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I. Preface and Summary

A. Executive Summary

The University of Colorado Health Sciences Center’s (UCHSC) paramount and time-honored mission of education, research, patient care, and clinical care will continue into the next century. The UCHSC is a unique regional public resource because it generates new knowledge and translates these discoveries to superior health education and human health. In all of its endeavors, the UCHSC will continue to achieve excellence and outstanding accomplishments, which will place the institution in the top tier of academic health centers.

The University of Colorado Health Sciences Center’s Master Plan creates a development guide for the relocation and expansion of the education, research, and clinical care programs from the Denver campus at Colorado Boulevard and Ninth Avenue to the Fitzsimons campus in Aurora. The new Fitzsimons campus development will allow the UCHSC to reach its goal of becoming a top-tier health sciences institution by accommodating program growth needs through the next century. The Fitzsimons development involves approximately nine million square feet of new program space and associated infrastructure for the Health Sciences Center, University of Colorado Hospital, and affiliate institutions.

The availability of new research space is essential to ensure the current and future success of the research enterprise at the University of Colorado Health Sciences Center. A total of approximately 1.4 million gross square feet of new research facilities is necessary by the year 2008 to adequately transition all research programs from the Denver site to the new Fitzsimons campus. This research space requirement will be accommodated at Fitzsimons by the development of three major new research complexes/facilities.

The 600,000 gross square foot Research Complex 1 (RC1) constitutes the first comprehensive research presence for the UCHSC on the Fitzsimons campus. Construction of the $216 million RC1 complex is now underway and completion is planned for June 2004. Departments and programs to occupy space in the new RC1 facilities will primarily include the basic science programs and core laboratories in the School of Medicine. Researchers from the Schools of Dentistry, Pharmacy, and Nursing will also occupy space within the new RC1. The RC1 includes a central vivarium to be support research programs located on the Fitzsimons campus.

The purpose of this program plan is to request university and state approvals necessary to initiate the design and construction of the second major research facility at Fitzsimons – the Research Complex 2 (RC2). The RC2 project involves the construction of approximately 400,000 gross square feet of new research space necessary for the transition of additional research programs from the 9th Ave to Fitzsimons. As currently envisioned, this facility will be sited immediately to the west of, and connected to the RC1 in the research zone. Tentative program occupants will include the remaining departments and programs within the School of Medicine and related core
laboratories. The facility may also house other research programs from the Schools of Pharmacy and Dentistry, if additional space becomes available. The RC2 facility will include wet laboratories, core laboratories, lab support space, research office and conference, and vivarium space. Consistent with the RC1 laboratory design, the RC2 laboratory and support space will be designed to be as generic as possible to ensure flexibility in use and the capability for interchange of space and activities among the various research departments and programs. The design phase of the $206 million RC2 facility will commence in July 2003 and completion is planned for December 2007.

A third major research facility – the Research Complex 3 (RC3) comprised of another 400,000 gsf is necessary to support the relocation of the Schools of Pharmacy and remaining campus research programs. Although the November 2002 master plan transition schedule indicates June 2010 as the tentative date for the initiation of the project design, the actual schedule for the development of the RC3 is contingent upon the availability of cash funds. Appropriate approvals for the RC3 facility project will be requested in a future program plan document, as the project funding becomes available.

The vision of the Fitzsimons campus includes the development of facilities that will enable new ways in which faculty, students, and staff will conduct their duties in the 21st century. In the new research facilities at Fitzsimons, flexibly designed research space will integrate clinical and basic science research programs to encourage a more effective flow of new discoveries to their application for the benefit of the patient and the community at large.

B. Program Planning Process

An expedited program plan process was completed during February and March 2003 with the formation of the campus Research Complex 2 Oversight Committee. A program consultant team consisting of planners, architects and engineers from Fentress Bradburn Architects, Kling, and GPR Planners Collaborative were employed to assist the Committee in the development of the program plan assumptions.

Consistent with the UCHSC’s vision to develop flexible and integrated research facilities, an essential requirement for RC2 was to program a facility sufficiently generic to facilitate adaptation from one investigator to the next with only modest changes. The campus has addressed this requirement by incorporating a universal lab space concept into the program plan. The building space will be finally programmed and designed at the time actual program occupants are identified during the design process.

In a manner consistent with the previous RC1 project, the generic space programming approach utilized in the RC2 program plan began not with a review of detailed investigator needs, but rather with an understanding of what makes a quality translational research building. “What are the basic components of the building type?” and, “What are the amounts and relationships of these components?” were the initial programming questions faced by the project team and the Oversight Committee. The essential goal was to program the RC2 building so that it will be flexible and useful in four years (at construction completion), as well as in 15 years and beyond.
The initial program planning focus was on the overarching issues: the concept of the laboratory modules, support space, animal space, office modules, interaction spaces, circulation systems, and connectivity to the RC1 facilities, the clinical zone, and the future RC3 research facility. The result is this program plan for the 400,000 gsf Research Complex 2 – a flexible biomedical research facility based on a common planning approach, sited and connected in such a way as to ensure the interaction among researchers along the entire research program spectrum.

The programming process included two major steps: 1) oversight committee review of RC1 laboratory space design concepts relative to the new RC2 facility – including the research laboratory module; and 2) development of general program and space requirements for wet and core laboratories, animal space, office, laboratory support, amenities and building support.

The program consultant team presented an overview of other new research facilities and laboratory facility design trends to the Oversight Committee to aid in programming considerations. Facilities presented included the Biomedical Research Building II (University of Pennsylvania), Pediatric/Cancer Research Building (Washington University), Building 50 (NIH), University of Michigan – School of Medicine, Memorial Sloan Kettering Cancer Center, and the Center for Comparative Medicine Expansion (Baylor). This virtual tour helped establish a benchmark of relevant laboratory and vivarium design principals to which the Oversight Committee and campus could refer.

The Oversight Committee reviewed the overall building space plan as well as initial space organization and siting concept options prepared by the consultant team. Three subcommittees were established to consider and define the special program and space requirements. The vivarium subcommittee reviewed the vivarium concept, operational requirements, and the initial space program. An imaging core laboratory subcommittee reviewed imaging core laboratory requirements for the building and recommended a space concept for core imaging. Finally, a building support group reviewed and recommended appropriate building support functions.

Integrating research program requirements with laboratory consultant and design team experience, a ‘rough-order-of-magnitude’ (ROM) program was developed. The ROM includes preliminary space allocations for generic research space, vivarium, core laboratories, research offices, and building support space. The ROM required a building efficiency of 65%, resulting in 260,000 asf of program space.

It was the decision of the RC2 Oversight Committee, wherever feasible, to utilize appropriate RC1 concepts for organizing laboratory, laboratory support and office space on the generic laboratory floors.

Based upon the program and space requirements identified during the program process, a program test-fit stage was completed by the programming consultants for the primary purposes of reviewing general site, infrastructure and life cycle cost requirements, as well as verifying the capital project budget and developing a project schedule.
Upon completion of the campus review process, the program plan will be presented to the University of Colorado Board of Regents and the Colorado Commission on Higher Education for appropriate reviews and approvals.

II. Program Information

A. Description of Program Plan – Purpose of Plan

The primary purpose of this facility program plan is to seek the appropriate approvals from the University of Colorado Board of Regents and the Colorado Commission on Higher Education (CCHE) to:

Allow the University of Colorado Health Sciences Center to proceed with the design and construction of the 400,000 gross square foot Research Complex 2 facility at the Fitzsimons campus. The total project budget will be $205,820,165. Project funding sources include cash funds comprised of debt, gifts and reserves, ICR, and federal funds.

The Research Complex 2 project involves the construction of approximately 400,000 gross square feet of new research space that will be the second research facility to support the UCHSC research effort at Fitzsimons. Included in the Research Complex 2 facility are wet laboratories, core laboratories, lab support space, research office and conference, and vivarium space capable of supporting health sciences research programs. Consistent with the Research Complex 1 facilities, the Research Complex 2 laboratory and support space will be planned and designed to be as generic and general as possible to ensure flexibility in use and the capability for interchange of space and activities among the various research departments.

B. Program Plan Assumptions

In a manner consistent with the campus research vision, the RC2 Oversight Committee has emphasized the need that the new facility be programmed and flexibly designed to accommodate the full spectrum of research programs. The spectrum of UCHSC research extends from basic focused biomedical research through application, applied research and development, and clinical research and investigation.

An essential program plan requirement is that the RC2 must accommodate the various research endeavors and be programmed, designed and constructed in a way that promotes maximum interaction among researchers along a spectrum ranging from studies with humans and human material to the basic molecular studies. The facility needs to take account of this broad spectrum of research endeavors inherent to a progressive medical school campus. A major programming requirement is the creation of an environment for research opportunity that spans the gamut of patient-oriented research, animal research, and work at the cellular, molecular, and sub-molecular levels.

The Initial program assumptions forming the basis for this program plan include:
The Research Complex 2 facility will include wet laboratory, lab support space, related research office and conference space and centralized animal research space capable of supporting biomedical sciences research program activities.

The project scope includes the construction of 400,000 gsf of research laboratory and laboratory support space for the total project budget of $205.8 million.

The program plan will address essential connection and access requirements to the Research Complex 1 facility, the adjacent office facility, and clinical zone of the Fitzsimons site.

The facility will include a central vivarium. The RC2 vivarium will be connected via a tunnel connection to central vivarium located in the basement level of the RC1 facility.

Flexible, modular, generic labs, consistent with the RC1 design, will be programmed in the RC 2. Laboratories will be programmed and designed to accommodate almost any wet biomedical laboratory research program.

Facility programming and design will include necessary materials management and environmental health and safety support requirements.

The Master Plan guidelines relating to building zoning, siting, infrastructure, utilities, and parking will be considered in the programming and design of the RC2.

Laboratory support space will include a linear equipment corridor concept.

Core labs will be included to support the research laboratories (and lab support spaces).

The facility will be programmed and designed to promote integration, collaboration and enhancement of faculty/researcher interactions.

The Research Complex 2 facility will be programmed with a minimum of a 65% efficiency (net to gross) to meet financial goals established in the master plan.
C. Program Needs and Trends

The UCHSC Research Vision

The University of Colorado Health Sciences Center is on the axis of one of the most exciting periods in the history of biomedical science - the breakthroughs of the past twenty years in cell biology, molecular biology, and genetics have transformed what we know about the mechanisms of disease and how to develop tools to attack them. The next decade promises to surpass this knowledge in ways that are practically unimaginable - every field of medicine and health care will be altered. With the development of the new research facilities at Fitzsimons, the UCHSC will be poised to undertake an agenda of the greatest importance to the University of Colorado’s future; it will assure that the University is a vital part of the progress of scientific discovery and training, with the potential of influencing the course of American science, medicine, and health care for decades.

The promise of science urges the UCHSC forward. Never before has there been greater opportunity to apply the knowledge discovered in the basic science laboratory to the practice of medicine, for the patient's benefit. The primary campus objective is to create a world-class health science center at Fitzsimons where tomorrow's scientific discoveries are translated into leading edge care, where collaboration flourishes across disciplines, and where all the resources required for extraordinary, humanistic research, education, and care are seamlessly integrated.

The physical proximity and integral working relationships among and between scientists and clinicians at Fitzsimons foster new levels of collaboration and integration. The expanding partnerships among faculty, students, staff, affiliates, and the community will continue to foster the development of new knowledge, and this knowledge will be applied to the prevention and treatment of human disease and to the improvement of human health. The institution will also create partnerships among faculty, students, and consumers in offering the highest quality of health care, and providing access for citizens to the latest scientific findings concerning the promotion of health and the treatment of disease.

Research and discovery are what make a major regional academic health science center such as the UCHSC unique. Basic research findings discovered in the laboratory are often translated into clinical trials. These trials lead researchers to new techniques and procedures that can be used directly to the benefit of patients. During the past 50 years, the UCHSC has emerged as a center for health-related research. In many fields, the UCHSC has earned a national and international reputation. It is essential that the UCHSC continue to expand and develop new partnerships with industry and biotechnology. A crucial component to the UCHSC vision of research in the future is the substantial interaction with and development of biotechnology and durable relationships with industry. Scientific advances on the campus are increasing at an exponential rate. Translation of these discoveries to the improvement of human health will require sophisticated and substantial resources with capacities and intellectual resources that differ from those in a biomedical research laboratory. Biotechnology transfer is the medium for this activity. UCHSC must have accessible and responsive biotechnology transfer capabilities. For this to occur, UCHSC will commit itself to the development of substantial partnerships with industry and
biotechnology. The vision is that Colorado is advantageously positioned to develop these relationships. The goal will be to translate scientific discoveries to human biology and the development of substantial resources to be recycled into the process of discovery. The future vision is that the UCHSC research enterprise plans for an innovative transition from an isolated "island of excellence" to an "umbrella organization of superior science" serving with and for all its alliances and constituencies.

