107
Email: jcrane@hdrinc.com

Construction Company:
McCar�y Construction
Bud Guest
1341 North Rock Hill Road
St. Louis
Missouri
63124
USA
314-968-3300
314-968-0032
Email: bguest@mccarthy.com

Casework & Laboratory Furniture Companies:
ISEC Inc.
James McAllister
Eastern Region
9305 Gerwig Lane, Suite M
Columbia
Maryland
21046
Phone: 410-381-6049
Fax: 410-381-6812

Fisher Hamilton
Jeanne Blahnic
1316 18th Street
Two Rivers
Wisconsin
54241
Phone: 920-793-1121
Fax: 920-793-3084

Fume Hood Company:
Fisher Hamilton
Jeanne Blahnic
1316 18th Street
Two Rivers
Wisconsin
54241
Phone: 920-793-1121
Fax: 920-793-3084

Laboratory Fixtures Company:
WaterSaver Faucet Company
Derek Graves
701 W. Erie Street
Chicago
Illinois
USA
60610
Phone: 312-666-5500
Fax: 312-666-8597

Flooring Companies:
(Office & Office Interiors)
Re:Source Georgia
Bobby Roan
3137 Chestnut Drive
Atlanta
Georgia
30340
Phone: 770-452-9898
Fax: 770-452-7674

The Emerging Infectious Diseases Laboratory
Lab Contact/Owner Contact:
L. Eugene Cole II.
NCID Lead Program Manager
Centers for Disease Control and Prevention
Executive Park Facility
Building 6
Level 2, Room 2053
Executive Park Drive
Atlanta
Georgia
30329
United States of America
Phone: 404-815-8601
Fax: 404-815-3107
Email: lec6@CDC.gov
Flooring Companies Continued:
(Vivarium & Lab Support Spaces
(glass wash, cage wash))
Federal Technical Services
Joe Lasko
980 Kenmill Drive NW
Marietta
Georgia
30060
Phone: 770-426-5191
Fax: 770-426-5091

(High Containment Lab)
Dudick Inc.
Tom Dudick
1818 Miller Parkway
Streetsboro
Ohio
44241
Phone: 330-562-1970
Fax: 330-562-7638

Containment Architectural Support:
Smith Carter USA LLC
Les Gartner
1123 Zonolite Road, Suite 25
Atlanta
Georgia
30306
United States of America
Phone: 404-815-5049
Fax: 404-815-5658
Email: lgartner@smithcarter.com

Containment Engineering Support:
Hemisphere Engineering, Inc.
Cory Ziegler
1123 Zonolite Road, Suite 24
Atlanta
Georgia
30306
United States of America
Phone: 404-815-4140
Fax: 404-815-4158
Email: cziegler@hemisphere-eng.com

Structural Engineering:
KSI Structural Engineers
Kurt Swensson
5881 Glenridge Drive, Suite 200
Atlanta
Georgia
30328
United States of America
Phone: 404-303-8317
Fax: 404-303-8319
Email: kswensson@ksise.com

Cost Estimating:
Boyken International, Inc.
Dwight Jones
400 Northridge Road, Suite 1200
Atlanta
Georgia
30350
United States of America
Phone: 770-992-3210
Fax: 770-992-1489
Email: djones@boyken.com

Sustainability Design Consultant:
Architectural Energy Corporation
Michael Holtz
2540 Frontier Road, Suite 201
Boulder
Colorado
80301
United States of America
Phone: 303-444-4149
Fax: 303-444-4304
We practice increased use of sustainable materials and reduction of material use.