As part of the master plan process completed in 1998, a core vision team representing research programs from the entire institution was engaged to develop a program vision statement for the year 2020. These vision statements have guided the development of the current master plan and this program plan. As articulated by the 2020 Research Vision Team, the vision foresees a research enterprise at the UCHSC that is:

- Larger, stronger, and better
- Highly interdependent, collaborative, and multidisciplinary
- Developing and utilizing new technologies
- Having even stronger federally funded grant support
- Expanding partnerships with industry and biotechnology
- Involving stronger support, and endowments

The UCHSC will continue to aspire to the high standards that have propelled the campus forward from its earliest beginnings. The campus will increasingly place emphasis on multidisciplinary programs, consolidating, integrating, eliminating duplication, and building on strengths to address the teaching, research, and clinical care needs of the future. In these endeavors, the UCHSC will continue to achieve excellence and outstanding accomplishments.
Overview of UCHSC Program Research

School of Medicine

As indicated in the UCHSC Sponsored Programs Annual Report for FY 2002, the School of Medicine is the major health research base in Colorado, attracting millions of dollars ($252 million) in research and training grants annually to advance knowledge of biomedical sciences through basic and applied research. Each School of Medicine department conducts research to expand knowledge about the intricacies of the human body. Some of this research is interdisciplinary in that it is a cooperative effort with other departments or with affiliated institutions on campus.

Major research programs at the school include those in basic sciences, molecular biology, neuroscience, and genetics. Clinical research areas include cancer, heart disease, AIDS, diabetes, and pulmonary diseases. The school has pioneered in transplantation and recognition of child abuse and neglect as an entity, as well as research in alternative forms of health professional education. Adult and Pediatric Clinical Research Centers have been continuously funded by the National Institutes of Health for more than three decades, and research programs in Native American mental health and alcohol and substance abuse have developed national and international reputations.

The School of Medicine receives significant research funds through grants and contracts. Nationally, during year 2002, the school ranked 20th out of 122 medical schools in total NIH awards.

School of Dentistry

The School of Dentistry is committed to the advancement of knowledge through research in the health sciences. Research is an integral component of the school’s programs and the research program continues to grow. During the 2002 fiscal year, the School of Dentistry received approximately $5.2 million in sponsored research grants and awards.

Funds for research have come from federal, state and private sources. Dentistry research is focused on both basic science and applied areas of research that address issues related to dental science, oral health and disease, and craniofacial biology. Areas of research include these broad areas: Developmental biology of the craniofacial region, cell and molecular biology of the oral facial tissues, oral pathology, neoplastic development, neuroscience which includes neuropathic and dental pain, development of polymers and other dental material science, and clinical dental research.

School of Nursing

The School of Nursing is committed to the advancement of knowledge through research in the health sciences. The school is successful in seeking extramural funding. During the 2002 fiscal year, the School of Nursing received approximately $6.3 million in sponsored research grants and awards.
Research in the School of Nursing is directed toward improving the health of individuals, groups, and communities. This research focuses on the development of new nursing knowledge and on the improvement of nursing practice. The School of Nursing has earned a national reputation for theory-based research, particularly in the areas of pain, rural health, migrant health, and pediatric nursing. For the future, the school is advancing the development of additional research strengths in informatics, cost and quality outcomes, and nursing’s role in environmental health.

School of Pharmacy

The School of Pharmacy has a strong tradition of research in the pharmaceutical sciences and consistently ranks in the top ten schools of pharmacy nationally for total NIH funding and NIH funding per faculty member. During the 2002 fiscal year, the School of Pharmacy received approximately $13.3 million in sponsored research grants and awards.

The current research activities in the School of Pharmacy are diverse in nature, reflecting the interests of faculty members in numerous disciplines including pharmacology, toxicology, medicinal chemistry, biochemistry, cancer biology, drug formulation, stability and delivery; pharmacokinetics, new drug development, pharmacy administration, pharmacoconomics, and the improved delivery of pharmaceutical care. The three principal areas of programmatic emphasis are pharmaceutical biotechnology, molecular toxicology and environmental health and pharmacoconomics. These activities are consistent with the stated goals and objectives of the school and support its mission of education, research, patient care and service.

Interdisciplinary Programs and Centers

During the past 25 years, many interdisciplinary programs have been developed which have achieved national prominence. Questions of human biology and human disease are becoming more complex and require faculty from many disciplines to join together to solve problems. Already the programs in molecular biology, neurosciences, and cancer research bring together specialists in all fields of biology and medicine. There are currently over 30 centers of excellence on the campus, bringing together groups of scientists and clinicians to focus on specific diseases such as diabetes, alcoholism, schizophrenia, and Parkinsonism, as well as more comprehensive problems like the genetic causes of cancer. In the future, such collaborative efforts must be enhanced because a single investigator will be unable to competently use all approaches needed to move a research domain forward. Scientific interdependency and collaboration will increase substantially in the Research Complex 1 and 2 facilities at Fitzsimons.

Animal Resource Center

The Animal Resource Center is a research service facility for procuring and maintaining animals for experimentation and for providing surgical facilities and consultation on matters relating to animal usage for research. Approximately 40% of all research funding at the UCHSC involves the use of animals, a fact that underscores the critical importance of maintaining the central facility at the current campus and developing new first-class animal facilities at the Fitzsimons site. The Animal Resource Center is located in 21,000 square feet on the 5th floor of the School
of Medicine. In addition there are several satellite facilities with a total of approximately 11,000 square feet located in the Webb Waring Institute, Barbara Davis Center, CPH Primate Laboratory, Perinatal Research Facility at Fitzsimons and several departmental rooms. At Fitzsimons, new centralized animal facilities are being constructed within the Research Complex 1 facilities with complementary facilities for the Research Complex 2.
The Research Complex 2 Tentative Program Occupants

The RC2 project involves the new construction of approximately 400,000 gross square feet of wet laboratory, laboratory support, and vivarium space to house UCHSC research programs. The RC2 facility is being planned to include flexible, modular, generic labs, consistent with the RC1 design, and as a result will be able to accommodate almost any wet biomedical laboratory research program.

It is important to note that the formal campus space allocation process to assign space within the RC2 facility will not be initiated until next year, after the anticipated date of CCHE program plan approval. Tentative program occupants will include the remaining wet research programs of those departments, programs, and related core laboratories within the School of Medicine not occupying space in the RC1. The RC2 facility may also house wet research programs from the Schools of Pharmacy and Dentistry, and space for vivarium expansion if the budget allows.

For the purposes of this program plan, the wet laboratory research and core research programs from the following schools and departments will be considered as the tentative occupants of the RC2 facility.

- School of Medicine
  - Department of Anesthesiology
  - Department of Immunology
  - Department of Medicine
    - Allergy and Clinical Immunology
    - Cardiology
    - Clinical Pharmacology and Toxicology
    - Gastroenterology and Hepatology
    - Geriatrics
    - Hematology
    - Infectious Diseases
    - Pulmonary
    - Renal Diseases/Hypertension
    - Rheumatology
  - Department of Neurology
  - Department of Neurosurgery
  - Department of Obstetrics and Gynecology
  - Department of Otolaryngology
  - Department of Pediatrics
  - Department of Radiology
  - Department of Surgery

- School of Dentistry
- School of Pharmacy
- Animal Resources
Trends – UCHSC Sponsored Program Growth

Sponsored project activity at the Health Sciences Center continues to grow. In FY 2002, total awards reached close to $300 million. At the end of FY 2002, total expenditures for the Restricted Fund totaled approximately $256 million. The restricted fund includes sponsored programs, gifts, and student aid. Total expenditures increased by more than 17% over FY 2001. Sponsored program expenditures exceeded $233 million and were more than 91% of total Restricted Fund expenditures. For sponsored program expenditures, this was an increase of almost 20% over the prior fiscal year and an increase of almost 64% over the expenditure level in FY 1997.

During FY 2002, over 2,220 proposals were submitted to obtain sponsored program funding for the UCHSC. Total funding requests equaled $467.1 million, almost twice as much as requested five years ago.

The total number of awards for sponsored programs received during FY 2002 was 1,444 for a total of $295 million. This was approximately $34.5 million greater than the prior year’s awards - a 13.3 percent increase over last year.
Awards by Funding Source

During FY 2002, approximately 70% of the total awards were received from the Federal Government. Over 93% of the federal dollars were from the Department of Health and Human Services (DHHS) with over 83% of the DHHS awards from the National Institutes of Health (NIH). Over 80% of the NIH funding is distributed among the nine institutes with the highest level of funding from the National Institute of Diabetes and Digestive and Kidney Diseases. The industry awards for FY 2002 amounted to $31.5 million, a 75% increase over FY 2001.

A summary of FY2002 awards by funding source is provided in the following table.

| UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER | AWARDS BY SPONSOR |
| FY 2002 | | |
| | Number of Awards | of Direct Costs | Facilities and Administrative Costs | Total Costs | Percent |
| Federal | | | | | |
| Department of Health and Human Services (DHS) | | | | | |
| National Institutes of Health | 494 | $118,980,000 | $39,690,000 | $158,670,000 | 54 |
| Other | 67 | $39,000,000 | $3,430,000 | $42,430,000 | 11 |
| Total DHHS | 561 | $147,980,000 | $43,120,000 | $191,100,000 | 65 |
| Federal Other Than DHHS | | | | | |
| Department of Defense | 12 | $1,980,000 | $830,000 | $2,810,000 | 1 |
| Department of Education | 8 | $2,010,000 | $230,000 | $2,240,000 | 11 |
| Department of Interior | 3 | $2,780,000 | $10,000 | $2,790,000 | 1 |
| National Science Foundation | 11 | $1,240,000 | $470,000 | $1,710,000 | 1 |
| Veterans Administration | 27 | $2,860,000 | $0 | $2,860,000 | 1 |
| Other Federal | 3 | $960,000 | $160,000 | $1,120,000 | 0 |
| Total Non-DHHS | 64 | $11,830,000 | $1,700,000 | $13,530,000 | 5 |
| Total Federal | 625 | $159,810,000 | $44,820,000 | $204,630,000 | 69 |
| Non-Federal | | | | | |
| Associations and Foundations | 213 | $20,170,000 | $3,270,000 | $23,440,000 | 8 |
| Hospitals & Universities | 151 | $9,300,000 | $2,310,000 | $11,610,000 | 4 |
| Industry | 271 | $26,420,000 | $5,060,000 | $31,480,000 | 11 |
| International | 8 | $430,000 | $60,000 | $490,000 | 0 |
| State/Local Government | 176 | $20,820,000 | $2,160,000 | $22,980,000 | 8 |
| Total Non--Federal | 819 | $77,140,000 | $12,860,000 | $90,000,000 | 31 |
| Grand Total | 1,444 | $236,950,000 | $57,680,000 | $294,630,000 | 100 |
Awards by Organization

As indicated in the FY 2002 Annual Report of Sponsored Programs and Restricted Fund Activity, the School of Medicine had the most significant dollar increase in awards over the prior fiscal year (FY 2001 and 2002) of $25.3 million and in expenditures of $28.1 million. The Schools of Dentistry, Nursing and Pharmacy had significant percentage increases in both awards and expenditures over the prior fiscal year. Over the prior year, awards for the School of Dentistry increased by +46% and expenditures by +208%. Awards for the School of Nursing increased by +31% and expenditures by +47%. During this same time period, the awards for the School of Pharmacy increased by +52% and expenditures by +77%.

A summary of awards by organizational unit for FY 2002 is provided in the following table.

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
AWARDS BY ORGANIZATIONAL UNIT
FISCAL YEAR 2002

<table>
<thead>
<tr>
<th>Organizational Unit</th>
<th>Direct Costs</th>
<th>Indirect Costs</th>
<th>Total Costs</th>
</tr>
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<tbody>
<tr>
<td>School of Medicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicine</td>
<td>$47,050,000</td>
<td>$13,080,000</td>
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<td>Psychiatry</td>
<td>$37,660,000</td>
<td>$5,470,000</td>
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<td>Pediatrics</td>
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<td>$6,380,000</td>
<td>$33,730,000</td>
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<td>Barbara Davis Center</td>
<td>$10,360,000</td>
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<td>$14,070,000</td>
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<td>Pharmacology</td>
<td>$9,100,000</td>
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<td>$12,700,000</td>
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<td>Dean</td>
<td>$11,810,000</td>
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<td>$12,600,000</td>
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<td>Preventive Medicine</td>
<td>$7,470,000</td>
<td>$2,470,000</td>
<td>$9,940,000</td>
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<tr>
<td>Cellular &amp; Structural Biology</td>
<td>$7,130,000</td>
<td>$2,750,000</td>
<td>$9,880,000</td>
</tr>
<tr>
<td>Cancer Center</td>
<td>$6,730,000</td>
<td>$2,680,000</td>
<td>$9,410,000</td>
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<td>Pathology</td>
<td>$3,740,000</td>
<td>$1,690,000</td>
<td>$5,430,000</td>
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<tr>
<td>Biochemistry/Biophysics/Genetics</td>
<td>$3,560,000</td>
<td>$1,520,000</td>
<td>$5,080,000</td>
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<td>Physiology</td>
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<td>Microbiology</td>
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<td>Obstetrics/Gynecology</td>
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<td>$360,000</td>
<td>$1,720,000</td>
</tr>
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</tr>
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<td>Dermatology</td>
<td>$1,070,000</td>
<td>$290,000</td>
<td>$1,360,000</td>
</tr>
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<td>Other</td>
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<td>$690,000</td>
<td>$4,630,000</td>
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<td>SCHOOL OF NURSING</td>
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<td>SCHOOL OF PHARMACY</td>
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<td>$2,720,000</td>
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<td>$236,950,000</td>
<td>$57,680,000</td>
<td>$294,630,000</td>
</tr>
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</table>
D. Relationship to Academic or Institutional Strategic Plans

This program plan is consistent with the current institutional master plan and the clinical care, research, education, and community service missions of the University of Colorado Health Sciences Center. Specific UCHSC institutional planning, policies and facility program plans that relate to the project include:


The University of Colorado Board of Regents approved the annual supplements to the 1998 Institutional Master Plan in September 1999, August 2000, December 2001, and November 2002. The Colorado Commission on Higher Education approved the Year 2002 Supplements in February 2003. The Research Complex 2 project is consistent with the UCHSC’s mission as outlined in these Master Plan Supplements. The Health Sciences Center strives to “improve human health” through the advancement of knowledge through research in the health sciences; the education of health professions; and the delivery of both health care and community services. An international reputation for excellence in research, teaching, and clinical care has been achieved by the UCHSC in fulfilling this mission. The UCHSC currently ranks in the top 20 among academic research institutions in the country in terms of extramural funding. During the past 11 years, funding for UCHSC’s sponsored programs has more than tripled - from $89.1 million in FY 1991 to $294.6 million in FY 2002.

2. Institutional Master Plan (September 1998)

The institutional master plan for the University of Colorado Health Sciences Center, approved by the University of Colorado Board of Regents in October 1998 and the CCHE in December 1998, involves the development of a new campus at Fitzsimons to be developed as a replacement to 9th Avenue campus located in east Denver. The Fitzsimons campus development involves the construction of approximately nine million square feet of new program space and associated infrastructure for the Health Sciences Center, University of Colorado Hospital, and affiliates. The Research Complex 2 project is consistent with the research mission of the UCHSC.


The application for the public conveyance of 186 acres of land and properties at the U.S. Army Garrison, Fitzsimons, was approved by the Board of Regents and submitted in August 1997 to the U.S. Department of Education. The conveyance application was approved by the U.S. Department of Education in September 1997. The Research Complex 2 project is consistent with the assumptions and guidelines of this conveyance.

E. Relation to Other Programs or Agencies

The campus is pursuing federal grant funding to assist in the partial construction and equipping of the Research Complex 2 facility. Tentative federal granting agencies may include HRSA, NIH, NCRR, and NCI. The UCHSC assures and certifies that the institution will comply with all federal grant requirements including design and operational safety requirements for the new facility.
F. Existing Programmatic/ Operational Deficiencies

Both the future of the research enterprise of the UCHSC at Fitzsimons and the growth of campus basic science, clinical research and translational research programs depend upon the availability of new research space at Fitzsimons. The space made available in the new Research Complex 2 is necessary to house the research programs of the School of Medicine transitioning to the Fitzsimons site. Without the completed research space, the School of Medicine research program will be split between the Ninth Ave. and Colorado Blvd. and Fitzsimons campus sites. This will result in a divided research program, negatively impacting research mission of the School of Medicine and the UCHSC.

The UCHSC’s Master Plan provides a guide for the expedited and efficient relocation of the research programs from the campus site at Colorado Boulevard and Ninth Avenue to Fitzsimons. In a manner consistent with the direction of the Colorado Commission on Higher Education and the University of Colorado Board of Regents, the Fitzsimmons master plan strategy includes the following goals and requirements: 1) to reduce the total cost of the total development by accelerating the transition to the Fitzsimons campus, however possible; 2) to realize the economic impact of the Fitzsimons development sooner; and, 3) to develop an efficient plan to vacate the 9th Avenue campus. As a result, any delay in the construction of the Research Complex 2 will result in the continued operation of a split campus and the continuing need to operationally support research programs residing on both campus sites.

G. Program Alternatives

Alternatives to the construction of the Research Complex 2 facility at Fitzsimons include: (1) Continue to utilize and renovate all available space at the existing 9th and Colorado Blvd. to house campus research programs. (2) Lease off-campus space in FRA research facilities for campus research programs. Neither of these alternatives allows the campus to meet its research program objectives.

Continue Reuse of the Existing Ninth Avenue Facilities for Research Programs
As previously mentioned, this approach would result in a divided research program negatively impacting the research missions and operations of School of Medicine and UCHSC. An essential planning assumption is that all School of Medicine research programs be relocated to Fitzsimons with the completion of the Research Complex 2 and academic office facilities, and that all campus research programs will be relocated to the Fitzsimons facility at the end of the Research Complex 3 construction.

Lease of Space
This alternative would also result in an inefficient split research program between researchers in the new Research Complex 2 and the FRA leased facilities resulting in redundant laboratory support, core laboratory and vivarium requirements.

The primary campus master plan objective is to create a world-class health science center at Fitzsimons where scientific discoveries are translated into leading edge education and patient care, where collaboration flourishes across disciplines, and where all the resources required for extraordinary, humanistic research, education, and care are seamlessly integrated. The Research Complex 2 is an essential element in this plan.
III. Research Space Requirements

A. Projected Research Space Need – Year 2008

As indicated earlier, the total campus sponsored program award funding has increased from a total of $120.4 million in FY 93 to $294.6 million in FY 02. This represents an average annual increase of approximately 16% over the last 9-year period.

Based on the status of the national economy, the campus master plan research space projection for the Year 2008 includes a total requirement of 890,000 assignable square feet (1.37 million gross square feet) of research space. This projection reflects a conservative annual rate of growth in total campus sponsored awards between FY2003 and FY2008 of 7%.

As indicated in the following table, the current year total campus research space inventory is 559,241 asf. The master plan total projection of 890,000 asf of total research space represents a +56% total increase in wet and dry laboratory, laboratory support, and research office requirements. The projection also includes a total increase in centralized vivarium space of +126%.

<table>
<thead>
<tr>
<th>University of Colorado Health Sciences Center</th>
<th>Master Plan Research Space Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary by Major Space Type</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research</th>
<th>Wet Laboratory/Laboratory Support</th>
<th>Research Office (Dry)</th>
<th>Vivarium</th>
<th>Total Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current UCHSC Space Inventory - Year 2003</td>
<td>ASF: 344,800</td>
<td>185,662</td>
<td>28,779</td>
<td>559,241</td>
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<td></td>
<td>GSF: 530,462</td>
<td>285,633</td>
<td>44,275</td>
<td>860,370</td>
</tr>
<tr>
<td>Master Plan Space Projection - Yr 2008</td>
<td>ASF: 536,250</td>
<td>288,750</td>
<td>65,000</td>
<td>890,000</td>
</tr>
<tr>
<td></td>
<td>GSF: 825,000</td>
<td>444,231</td>
<td>100,000</td>
<td>1,369,231</td>
</tr>
<tr>
<td>Increase ASF</td>
<td>+191,450</td>
<td>+103,088</td>
<td>+36,221</td>
<td>+330,759</td>
</tr>
<tr>
<td>Increase GSF</td>
<td>+294,538</td>
<td>+158,598</td>
<td>+55,725</td>
<td>+508,861</td>
</tr>
<tr>
<td>% Growth Total - 5 Year</td>
<td>56%</td>
<td>56%</td>
<td>126%</td>
<td>59%</td>
</tr>
</tbody>
</table>
Other master planning assumptions pertinent to the Research 2 programming include the following:

- The calculation of research space is based on an actual research productivity allocation methodology that assumes wet research laboratory space will be allocated at $400/asf and dry laboratory at $800/asf in year 2008.
- The master plan uses a ratio of 65/35, wet research & lab support to dry research & office in its research space projections.
- This same wet-dry average was utilized to estimate the dry lab/research office space inventory for the current year 2003.
- Vivarium space is included in the research space total.
- The 1,369,231 gsf research space requirement will be accommodated by the construction of the Research Complex 1 (600,000 gsf), the Research Complex 2 (400,000 gsf), and the future Research Complex 3 (400,000 gsf).
- The UCHSC will retain the use of the Biomedical Research Building and School of Pharmacy Building at 9th Ave until the Research 3 facility is constructed at Fitzsimons.

B. Space Requirements for the Research Complex 2

University of Colorado Health Science Center proposes to construct 400,000 gross square feet (260,000 net assignable square feet) of new research space. This is the second major project toward the development of the new research complex at Fitzsimons. Included in the Research Complex 2 facilities will be research laboratories, lab support space, related research office and conference, animal research space, and building support space.

Research Complex 2 facility is planned to meet eight key objectives:

- Basic, Clinical & Translational Research (70% Lab / 30% Office)
- “Open” Laboratories
- Wet/ Dry Relationship
- Horizontal & Vertical Integration / Interaction
- Core Labs (both centrally located and distributed)
- Vivarium (Rodents & NHP)
- NIH Funding
- Homeland Security
1. Space Program

A summary of the Research Complex 2 space program developed during the detail program planning process is presented below.

Summary Space Program

<table>
<thead>
<tr>
<th></th>
<th>Bldg. nasf</th>
<th>Breakdown</th>
<th>% of Total</th>
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</thead>
<tbody>
<tr>
<td><strong>Research</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lab Module (21x28.5) Subtotal</td>
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<td>40%</td>
<td></td>
</tr>
<tr>
<td>Lab Support Subtotal</td>
<td>66,000</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Office/Amenity Subtotal</td>
<td>65,400</td>
<td>30%</td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>219,000</td>
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<td>84%</td>
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<tr>
<td><strong>Core Lab</strong></td>
<td>9,700</td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td><strong>Vivarium</strong></td>
<td>23,800</td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td>Animal Research Lab Subtotal</td>
<td>15,800</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>Procedure/Lab Subtotal</td>
<td>3,520</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Animal Support Subtotal</td>
<td>2,800</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Office/Amenity Subtotal</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>15,800</td>
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<td>66%</td>
</tr>
<tr>
<td><strong>Building Amenities</strong></td>
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<td>2%</td>
</tr>
<tr>
<td><strong>Building Support</strong></td>
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<td>1%</td>
</tr>
<tr>
<td><strong>Program ASF Total</strong></td>
<td>260,000</td>
<td></td>
<td>100%</td>
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</tbody>
</table>

**Building GSF:** 400,000
Building Efficiency Range: 0.62 - 0.68%
Assignable area to gross area
Assumed Building Efficiency: 0.65
Program ASF Target (GSF x Bldg Eff): 260,000
### Detailed Space Program

<table>
<thead>
<tr>
<th>Detailed Space Description</th>
<th>Unit</th>
<th># of Units</th>
<th>Sub Total</th>
<th>Sub Total</th>
<th>Total</th>
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<td></td>
<td>ASF</td>
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<td>ASF</td>
<td>ASF</td>
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<tr>
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<td>Linear Equipment Room</td>
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<td>800</td>
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<td><strong>Lab Support Subtotal</strong></td>
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<td>Admin Support</td>
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<tr>
<td><strong>Research Subtotal</strong></td>
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<tr>
<td><strong>Core Lab</strong></td>
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<td><strong>Research Imaging Facility</strong></td>
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<td>300 &amp; 500 mHz NMR</td>
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<td>Feed/Bedding Storage</td>
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<td>50</td>
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<td>Pharmacy</td>
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<td>300</td>
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<td>Scientific Director Office</td>
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<td>Storage Rm</td>
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<td>600</td>
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<td># of Units</td>
<td>Sub Total ASF</td>
<td>Sub Total ASF</td>
<td>Total ASF</td>
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<td>----------</td>
<td>------------</td>
<td>---------------</td>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Vivarium</strong></td>
<td></td>
<td></td>
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<tr>
<td>Animal Research Lab (16x22)</td>
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2. Space Concepts and Guidelines

a. The Laboratory Concept

The laboratory must accommodate a range of activities, as well as programs varying widely in size. The ebb and flow of research funding and the ever changing demands of research equipment and protocols necessitate a flexible environment. In accordance with the 2020 Vision Statements, the research laboratory must be adaptable to this range of programs, must provide for a highly interactive environment, and yet be respectful of the needs of individual research. Additionally, the laboratories must be adaptable over time, easily accommodating shifts in types of activity and density of personnel while minimizing remodeling costs associated with these programmatic adjustments.

The physical characteristics of the research laboratory and its basic module are established in response to these objectives. The laboratories will be organized around modular planning principles, constructed in standardized units of common size. Modular planning is used as an organizational tool to allocate space within the building. The module is developed around an investigation of activities and equipment in the lab.

The appropriate size and locations of laboratory desks, laboratory benches, sinks, fume hoods, freestanding equipment, circulation aisles and other related amenities is an outgrowth of this investigation. The module establishes a grid by which walls and partitions are located. As modifications are required because of changes in laboratory use, instrumentation, or departmental organization, partitions can be relocated, doors moved, and laboratories expanded into larger or contracted into smaller laboratory units without requiring reconstruction of structural or mechanical building elements.

Wherever possible, the planning modules are combined to produce large, open laboratories. Where required by special security or environmental needs, the modules may be separated by walls to produce small instrument or special-use laboratories.

The description of the planning module also includes the organized and systematic delivery of laboratory piped services, HVAC, fume hood exhaust ducts, power and data cables. If these services are delivered to each laboratory unit in a consistent manner, future changes in laboratory use requiring addition or deletion of services will be easily to accomplish because of the regular nature of the infrastructure and with a minimum of disruption to adjacent labs.

The wet laboratory zone of a typical floor consists of movable desk stations, movable laboratory benches, special procedure alcoves, a Linear Equipment Room, offices and office support. The concept of movable and adjustable work stations, both lab benches and desks, is developed to accommodate changes in the number of personnel using the space, as well as functional change in research requirements. The special procedure alcoves are enclosed or partially enclosed work and equipment spaces within the open lab environment intended to accommodate those functions, which by their nature may require
some form of containment or segregation. Alcoves will typically accommodate primary free-standing equipment, fume hoods, tissue culture procedures and microscopy work.

b. Laboratory Module Guidelines

The proposed laboratory planning module (as illustrated below) was derived by analyzing the laboratory bench, equipment, and circulation space required for the building’s functions. The module is based upon the bench space (width and length) required for technician workstations, instruments, and procedures. The space required between benches is designed to allow people to work back-to-back at adjacent benches, to allow accessibility for the disabled and to allow movement of people and laboratory carts in the aisle.

![Laboratory Module Diagram]

**Laboratory Module Size**

The laboratory module is based upon a 10’-6” on-center width dimension. The depth of the laboratory module is approximately 36’-0”, based upon workspace and circulation requirements, summarized as follows:

- Desk zone: 8’-0” deep, based on two desks at 4’-0” each.
- Bench zone: 12’-0” deep consisting of two 6’-0” movable tables.
- Sink/equipment zone: 2.5’ wide.
- Transverse aisle: 4’-0” wide.
- Alcove zone: 9.5’ deep (considered laboratory support).

The lab module is based upon the concept of 6 - 8 workstations/persons per double module, or lab unit. Each double module, not including alcoves, is 600 asf, thereby allowing 100 asf of lab space for 6 people or 75 asf for 8 people.
Desk Location
Six to eight desks are located perpendicular to the exterior wall/windows in the lowest traffic zone within the laboratory. Researchers sit back to back, have direct access to natural light and view and are located proximate to their designated workspace. In this configuration, benches can provide one or two desk stations per bench. The intermittent benches can have one desk per bench, separated from the bench by an aisle connecting the module. By utilizing a movable, adjustable desk system, desks may be removed or added to the module resulting in the capability to provide from six to eight desk stations per module. Desk surfaces are also designed to be utilized for laboratory work.

Laboratory Bench
The laboratory bench zone consists of two 6’-0” long, adjustable height/movable tables. Based upon the average of 6 (or 8) researchers per double module, each researcher will have an average of 8 (or 6) linear feet of bench. Each bench includes drawers and shelving, and is served by typical laboratory services, except water, supplied from an umbilical at the end of the row of tables.

This movable table system offers the opportunity both to relocate tables as well as to alter their height. The adjustable height feature permits individual researchers to customize their lab space to standing or sitting requirements without altering the laboratory prototypical organization. The ability to relocate benches permits the laboratory module to respond to changing relationships of work surface and equipment requirements which provides for a great deal of latitude in the utilization of work surfaces for wet or dry type activities.

Sink and Equipment Zone
In order to maximize the flexibility of the laboratory bench zone, laboratory sinks are located on the transverse aisle adjacent to the laboratory benches. Locating the sinks along the interconnect aisle helps to centralize fixed drain connections within a minimum area, within the laboratory.

Interconnect Aisle
The traditional interconnect aisle is usually 5’-0” wide assuming a parallel equipment zone. When opening equipment with large hinged doors, this aisle would be restricted by the depth of the door swing and the researcher. By employing the alcove concept, such equipment will be placed in alcoves (or a linear equipment room). With the elimination of this potential obstruction, the transverse aisle can be reduced to 4’-0” in width.

Linear Equipment Room
Today’s research tends to be equipment intensive. Much of the equipment, like refrigerators, freezers and centrifuges, is large, noisy and/or heat producing. By removing this equipment to a readily accessible space near, but outside, the open lab, valuable research space is made available for benchtop work and the open lab environment becomes quieter and more comfortable. The linear equipment room (LER) is the name given to this removed, but accessible space. It is typically a minimum of 11 feet wide and runs the length of the building. The 11 foot width provides adequate space for large
equipment on either side of a 5 foot wide circulation space. The LER is located between the laboratory and laboratory support zone. Thus the LER combines the functions of general circulation, service corridor and accessible equipment housing. When combined with a clustering of office functions separate from the lab zone, the LER increases the potential for higher floor plate efficiencies (+/-75%) while segregating public and laboratory circulation patterns, thus enhancing both safety and security.

c. **Laboratory Support Space**

The ratio of lab to laboratory support has been steadily increasing over the years. Whereas 20% to 25% was common in the 1980’s, and 45% to 50% was common in the early 1990’s, the projected ratio for biomedical research is 65% - 70%. The following are some of the more common functions that occur in these lab support spaces.

**Alcove**

Laboratory alcoves serve a variety of functions either as a component of the laboratory or as a support element for dedicated or shared use within the laboratory. The following are some common alcove uses.

- Entry alcoves provide access to the laboratories from the common circulation areas or equipment rooms. These alcoves will typically contain storage cabinets for lab supplies as well as safety and other equipment.

- Fume hood alcoves used in direct support of laboratory space will include a 5’-0” fume hood, adjacent preparation bench space and space for tables or equipment. The fume hood shall be located remote from the transverse aisle to ensure that airflow at the face of the hood is not disturbed.

- Special procedure room alcoves may be used in a variety of ways. The alcoves may be open in direct support of laboratories and be utilized for related functions such as electrophoresis. Alternatively, the alcove can be used to create small, separate rooms that can house special controlled environments such as tissue culture or microscopy (light control).

- The alcoves offer the potential to vary the ratio of lab and lab support space. The alcove entrances may be turned toward the Linear Equipment Room to create additional shared support space.

**Environmental Room**

For experiments requiring controlled environmental conditions and storage of materials/specimens that require a controlled environment. Range is typically controllable from 4 deg C to 37 deg C. Humidity is controlled only where specifically required, due to the substantial cost of humidity control.

(i) **Glasswash/Autoclave Room**
(ii) Facility to handle cleaning and sanitizing of glassware and other materials used by the researchers.

Dark Room
Various types of light controlled environments are required. The darkrooms can be light tight, light controlled spaces capable of accommodating a variety of wet or dry functions. These may include fluorescence microscopy, confocal microscopy, x-ray processing, photographic processing, and in-situ hybridizations. The use of wet, photographic darkrooms is rapidly declining with the advent of digital imaging. The oversight committee has determined that wet, photographic darkrooms would be a specific program tenant fit-out issue.

Equipment Room
An equipment room is used to free up lab bench space, by locating noisy, heat producing, or intermittently used equipment/items in a separate room. The equipment can be shared by more than one lab to reduce purchase of multiple items. This room can also provide access to other support spaces without having to traverse a corridor.

Procedure Room
Procedure rooms are capable of various research support functions commonly required by the disciplines. These may include such activities as tissue culture or special instrumentation requirements. They may also include various special environments such as plant growth rooms and drosophila rooms. Because of the undetermined final use of these spaces, a minimum of built-in furnishings and services are provided.

d. Wet and Dry Relationship

Translational research, bringing basic science discoveries to clinical application or translating clinical observations into basic science research, is characterized by interdisciplinary efforts. This process brings together basic science researchers from the wet bench environment and computational researchers from the dry lab/office environment. The overall layout of the laboratory floor and the proximity and availability of these two types of research space to one another are important factors in enhancing the translational environment.

e. Office/Amenity Space Concepts

Offices are based upon a repeatable 120 asf module. One private office shall be provided for each principal investigator and others as identified.

Conference/Library
Conference Rooms will be provided on each floor comfortably accommodating a group of 30 (around a table) or 40 (classroom style) persons for lab team meetings, faculty meetings and small group seminars. The rooms may be subdividable by means of a
retractable wall to permit use by a smaller group. This space may also be used as a library.

**Break/Pantry**
This space is intended to serve the researchers for breaks, lunch and other casual interactions, but may also serve as a small group meeting area. May be two separate spaces or a single space depending on the configuration of the floor.

**Copy-Mail Room**
A location on each floor to accommodate requirements for copying, faxing, mail distribution, assembling reports and other similar activities in support of administrative requirements. The space will be located to limit disruption to other activities on the floor, yet it must be accessible to research staff at all times. This room shall include a photocopy machine, fax machine, mail slots for floor residents, ample counter space for sorting materials, and storage space below and above the counter for supplies.

**Administrative/Secretarial**
Multiple secretarial workstations per floor shall be provided. It may be desirable to co-locate these work areas in order to provide for continuous coverage and centralization of the required activities. The secretarial area may be a closed space or part of an open office environment.

**f. Core Laboratory Space**
A number of “core” or centralized laboratory functions were identified to support the overall research community. They may be located on the lab floor in lab or lab support space (eg. PCR, Flow Cytometry, DNA Array) or in a remote location if technical requirements mandate (eg. BSL3, Research Imaging).

**BSL3 Suite**
A BSL3 suite is required to support general isolation work and in particular for ongoing work with Tuberculosis. In light of current work ongoing at the Centers for Disease Control (CDC) it was recommended that the suite be a BSL3+ configuration. The program recommendation is for a consolidated BSL3 suite combining both functions and comprised of multiple isolated workrooms, each housing a biosafety cabinet. The BSL3+ area will be supported with an air shower and a pass through autoclave. Special attention must be paid in designing the suite’s mechanical system to assure compliance to the CDC/NIH and UCHSC guidelines.

**Research Imaging Center**
A major core within RC2 is the Imaging Center, which will house an imaging program focusing on basic, translational and clinical research involving the use of ionizing and non-ionizing radiation in the diagnosis, early-detection, molecular imaging, staging, and treatment of various diseases including cancer.
The technical requirements, spatial arrangements and potential for shielding make the location of this center a critical issue. Much of this space is devoted to imaging facilities and other resources that are widely subscribed to by clinical research, including Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) scanning facilities. This facility is multi-use, multi-user and is an important resource for the campus.

**Flow Cytometry**

This laboratory may be housed in single room with a workroom/office enclosure located within. Within RC1 there will be one cell sorter unit mounted on an air table. There will be at least two flow cytometry units and potentially three. A similar core lab is desired for RC2. This laboratory can be located on the typical lab floor in lab support space.

**Quantitative PCR**

Given the current state of technology, the existing PCR equipment does not have to be housed in an isolated environment. Therefore this laboratory can located in the generic laboratory environment. Besides the PCR equipment, the lab will house a laminar flow clean bench and a number of freezers and refrigerators.

**DNA Array/ Sequencing**

This suite requires that each major component, Array and Sequencing be housed in a separate zone, each with it own office. In addition there is a need for a related wet laboratory and equipment zones for freezers, and refrigerators. This suite will house equipment that requires subdued light but still can be located on a lab floor in the generic laboratory or lab support space.

**g. Vivarium Space Concepts**

A full service vivarium was constructed with the RC1 project, designed to meet the animal research needs of the research community in the two buildings which comprise RC1. In conjunction with the added growth of research space in RC2 is a corresponding growth in the demand for supporting animal research space. The RC2 vivarium will also be full service. It will be connected to RC1 by a tunnel and will have a reduced cage-washing component by making use of the facilities in RC1.

A system of suites, containing animal research labs and procedure room will provide flexibility to house colonies of varying sizes and species while providing a secondary barrier against cross contamination.

The facility operates using a concept of directional workflow to keep activities moving from most stringent to less stringent environments. Holding Suites will be organized around a central core of support services. The entrance will provide for entry protocols required for a barrier environment. The purpose of this approach is to provide the capability to alter the size of the barrier and non-barrier zones through provision of a multiple doors located along the main corridor. The location of the soiled and sterile side of the cage wash area relative to the suites will facilitate this capability.
Animal Census

Working closely with the Vivarium Space Subcommittee, the following projected average daily census and room requirements were established:

<table>
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<tr>
<th>Species</th>
<th>Census</th>
<th>Cages/Rack/Racks/Rms Req’d</th>
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<tr>
<td>Mice</td>
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<td>135 (a) 6 (b) 37</td>
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<tr>
<td>Aquatics</td>
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<td>5 (e)</td>
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</tr>
<tr>
<td>Total</td>
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<td>47</td>
</tr>
</tbody>
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Notes:

a. Double-sided racks can house maximum of 140 cages; 135 cages represent a 96% rack utilization.

b. Room will be configured with 6 single-sided racks (70 cage max/63 cage @ 90% utilization) and 3 double-sided racks for a rack equivalent of 6 double-sided racks.

c. Two suites will be dedicated to aquatic species such as zebra fish, frogs, catfish and mud puppies.

Animal/ Aquatic Research Labs

Formally referred to as animal holding rooms, these animal research labs (ARL) reflect the degree of active research occurring in the vivarium. Each 16’ x 22’ ARL can accommodate virtually any animal species. Each suite will contain four ARL’s, one dedicated procedure room, one convertible ARL/procedure room, an internal 7’ wide corridor and a janitor’s closet. Based on 47 ARL’s required, 10 to 11 suites will be provided (Aquatics, Rodents and Aquarantine/ABSL3).

Since mice will take up most of the ARL space (>50%) and require the most staffing and cage processing space, discussion centered primarily on the mouse rooms and cage/rack system. These include the following:

- High density, ventilated micro-isolator cages to maximize cages/asf and reduce the cage changing frequency from weekly to once every two weeks.

- Rooms configured with 6 single-sided racks and 3 double-sided racks to eliminate rack movement during cage changing, facilitate animal inspection and maximize cage changing efficiency by bringing the animal transfer station (ATS) to the rack.

- An auto-watering system to ensure consistent delivery of chemically suitable water with minimal commitment of staff time.

- Material in each designated Aquatic room shall be non-ferrous.

As the majority of the ARLs will house rodents, they will be constructed without floor drains. However, to enhance flexibility for future species change, a certain percentage of ARLs will be equipped with trench drains along both 22’ long walls. This will allow the rooms to be converted to use for larger species or aquatics.
Aquatic/ Specialty & Procedure Room
Each Aquatic suite will be provided with one dedicated procedure room and one convertible ARL/procedure room. The procedure room will be located adjacent to the primary Vivarium corridor. While it is recommended that the procedure room be entered from within the suite, the location along the corridor offers the option to enter from the main corridor, if desirable, and acts as a sound buffer. Stainless steel counter space shall be cantilevered off one wall of the room, with mobile storage units below. The other wall, in the dedicated procedure room, shall include a class II, type B-2 biosafety cabinet and additional utilities for connection of movable equipment. Material in each designated room shall be non-ferrous.

Cage Wash/Autoclave
An Autoclave and Cage Rack Washer will be utilized to support the washing and sterilization operations. As stated above, a robotically operated tunnel washer located in the RC1 cagewash area will accommodate all of the rodent cage cleaning. A conveyor system will move the pallets of cages to and from the RC1 facility.

Clean/Sterile Equipment Storage
The sterile holding room provides space for storage of racks, cages, bottles and supplies, which have been sterilized. The space is sized to accommodate cages and racks equal to approximately 15% of the barrier animal research lab cage capacity to accommodate changeover on an average of once per two weeks. Access to this space will be through the pass-through, floor loading sterilizer and medium sterilizer connecting it to the clean holding area, and from the vivarium corridor.

Feed/ Expendable Storage Alcove
Feed and expendables will be sterilized at the loading dock prior to entering the facility. Access from the dock will be by a designated vivarium clean elevator. Once in the vivarium, feed will be staged on clean pallets in alcoves along the circulation corridor for easy access by the caretaking staff.

Aquatic Mech. Rm
A room will be designated for the equipment required for adjacent aquatic research labs. Material in each designated room shall be non-ferrous.

Bedding Storage
Bedding for the rodent population will be delivered at the RC1 dock in one ton bags. From the bags it is dumped into a hopper which distributes the bedding via pneumatic piping to stations in the cagewash area, where it is robotically placed in the individual clean cages.

Detergent Storage
This area will be located off the main building dock. It will contain tanks/ barrels of detergent. From this location, detergent will be piped to the cagewash and to individual
janitor’s closets in the vivarium. The space will be designed to contain spillage in the event of a tank rupture.

**Hazardous Box Storage**
An alcove will be provided adjacent to necropsy to house freezers for the storage of biohazard wastes.

**Gown Storage**
A room will be designated for the storage and dispensing of gowns and other clean laundry.

**Ice Flaker Alcove**
An alcove will be designated for ice flaker equipment.

**Clean Animal Dock**
A separate and dedicated animal shipping/receiving dock shall be provided that will allow direct access of animals and related supplies into the animal facility. This will also enhance the security of the facility.

**Material/Animal Shipping & Receiving**
Animal shipments will be received in a workroom adjacent the animal dock. Animals will be unpacked within a double-sided bio-safety cabinet and placed in a clean cage. Once this process is completed, the operator will lower the dirty side sash of the bio safety cabinet, allowing personnel on the clean side to access the animals.

**Offices**
Five enclosed offices will be provided

**Lockers**
The locker rooms will utilize a step-over bench concept whereby a bench in the path of travel serves as a barrier between the street side of the locker room and the clean side to prevent inadvertent contamination of the clean area. Full height lockers for personnel and half-height lockers for investigators will be provided on the street side. Clean supplies and a hamper for disposal of used uniforms will be provided on the clean side. The specific number of lockers/type shall be determined.

**Break/Conference/Training Room**
This room will be located before entering the air shower into the barrier side of the facility to serve employees. It will include a small kitchenette unit, a writing surface, message board and seating for eight persons. It may also be used for small group meetings occurring within the vivarium. There will desirably be a vision window between the break room and the main vivarium corridor for supervision of the space.
h. Building Support

The following are the spaces defined as building support in the space program

Main Lobby
The main entry lobby will provide a sense of identity and orientation for visitors to the building. This space will tie together the public circulation to the building’s major public program spaces with its related corridors, stairways, and passenger elevators. A building directory will be provided in the main lobby to assist visitor orientation and circulation within the building.

Conference Rooms
Three conference rooms will be designed to combine into one large room. They will either be proximate to the warming kitchen or will have a separate support kitchenette.

Pre-Function Space
This space will serve as a gathering place for functions that take place in the auditorium. This area will be an extension of the building’s main entry lobby and adjacent to the auditorium. Temporary tables could be set up in this area for function reception and orientation.

Warming Kitchen
A dedicated room will be provided for outside catering services to store and stage their material in anticipation of a catered event. This room will be located off the lobby, adjacent the conference rooms.

Vending Area
An area will be established for the installation of vending machines. This space requires floor drains and sufficient power to support the anticipated machines.

Loading Dock
The loading dock will be capable of supporting the needs for the entire building with the exception of animal related materials. Dock will incorporate gas cylinder, alcohol storage facilities and liquid nitrogen dispensing operations.

Dock Office
An office will be located at the shipping dock for the Dock Manager. Office will be equipped with windows to allow for an unobstructed view of the entire dock area.

Mail Room
The mailroom will be located off the dock and be accessible to building occupants. The room will be fitted out with sorting bins, and sufficient space to support the movement of mail in and out of the building.
Infectious Waste Staging
A dedicated room will be provided for the staging of infectious waste. This room will be located near the shipping dock and will have limited access. The room’s finishes will allow for decontamination if and when the need arises.

Hazardous Material Staging
A dedicated room will be provided for staging hazardous chemical and radioactive wastes while awaiting removal to the remote campus waste handling facility.

Radioactive Material Control
A dedicated room will be provided for the control and monitoring of incoming radioactive materials. This room will be located near the shipping dock and will have limited access. The room’s finishes will allow for wash down if and when the need arises.

Cylinder Storage
A dedicated room will be provided for the storage of cylinders. This room will be located near the shipping dock.

Storage
A dedicated storage room will be provided. This room will be located near the shipping dock.

Housekeeping/Maintenance Storage
This room will contain sufficient floor mounted storage to support the housekeeping supply needs of the staff. In addition floor space will be provided to store cleaning equipment such as buffers and vacuums.

Environmental Health and Safety (EHS) Closet
A dedicated storage space will be provided to store emergency response materials that EHS will require when responding to an emergency. These materials may include a Scott pack, spill kit, etc.
IV. Facility Requirements – The Research Complex 2

A. General Requirements

When completed, the Research Complex 2 will total approximately 400,000 gross square feet (gsf) of new research space. The building net to gross SF efficiency is programmed at 65%. The animal facility is approximately 37,000 gsf and is included within the research complex space.

The building which comprises Research Complex 2 will range from 8 to 12 stories in height with internal mechanical rooms and outdoor exhaust fans. The animal facility will be located at a basement level with receiving docks at the first floor level. The animal facility will be supported by a partial interstitial space, minimizing the impact of routine maintenance and required system repairs on the animal facilities below. The interstitial space will consist of a system of catwalks over the vivarium corridors and, minimally, over the animal and procedure room ceilings.

Typical laboratory floors will consist of large, open, generic laboratories, supported by zones of specialized lab support and departmental offices. Principal investigator offices will be enclosed and may be grouped with dry lab space. Core labs are planned to support research as shared facilities. A Research Imaging Core Facility is planned at the first floor. Smaller core labs will be distributed on the typical lab floors, or, as in the case of the proposed BSL3 lab, will be located at the top of the building to accommodate special ventilation requirements.

The animal facility is to be located on a single basement level. The facility will be designed to for a single directional flow of materials and an adjustable barrier in the rodent housing area. The RC2 vivarium will be connected to RC1 vivarium by a tunnel. The tunnel will, among other benefits, facilitate the sharing of primary cagewash facilities.

The site selected for Research Complex 2 is located within the master plan research zone of the Fitzsimons Campus. The specific site is west of the RC1 facility, directly South of 19th Street and north of 17th Place. The site is considered to extend to roughly 100 feet from the face of the proposed buildings on both the east and west. Research Complex 2 will to be constructed in a single phase, to match the funding approval process. The building will be interconnected to the adjacent RC1 research building by a bridge and an underground tunnel. RC2 may also be connected to the planned office complex to the South.

Exterior Closure
The Fitzsimons Master Plan has identified a palette of materials for use throughout the campus. The Research Complex 2 will follow this approved palette. The exterior wall is planned to be of masonry construction and to be contextual, using a combination of brick and stone. Glazing will be provided with attention given to solar loads. Use of exterior sun control devices will be used at windows where appropriate. The roof will be single ply over rigid insulation. Roof top exhaust fans are intended to be concealed by screen walls.
Foundations/Substations
It is likely that "drilled piers" will be used to support grade beams and interior columns. Determination of the final system will be made during the design phase of the project. The building is planned to have a basement for the animal facility. Shoring may be required as the basement depth could be 20 feet or greater. Reinforced concrete walls to retain adjacent earth will be used at the basement level. Extrapolation from soil borings on adjacent sites suggests that the water table will be 26 feet or more below the existing grade. With the necessary addition of approximately 2 feet of fill to the site to accomplish surface drainage, the proposed basement depth of approximately 20 feet should be sufficiently above the water table to eliminate the need for special dewatering provisions. Soil borings will be performed at the outset of the design phase to verify actual water table location, as well as the physical make-up of the soil. Based upon this information, the final depth of the basement and the selection of appropriate moisture barrier for the subterranean portion of the building will be determined.

Superstructure
A steel superstructure system will most likely be used for Research Complex 2 due to its speed for construction. Selection of the most appropriate system will be made during the design phase based on an evaluation of cost, material availability, and ability to meet the specific vibration and loading characteristics of the program. The structure will be designed to meet 125 psf live load. If a steel structure is selected, approximately 12-14 p/sf of material is estimated.

Mechanical Systems
Mechanical systems for laboratories and animal facilities are discussed further later in this section. The loads and equipment sizing are preliminary and will be refined in subsequent design phases. A summary of tentative building utility loads is provided in Appendix B.

1. Laboratory Facility Requirements
Design of the typical laboratory floor is to address the following considerations:
   a. Offices and laboratories (both wet and dry) are to have access to natural light.
   b. Principal Investigator (PI) offices are to be enclosed.
   c. A single corridor system may be used to optimize building square foot efficiency.
   d. Service and passenger elevators are to be provided.
   e. Laboratories are to be modular and open to maximize flexibility.
   f. The plan is to foster a sense of community.
   g. Laboratory support spaces are to be interior to the floor plate.
h. An Imaging Core Facility is to be located at grade for shared access and ease of expansion.

i. Smaller, specialized Core Laboratories will be distributed in the general lab area.

j. Each laboratory floor is to have conference and break areas.

k. Maintenance access of mechanical devices is to be via ceilings above laboratory aisles and linear equipment corridors.

**Interior Construction**
The typical planning module for laboratories is 10'-6" x 38'-0" including a 10'-0" alcove, and 10'-6" x 11'-6" for laboratory offices and dry lab space. Ceiling heights in laboratories are planned to be 9'-6" with a building floor to floor height of 16'-0". Typical laboratory doors are single 36" leaf.

Typical laboratory finishes include VCT flooring, GWB partitions with washable, low-luster paint, and 5/8" vinyl coated acoustical tile. Casework will be plastic laminate with epoxy resin counter tops. Special finishes will be provided as needed.

**Equipment**
Autoclaves, glassware washers and dryers are planned on each lab level. A detailed equipment listing is provided in Appendix A.

**Sustainable Design and Energy**
The Design Team will include Leadership in Energy and Environmental Design (LEED) certified Engineers and Architects focused on addressing issues for sustainable designs. The determination of application toward LEED certification will be made after preliminary design considerations have matured sufficiently to incorporate discussions related to materials and resources, water efficiencies, energy and atmosphere, etc. Regardless of certification application the design of this project will accelerate the concepts of the program including mechanical designs slated to exceed ASHRAE standard 90.1 – 1999. The minimum standard should be established at 10% beyond ASHRAE 90 – 1999 to ensure availability to be considered in Xcel Energy’s “Energy Design Assistance” program. The design team is committed to the conservation of resources while meeting the desires and needs of the owner uses. Life cycle cost analysis on various design issues will be present for discussion and determination of design direction.

**HVAC Systems**
Based on the program requirements developed thus far, the laboratory environment is not fume hood or biosafety cabinet intensive. The maximum density contemplates either one 5’ Chemical Fume Hood (CFH) or one 5’ BioSafety Cabinets (BSC) per laboratory module alcove, but the initial fit-out is considerably less than that. Therefore, the primary driver for airflow requirements in lab areas is the cooling loads. This includes both the internal heat gains of equipment and lighting as well as the building skin loads. Therefore the envelope will be carefully assessed and design solutions will be optimized to minimize the impact of envelope loads on cooling and consequent airflow requirements.
Laboratory supply air will be filtered, cooled, heated, dehumidified, and provided in sufficient quantities to meet space ventilation (dilution, contaminant removal, and space pressurization) requirements and conditioning (comfort) requirements. Laboratory exhaust air systems will be provided to exhaust the laboratory environment of potentially harmful contaminants and maintain appropriate space pressurization's (labs negative). All systems for laboratories, laboratory support and core labs will essentially be 100% (non-recirculated) outside air. No research laboratory air will be recirculated, or returned to the main air handlers. The air systems serving non-lab functions may include a conventional return air approach, mixing that return air with the centralized main air-handling units. These areas will be supplied by the same systems serving the labs and will therefore also receive essentially 100% outside air. The anticipated volume of potential office return air to the system is 10% of the centralized main air-handling units capacity.

The primary supply air service for the research lab portions of this laboratory building will be provided by a single HVAC air handling system – comprised of multiple units to serve the 363,000 sq ft. above grade, non-vivarium portions of the building. Air handling systems will be provided such that, upon a device failure, the reliability and availability of system capacity will have minimal impact on critical building activities. The building will have four to six custom built air handling units located in mechanical room(s) at or near grade which, for reliability and flexibility of operation, will be connected through a common galvanized distribution system at the lower level. Each unit will deliver between 70,000-95,000 cfm of conditioned air to a manifolded supply air distribution system. Unit selection will attempt N+1 configuration where the number and size of the main units N will match the design load and have one additional standby unit (+1). The vertical distribution to the 10 above grade levels in the building will be through multiple duct risers up through the various parts of the building. The air intakes will be coordinated with site and building issues to minimize contamination of the entering outside air, probably by raising the intakes above grade by at least 10-12 feet, possibly up to the second floor.

The air handling units will be VAV type with 30 and 85% prefiltration, low pressure steam preheat coils, and chilled water cooling coils, sound attenuation and 95% final filters. The use of a heat recovery system is not expected to be economical, but will be evaluated. The air handling units will supply air to all laboratory floors, and will serve all research lab, laboratory support, procedure rooms and associated office/administration spaces, adjacent core labs as well as building support functions all above grade.
The supply air system to the laboratories will be a variable (or two-position) air volume control concept at the room level with terminal hot water reheat coils to maintain space temperature. Humidification will be provided only as required for critical applications. The air delivered to the BSL-3 suite (potentially 1-2 modules on the top level) will have supply air delivered from main building air handling units plus an in line (series connected) supply fan and HEPA filtration in the supply ducting. BSL-3 supply fan will be a single fan unit, on emergency power sources.

The general design criteria for the major laboratory building spaces are summarized in the following Table. Note that the supply air changes per hour in the laboratories may be reduced during unoccupied periods for energy conservation.

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Temperature °F</th>
<th>Relative Humidity Winter / Summer</th>
<th>Minimum Ventilation Air Changes per Hour (ACPH)</th>
<th>Average Equipment Load Watts/SF</th>
<th>Average Lighting Load Watts/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>70°F - 72°F</td>
<td>35% - 55%</td>
<td>10 (6 Unoccup.)</td>
<td>8-16</td>
<td>2.25</td>
</tr>
<tr>
<td>Lab Support</td>
<td>70°F - 74°F</td>
<td>35% - 55%</td>
<td>10 (6 Unoccup.)</td>
<td>8-16</td>
<td>2.25</td>
</tr>
<tr>
<td>Core Labs</td>
<td>70°F - 72°F</td>
<td>35% - 55%</td>
<td>10 (6 Unoccup.)</td>
<td>10-16</td>
<td>2</td>
</tr>
<tr>
<td>Linear Equipment Room</td>
<td>70°F - 74°F</td>
<td>35% - 55%</td>
<td>10 (6 Unoccup)</td>
<td>10/16</td>
<td>2</td>
</tr>
<tr>
<td>(Corridor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td>70°F - 72°F</td>
<td>35% - 55%</td>
<td>4</td>
<td>3-5</td>
<td>2</td>
</tr>
<tr>
<td>Corridors (Office)</td>
<td>70°F - 76°F</td>
<td>35% - 55%</td>
<td>1</td>
<td>NA</td>
<td>1</td>
</tr>
</tbody>
</table>

All laboratory spaces will be maintained at a negative pressure with respect to surrounding corridors and office/administration areas. The laboratory exhaust system will be comprised of 4-6 single width, single inlet centrifugal exhaust fans each exhausting approximately 50,000-75,000 cfm of air at peak load. This equipment will be roof mounted with direct connection to individual stacks of sufficient height to allow for effective discharge and to minimize intake contamination potential. The design of the system is based on having multiple lab exhaust air risers throughout the building manifolded on the roof. This ducting system will have multiple fans functioning as a manifolded system with N+1 redundant
exhaust fans. This means that upon the failure of any single fan, 100% of the full capacity of the exhaust system will be available. The exhaust fans will be variable air volume using variable speed drive motors and static pressure control based on system static pressure measured in the plenum in the penthouse mechanical room adjacent to the fans. Biosafety cabinets are planned to be recirculating units. If ducted in the future the exhausts of biosafety cabinets may not be manifolded, but shaft space will be provided and dedicated for future risers.

The facility will include constant volume exhaust fans for glass washer, sterilizer and autoclave service, toilet room exhaust, electrical and janitor’s closet exhausts. These fans will not be redundant.

Mechanical and electrical equipment spaces will be provided with separate air handling systems to provide for minimum environmental requirements of these spaces.

A separate biohazard exhaust system will serve the BSL-3 laboratory. This system will include two fans, one active and one standby, and a bag-in bag-out 99.97% DOP HEPA filter assembly at the roof to prevent the exhaust of particulate contaminants in excess of 0.3 micron in size. No special provisions are necessary for the decontamination of these spaces because chemical decontamination is the proposed approach to clean up the space of any potential contamination.

Chilled Water
Chilled water for the buildings will be supplied from the site chiller plant and will be distributed to the building year-round at approximately 42°F. The plant has redundant capacity sufficient to guarantee reliable chilled water service in the event of a failure of a major piece of equipment (i.e. - chiller, cooling tower, chilled water pump, condenser water pump, etc.). In the event of a power outage, the plant does not have emergency power capabilities sufficient to provide any cooling to the laboratory facility. Critical cooling requirements within the laboratory facility, such as stability chambers, will be cooled by stand-alone cooling equipment (probably DX) located within the research complex. This equipment will be served by a local emergency generator system (Refer to Electrical).

The chilled water control on the air handling units will be via two-way valves with circulation within the building provided through local variable flow chilled water pumps located in the lower level mechanical room. At this time, Research Complex 2 will have its main air handler cooling coils connected to the campus chilled water system. An additional “process cooling” chilled water loop will be provided with a plate and frame heat exchanger for isolation of cooling systems vertically rising through the building. Units on this system include electrical and telecom room FCU’s and environmental rooms, plus any specialized lab chilled water needs. A pair of pumps (duty and standby) with variable speed drives will circulate process cooling water throughout the building and all connections to the process cooling loop will get 2 way control valving.
Emergency Chilled Water

The basement level vivarium air handlers (see 2. Animal Facility Requirements) will require conditioning capabilities 24 hours per day, 7 days per week. Given the inability of the campus central chiller plant to guaranty uninterrupted chilled water, emergency chilled water provisions have been made by connection to the Building 500 chilled water plant as a part of the RC1 project. Building 500’s chiller and pumping units are backed up by an emergency generator power source to maintain cooling operations at all times. Loss of normal chilled water will be monitored by RC1 systems, initiating delivery of emergency chilled water for the vivarium air handlers. RC2 will switch chilled water source with valving at its vivarium air handlers upon switch to emergency chilled water mode. Conversion back to normal campus chilled water mode will be manual.

Steam

Building heating and process steam for the building will be supplied from the site steam plant and will be distributed to the building year-round at a minimum of 100 psig. The plant has redundant capacity sufficient to guarantee reliable steam service in the event of a failure of a major piece of equipment (i.e. - boiler, deaerator, condensate pump, etc.). In the event of a power outage, the plant has emergency power capabilities sufficient to provide heating to the laboratory facility only for freeze protection and safety purposes. This will include preheating and reheating capacity (of supply air quantities sufficient to provide make-up air for minimum ventilation of spaces and devices such as fume hoods and biosafety cabinets) as well as limited critical heating/process requirements within the laboratory facility, such as autoclaves associated with the BSL-3 suite.

Given the site will deliver steam containing amines and similarly unhealthy additives, the use of plant steam for humidification or autoclaving is not recommended. Incoming steam will be used as high pressure (100 psig) steam to feed one clean steam generator located in the mechanical room for humidification and autoclaves. This clean steam generator will create clean steam utilizing deionized feed water at an output pressure of approximately 60 psig for distribution up to multiple autoclaves and glass washers in the research building as well as any potential needs in the Vivarium. 60 psig clean steam will then be regulated down to lower pressure (15 psig) for humidification purposes in the vivarium air handling units, and any other critical areas requiring humidification.

The incoming high pressure steam service (100psig), after the clean steam generator take-off, will be regulated down to medium pressure (60 psig) for: 1) Steam to hot water converters serving hot water heating systems pumped to reheat coils and radiant fin tube perimeter heating coils, 2) domestic hot water generators.

The 60 psig house steam line will then be regulated down to low pressure house steam (15 psig) for the preheat coils in the research laboratory air handling units. 100 psig house steam will be flashed to 60 psig house steam main. The 60 psig clean steam will be flashed to atmospheric and condensate return pumps (electric) will circulate clean condensate back to the clean steam generator feed system. The 60 psig house steam will be flashed to 15 psig house steam main, and the 15 psig house steam condensate will be flashed to atmospheric pressure and collected in a pressure powered condensate return pump.
original incoming 100 psig high pressure house steam will be used to drive the pressure powered condensate return pump, circulating back to the campus boiler plant.

Each of the described steam pressure reducing stations shall have 1/3 – 2/3 PRV’s with isolation valves for PRV maintenance and globe valves in a bypass line.

**Plumbing/Piping Systems**

The building will receive domestic and fire water service from the site distribution main along 19 Street. This service will enter the basement mechanical room. It will be metered and, because of the size / height of the building, be boosted to provide adequate flow / pressure to all floors of the building(s) using a triplex constant pressure booster pump system which handles 250 gpm at each pump at 80 psig of boost. The pumped domestic water will be distributed through risers in the mechanical shafts throughout the building that include local pressure regulating devices at take-offs in the shaft up to the 4th floor. Per the UCHSC standards, the domestic water system will also serve all safety showers without tempering of the water.

The domestic water system will also serve the steam-fired domestic hot water generator plant to produce 110°F for circulation throughout the building via a full return loop system. The domestic water system will also provide feed water (through water softeners) for the deionized water system.

Based on the inverts available with the existing waste collection systems, all areas above the basement will be capable of being drained by gravity. All basement level drains will require pumping through a sump.

Drainage from the laboratory building(s) will include two separate systems:

- A standard cast iron pipe sanitary riser system will serve all non-laboratory fixtures including toilet rooms, locker rooms and floor drains from janitor’s closets, mechanical rooms and other similar service spaces. This system will receive no treatment and will be connected directly into the site sanitary sewer main.

- A specialty laboratory waste drainage system utilizing polypropylene pipe will serve all laboratory fixtures. Based on the UCHSC strict controls on chemical disposal "down the drain" and the sizable nature of diluting waterflows (especially from cage-wash and similar activities) within the "lab" waste system, it is expected this special waste piping will be limited to connection from fixture to riser and that waste treatment is not required. This drainage system will be routed independently outside of the building without interconnection with the building’s sanitary sewer and will connect onto the site sewer after passing through a man-hole. This man-hole is intended to enable both the monitoring of waste stream flows / composition and the possible introduction of a neutralization system in the future as necessary to adjust for either changes in codes or in lab practices.
The following laboratory systems will be evaluated for inclusion:

- An oil-free compressed air system (with redundant compressors and connection to emergency power) that will deliver 60 psig to each lab bench.

- A dry vacuum system (with redundant pumps and connection to emergency power) (at -40°F DP) air that will deliver 26” Hg vacuum to each lab bench. The vacuum system will consist of several zones each with a duplex vacuum pump and individual receiver tank. This system will also be manifolded in the mechanical room so that any vacuum pump set may serve any riser line within the building.

- Laboratory deionized water (with minimum 1.0 megohm/cm resistivity at all benchtop outlets) will be provided to all labs from a central recirculating system located in the mechanical room. Any local requirements for better quality water (i.e.-Type I) will be produced using local / in-lab polishing units.

- Natural gas distribution to bench top turrets and CFH’s in alcoves will be provided with regulation to 7” wg at the benches

There are no requirements for any centrally piped gas services (N2, O2, CO2, He, etc.) within the research laboratory building. All specialty gas requirements will be handled by local cylinders within each lab as necessary.

**Fire Protection Systems**

The building fire protection system will consist primarily of wet sprinklers and standpipes located throughout the facility. Water will be provided from an interconnected fire protection standpipe system network, thereby creating a combined standpipe / sprinkler system. The water supply will be from connections to the combined site domestic water / fire protection distribution system. A booster pump will be necessary to provide sufficient flow and pressure to the upper half of the building.

In addition, dry pipe systems will be located in areas subject to freezing such as the loading dock area. Single interlock preaction sprinkler systems will be provided in areas such as those with sensitive electronic equipment, pyrophoric chemicals, and other areas where an accidental discharge would be problematic.

**Instrumentation & Control Systems**

The building mechanical systems will be continuously monitored and under the control of a distributed direct digital control (DDC) building automation system (BAS) with main supervisory PC-based controls. The main interface console will be located in the engineer’s office or fire command center on the grade level.

This BAS will monitor and control all of the mechanical air handling and water service equipment, selected electrical equipment including automatic transfer switches and also includes interface to the building fire alarm and perimeter security systems. The BAS will
include the ability to monitor, control and revise operating control parameters for all of the variable (two-position) air volume control boxes for all lab areas.

The building system will communicate with existing campus control systems. Pneumatic actuation will be provided for control valves and dampers on major equipment. Electric actuation will be provided for all smaller valves and dampers. Instrumentation compressed air will be provided by an independent controls only compressed air system.

The building fire alarm system will consist of an addressable device annunciated system compatible with existing central campus systems. The system will include smoke detection and voice evacuation announced by speakers located throughout the facility in accordance with the local codes. The fire alarm system building command center will be located in the security office of the facility and will provide interface and override capability of the HVAC equipment via a dedicated BAS remote console.

Building security system will consist of door switches and alarms on exit doors on the first Floor as well as at the main entrance area and loading dock. The security system will be compatible with existing central campus security systems. A card reader access system will be provided between public and research zones on each floor, within elevator cabs for floor-by-floor control, at ground floor elevator lobbies and throughout the vivarium. A closed circuit television system will be provided at circulation nodes within the vivarium and at all building entrances. This system will interface with the existing central campus security systems.

**Electrical Systems**

Dual 13.2 kV service will be supplied to each the building from the site distribution system. Each service will be sized for the entire capacity of the research building. Redundant 13.2 kV/480v transformers will be provided to serve double-ended substations each sized to accommodate the entire load of the research building with the use of an automatic tiebreaker. Either transformer will continue to carry the substation load in the event of the failure of the other transformer thereby providing redundancy in the distribution transformers. Power will be distributed throughout the building at 480 volt, 3 phase. Local transformation to utilization voltages will be provided. Laboratories will be provided with 208 and 120 voltages, however, 480v power will be available on each floor of the building from the main electrical distribution room. Lighting will be provided with 277 volts. TVSS surge suppression will be provided at both the service entrance and at individual lab and office panels.

The general criteria for electrical design includes the following for laboratory equipment power:

- 40 watts / NSF maximum per individual lab
- 20 watts / NSF average per floor
- 15 watts / NSF for all labs
• 20 watts / NSF for overall building power supply including all electrical loads

An emergency power system consisting of two (2) diesel powered standby generators and appropriate automatic paralleling switch gear and automatic transfer switches will be provided to maintain power supply continuity in the event of a utility outage for life safety (egress lighting, fire alarm, etc.), elevators (one at a time for passenger discharge), designated critical HVAC and mechanical systems, designated laboratory equipment, and UPS systems. Based on an estimated standby power load of about 15% of the peak demand, the generator load is about 1,500 KVA.

Uninterruptible power systems (UPS) will be provided to maintain emergency lighting through all modes of operation without momentary losses. A centralized 75kw UPS in the main electrical room area will generate 480/227 V power for distribution. User specific UPS needs will be local user dedicated systems versus building-wide shared systems. UPS will also be provided for critical building automation system (BAS) components. Input to the UPS will be from the normal / emergency power system.

The primary source of lighting for these facilities will be fluorescent lamps. Accent, decorative, outdoor, or high ceiling applications will be lit with compact fluorescent or metal halide lamps. Special fixtures will be provided, as required, for specific applications such as hazardous or clean environments. Laboratory design light level is 100 foot candles (FC).

A lightning protection system will be provided to minimize the impact of lightning strikes on the facility and critical equipment.

2. Animal Facility Requirements

A summary of special facility requirements and issues relating to the future design and construction of the animal space is provided below.

Interior Construction

Design of the animal facility is to address the following considerations:

a. The facility is to be centralized in the basement.

b. The facility is to be designed to allow future underground connection to vivarium in RC3.

c. The shared support functions, such as cagewash, are accessible via an underground link connection to RC1.

d. A partial interstitial area is requested as a means to separate maintenance access from the animal envelope.
e. Holding rooms are to be designed in suites off of a common corridor.

f. A single corridor system will be used, as clean and dirty material can flow on the same corridor.

g. Receiving docks are planned at the first floor level.

h. The facility is to be secure with use of card key controlled access.

i. The vivarium will contain primarily a rodent population housed in ventilated, microisolator cages. A limited number of aquatic suites will also be provided.

Typical animal rooms (ARL) will be approximately 16’ x 22’ with ceiling heights at 9’-0”. Rooms are to be arranged in suites with a shared procedure room. Typical interior finishes are epoxy flooring, impact resistant GWB walls with epoxy paint and GWB ceiling with epoxy paint. Cantilevered stainless steel counter tops with mobile undercounter storage units and fixed phenolic resin wall cabinets will be used in the vivarium.

The interstitial area will be walkways constructed of steel members, metal deck and / or grating with steel handrails.

**Equipment**

Major equipment includes a robotically operated tunnel washer to be added in the RC1 cage wash area, an autoclave and cage/rack washer in the RC2 cage wash area and separate clean and soiled conveyor systems between RC1 and RC2. A listing of specific equipment requirements is provided in Appendix A.

**HVAC Systems**

The vivarium will be provided with supply and exhaust air systems separate from the lab systems due to the increased reliability and availability requirements for these areas.

Vivarium supply air will be filtered, cooled, heated, humidified, and dehumidified, and provided in sufficient quantities to meet the AAALAC guidelines for space ventilation (dilution, contaminant removal, and space pressurization) and environmental conditioning (animal comfort). Vivarium exhaust air systems will be provided to exhaust the vivarium environment of odors and maintain appropriate space pressurization’s. All systems for the vivarium will be 100% (non-recirculated) outside air. In addition, the requirement for Class 100 air to be supplied to the ventilated cages planned for most small ARLs suggests that local recirculation air handling systems dedicated to each room be used as an option to using air circulation systems provided by the rack/cage manufacturer. This approach will be evaluated in detail during design.

The primary supply air service for the vivarium will be provided by a manifolded HVAC air handling system consisting of custom built air handling units located in mechanical rooms. The system will operate with two units active and one unit on standby. Each unit will deliver approximately 40,000 cfm of conditioned air to a manifolded supply air distribution system.
Units will be of hospital grade construction, have a draw through coil arrangement with HEPA final filters and be of double wall insulated construction with a perforated metal liner to aid in noise attenuation. The air intakes will be coordinated with site and building issues to minimize contamination of the entering outside air, probably by raising the intakes above grade by at least 10-12 feet, possibly up to the second floor.

The system will include a humidifier located in the vivarium air handlers. This humidifier will be fed with clean steam from the clean steam generators, which utilize a deionized water feed. The primary system humidifiers will be designed to maintain a minimum of 40% RH within the entire animal facility. In addition there may be individual in-room humidifiers located in the ductwork at a few holding rooms to permit adjustment to specific set points within the animal research labs.

Although the ARLs will typically be constant air volume for any given occupancy or use, there is a requirement for various room-suite applications that may require "variable air volume" type control capability. This will allow for both various room "applications" as well as the conversion of rooms/suites from a "negative" (containment) mode to a "positive" (isolation) mode. Therefore, the air handling units will be VAV type with filtration, steam preheat coils, steam humidifiers and chilled water cooling coils. Although the use of a heat recovery system is not expected to be economical, its application will be evaluated. These units will supply air to all vivarium areas including holding, procedure, and miscellaneous support areas.

The supply air system to most vivarium areas will be a variable (or two-position) air volume control concept at the room level with terminal hot water reheat coils to maintain space temperature. Humidification will be provided centrally with local humidification only as required for possibly a few critical applications.

The general design criteria for the various spaces is summarized in the following Table. Note that the supply air changes per hour in the animal laboratories may be reduced during unoccupied periods for energy conservation.

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Temperature °F Winter / Summer 65°F - 72°F*</th>
<th>Relative Humidity Winter / Summer</th>
<th>Minimum Ventilation Air Changes per Hour (ACPH)</th>
<th>Average Equipment Load Watts/SF</th>
<th>Average Lighting Load Watts/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivarium Rooms</td>
<td>70°F - 74°F</td>
<td>40% - 55%*</td>
<td>15</td>
<td>4-8**</td>
<td>2</td>
</tr>
<tr>
<td>Corridors (Vivarium)</td>
<td>40% - 55%</td>
<td>6</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*varies depending on the species  
**equivalent heat load from animals and ventilated racks

The animal facility will be exhausted through three 30,000 cfm single width, single inlet exhaust fans located on the roof. The system will operate with two units active and one unit.
on standby. These systems will also be provided with medium efficiency filters to remove animal hair and dander prior to exhausting from the building. In addition, roughing filters will be provided on the exhaust grilles within each individual ARL. A separate fan and duct system will exhaust the cage and rack wash area because of the high humidity levels in the exhaust air.

Class II type B2 biosafety cabinets will be utilized in the vivarium procedure rooms. Those units will direct connect with an independent exhaust ducting system up to redundant duty and standby exhaust fans on the roof.

The system distribution ductwork within the mechanical room will be of double wall construction using a perforated metal liner with a mylar faced acoustic lining. Packless sound attenuators will be provided at the duct penetration through the mechanical room walls to attenuate noise in duct systems. Acoustic lining will not be used in the ductwork in this system. The supply air ductwork for the facility will be galvanized steel and the exhaust ductwork will be type 304L stainless steel.

The animal area will receive domestic and fire water service from the laboratory building main within the mechanical room.

All of the animal suites will be provided with one hot and cold water service sink within the suite corridor, as well as one janitor closet. These hand sinks are to be fully automated, hands off operation for tempered water, soap and electric blower hand dryers. An automatic animal drinking water system for the animals will be provided with stainless steel distribution piping, solenoid flush valves and quick connections provided for each animal rack. The automatic animal drinking water system will be fed reverse osmosis (RO) water from the house deionized water system described previously to insure a clean supply and to prevent chemical treatments in the domestic water from potentially modifying the experimental results. Animal water systems will have multiple holding tanks (3) at 500 gallons each to maintain operations for 1 – 3 days with loss of city water. Multiple tanks are used to reduce single point of failure potential.

The ARLs will not be equipped with floor drains. Aquatic suites and special variable species ARLs will receive trench drains for wash down. The animal facility does include a segregated sanitary waste system for specialized treatment. Any special treatment required for special handling of waste from the animal facility will be developed in conjunction with specific research protocols at such time as they arise.

All animal functions are anticipated to be on the basement level. All basement level drains will require pumping through a sump.

Drainage from the animal facility will include two separate systems:

- A standard cast iron pipe sanitary riser system will serve all non-laboratory fixtures including toilet rooms, locker rooms and floor drains from janitor’s closets, mechanical rooms and other similar service spaces. This system will receive no treatment and will be connected directly into the site sanitary sewer main.
• A specialty animal waste drainage system will serve all animal and procedure rooms in the animal area. It is expected that waste treatment is not required. This drainage system will be routed independently outside of the building without interconnection with the sanitary sewer and will connect onto the site sewer after passing through a manhole. This manhole is intended to enable both the monitoring of waste stream flows / composition and the possible introduction of a neutralization system in the future as necessary to adjust for changes in codes or regulations.

The animal area will be provided with:

• Vacuum outlets connected from the laboratory building system.

• Laboratory deionized water connected from the laboratory building system. This water will feed some special need sinks in the procedure areas as required. Any local requirements for better quality water (i.e.- Type I) will be produced using local / in-room polishing units.

• Laboratory RO water will be delivered to the animal drinking water system.

• Central Carbon Dioxide (CO\textsubscript{2} system) with piping from a main cylinder storage area will be distributed to animal suite procedure rooms.

• Central Oxygen (O\textsubscript{2} system) with piping from a main cylinder storage area will be distributed to animal suite procedure rooms.

• There are no requirements for any compressed air or other centrally piped gas services (NG, N2, He, etc.) within the animal areas. All gas requirements will be handled by local cylinders within each procedure room as necessary.

**Fire Protection Systems**
The animal area fire protection system will be fed from the lab building combined standpipe / sprinkler system. Protection in the animal areas will consist of a pre-action system zoned into multiple areas for the entire animal area including the operating suite.

In addition, dry pipe systems will be located in areas subject to freezing such as the loading dock area or where accidental water discharge could jeopardize the operations.

The fire alarm detection and annunciation systems utilizes both smoke detectors and heat detectors employing both rate-of-rise and fixed temperature technology. The annunciation system also utilizes strobe light visual alarms and low disturbance audio alarms typical for use within an animal facility.

**Instrumentation & Control Systems**
The animal area system will communicate with the laboratory system and the existing campus control systems. Pneumatic actuation will be provided for control valves and dampers on major
equipment. Electric actuation will be provided for all smaller valves and dampers. Instrumentation compressed air will be provided by the building compressed air system.

There is a segregated remote console for the animal facility. This BAS console will allow the animal facility operators to monitor and revise set points and operating parameters in the animal holding cells, store historical data regarding temperature, humidity and light levels within the animal rooms, and develop historical trend data for the use in their experiment documentation without interfering with the day- to-day operations of the primary building systems. This animal facility BAS remote console will not be capable of overriding or controlling the primary air handling equipment or exhaust fans serving the animal facility.

The building fire alarm system will consist of an addressable device annunciated system compatible with existing central campus systems. The system will include smoke detection and voice evacuation annunciated by speakers located throughout the facility in accordance with the local codes. Fire alarm devices will be appropriate for animal spaces by avoiding stressful frequencies for alarms and gongs.

The animal area security system will interconnect with the laboratory building system and will be compatible with existing central campus security systems. It will consist of door switches and alarms on exit doors as well as a card reader access system to restrict access to and within the animal facility. A closed circuit television system will be provided in the animal corridors serving the holding rooms. This system will interface with the existing central campus security systems.

**Electrical Systems**

The animal areas will be fed from the main research complex distribution system with dual feeders, dual transformers, and double-ended switchgear. All redundant critical systems will be fed from two clearly separate power sources traceable through the entire electrical system.

Power will be distributed throughout the animal areas at 480 volt, 3 phase. Local transformation to utilization voltages will be provided. Procedure rooms and Operating areas will be provided with both 208 and 120 voltages, however, 480v power will be available from the main electrical distribution room. Lighting will be provided with 277 volts supported by the laboratory buildings centralized UPS system. TVSS power surge suppression will be provided at each panel serving procedure and other instrument rooms.

The general criteria for electrical design is similar to that used for the laboratory equipment power.

All critical animal area functions will be powered by the standby emergency power system. This includes all necessary environmental systems as well as the distribution systems (such as local pumps and controls) necessary to keep the ventilation systems operational and correctly controlling the animal areas for temperature, lighting, etc.

The primary source of lighting for these facilities will be fluorescent lamps. High ceiling applications will be lit with compact fluorescent or metal halide lamps. Special fixtures will be provided, as required, for specific applications such as hazardous or clean environments. Typical vivarium light level is 60 – 70 footcandles (FC).
B. Site Requirements

1. Project Site

The current build-out of the University of Colorado’s new Fitzsimons campus is shown on the accompanying aerial photo. The original military hospital, Building 500, is the dominant structure near the center of the image. The two structures which comprise Research Complex 1 are directly west of Building 500.

As indicated on the Fitzsimons Master Plan site plan (Appendix I), the campus is divided into quadrants defined by their predominant functional use. The research quadrant is west of Building 500 and north of 17th Avenue. Research Complex 2 is to be located within the research quadrant, directly west of Research Complex 1 (RC1).

The following criteria were used in determining the appropriate location for Research Complex 2:

A. Functional proximity. Research Complex 2 is to be proximate to Research Complex 1 and to the proposed Faculty Office Building. The Faculty Office Building is to be located convenient to both the research community in RC1 and RC2 and to the hospitals located south of 17th Avenue. The basement vivarium currently constructed in RC1 is to connect to the programmed RC2 vivarium, and to future vivarium construction within the research quadrant. Similarly, the auditorium facilities constructed within RC1 are to be accessible to researchers in RC2 and the conferencing opportunities of the complex enhanced by the addition of conference facilities in RC2. A bridge connection at level two between RC1 and RC2 is desired, continuing the development of the campus wide “internal street” system which was started between the buildings of RC1.

B. Development of a sense of campus. Historic Building 500 is intended to serve as the central image for the new Fitzsimons campus. The placement of the facilities, in both the patient care and the basic research zones, reinforce Building 500’s prominence. In addition, the placement of the first buildings and the nature of their physical relationship to one another have begun the process of developing the character of the new campus as a whole. RC2 is to respond to the context established by RC1 and continue the development of the external courtyard and pedestrian walkways established in RC1.

C. Campus connections. The new campus infrastructure is being developed and extended to tie into the Research Complex 2. The site of the building will relate to the position and extent of these connection points. Included in the analyses are
basic utility routing (water, sewer, steam, communications, etc), proposed pedestrian patterns, and vehicular access for both public and service.

D. Views. The Fitzsimons campus has magnificent views of the Front Range of the Rockies. Although in the ultimate build-out of the campus not every window will provide access to mountain views, the site for Research Complex 2 is to take advantage of the views at this time. Preservation of view corridors from RC1 to the mountain should also be studied.

E. Campus Build-out. The Campus Master Plan indicates that the research quadrant of the campus is anticipated to have an ultimate build-out of 1.8 million square feet of research. Research Complex 1, currently under construction, defines the eastern and southern extremes of the research quadrant. Research Complex 2, must recognize the implications of future research construction. Despite the fact that the combination of RC1 and RC2 will provide over 55% of the initially master planned research build-out, recognition should be given to responsible maximization of the site’s potential to accommodate future changes and growth in research related space demands.
Research Complex 2 Site
2. Program and Site Test Fit

UCHSC has considered preliminary alternatives for placement and configuration of the Research Complex 2 program on the selected site and within the Master Plan guidelines. Each of the alternatives have the following conditions in common:

- The 400,000 gsf program can be accommodated in the portion of the Research Zone directly west of Building 500 and RC1.

- The total 400,000 gsf may be built in a single phase.

- Physical connections to the RC1 and Office Complex are to be possible.

- A basement level vivarium as programmed at 37,000 gsf can be accommodated.

- The basement level vivarium facility can be connected to the animal facility in RC1 and have provisions for connection to future vivarium built in subsequent projects to the west.

- The open lab / linear equipment room / lab support concept of RC1 can be accommodated, continuing the new campus lab facility standards.

The alternatives are based on building heights between eight and twelve stories with a screened mechanical equipment area on the roof. The variables between each of the alternatives include the following:

- The typical floor plate size.

- The height of the building.

- The location and configuration of the office and dry lab functions.

- The location of the building entrance.

- The configuration of the service entrance.

In the subsequent phases of the design process, these and other alternatives will be further evaluated based on specific programming issues and basic building design requirements.

A brief discussion of three preliminary options related to office / dry lab space follow. All three options assume a common building length, comparable to that in the north building of RC1.
Scheme A – Concept Floor Plan

Scheme B – Concept Floor Plan

Scheme C – Concept Floor Plan
Scheme A

- This floor plate has 18 lab units, or double modules. This will result in the equivalent of 8.1 lab floors to provide the programmed 146 lab units.

- The office and dry lab component of the program runs full length along the east face of the floor plate in a double-loaded corridor configuration.

- The double-loaded office and dry lab corridor results in a portion of the office spaces being away from the exterior wall and views.

- Assuming a constant depth for the lab and lab support zone of the floor in each of the schemes, the double loaded office and dry lab configuration results in a floor plate approximately 12 feet wider than the other schemes.
Scheme B

- This floor plate has 16 lab units, or double modules. This will result in the equivalent of 9.1 lab floors to provide the programmed 146 lab units.

- The office and dry lab component of the program is split approximately equally between a single loaded corridor configuration along the east face and a large suite at the south end of the floor plate.

- The split of office and dry lab space types offers a broader variety of potential layouts than Scheme A.

- The concentration of office and dry lab space at the south end of the floor relates well to the proposed position of the Faculty Office Building to the south. This relationship provides a visual tie as well as a reduction in travel distance between the two facilities, particularly on the bridged floors.

Scheme B – View from the North
Scheme C

- This floor plate contains 18 lab units, or double modules. This will result in the equivalent of 8.1 lab floors to provide the programmed 146 lab units.

- The office and dry lab component of the program is split approximately equally between a single loaded corridor configuration along the east face and a large suite at the north east corner of the floor plate.

- The split of office and dry lab space types offers a broader variety of potential layouts than Scheme A.

- The concentration of office and dry lab space at the north east corner of the floor relates well to RC1. At the lower floors, this configuration has the potential to shorten the length of the bridge connecting RC1 and RC2.

- The concentration of office and dry lab space over the building’s main entrance develops good visual and functional relationships between vertical circulation and conference spaces.

- The potential exists for development of multi-floor conference / libraries to enhance floor to floor interaction.
3. Existing Site Conditions

The Research Complex 2 site is bounded by 19th Avenue to the north, 17th Place on the south, and is adjacent to the west edge of the RC1 courtyard.

The site is essentially level and will be re-contoured with approximately 2 feet of fill, taken predominantly from previous building excavations, in order to develop positive drainage. Several mature trees exist on the site. To the extent possible, efforts to maintain some of the trees will be evaluated. Unfortunately the primary stand of trees is located in the center of the designated building site. The site has significant views of the Rocky Mountains to the west. Coordination of construction staging, trailers, and contractor parking is required between all sites being developed.

Soil and subsurface conditions are fairly uniform and homogenous across the site with the water table anticipated to be between 28 to 49 feet below grade.

Anticipated stratum is:

- Lean/sandy clay: 0-28’; 200 psf
- Clayey/silty sand: 28’-49’; 440 psf
- Shale: 49’-65’; 150 psf

This information is based on extrapolation of existing test boring data from sites directly adjacent to the Research Complex 1. Test borings of this specific site will be taken during the subsequent design phase.

4. Site Relationship to Master Plan

The siting option for the Research Complex 2 facilities is consistent with the approved Institutional Master Plan. Significant components of the Master Plan as related to Research Complex 2 are as follows:

a. Site areas are to be landscaped with new trees and shrubs to compliment existing landscape material.

b. An east/west pedestrian way will be developed in place of Charlie Kelly Boulevard (now renamed 17th Place).

c. Restricted traffic is anticipated along the planned 17th Avenue.

d. Service vehicular traffic will be via 19th Avenue.

e. Structured parking is planned as a future development. Surface parking will be provided for Research Complex 2 on adjacent land within the campus. No significant
parking is included within the scope of this project. Minimal parking for deliveries and guests will occur on the immediate site.

f. Research Complex 2 is in a Master Plan zone that permits building heights in the range of 6 to 12.

g. Individual research buildings are to be linked via bridges and tunnels.

h. A warehouse/receiving facility will be located (separate project) at the east end of the Fitzsimons campus. This facility will reduce individual building storage needs as supplies are delivered on a just-in-time basis.

i. A radiation and waste handling facility is planned (separate project) to support the campus research zone.

j. Steam (gas fired boilers) and chilled water are to be produced and delivered to the Research Complex 2 site from a central power plant.

k. Power will be supplied from dual sources to a Fitzsimons site centralized automatic transfer switch and delivered in ductbank to the Research Complex 2 site.

l. Major east/west utility corridors for sanitary, power, steam, domestic/fire water and chilled water are located in 19th Avenue. A natural gas line is located in 17th place, at the south end of the site.

m. Storm water from the immediate site will be piped to a detention basin directly south of the project site, between 17th Place and 17th Avenue. This detention basin is a temporary facility until the infrastructure storm drainage lines are extended to this part of the campus. Storm drainage from the west side of the building site will be surface drained to the west.

5. Site Infrastructure

**Site Utility/Steam**
Steam generated centrally at the Fitzsimons campus Central Utility Plant will be delivered direct burial as a dual loop system to the Research Complex 2 site in utility corridor along 19th Avenue. The Research Complex 2 project is responsible to tie into the system at vaults located along those utility corridors. Site steam is planned to be at 100 psi. Research Complex 2 is responsible to pump condensate to the site steam condensate lines in the utility corridors.

**Site Utility/Chilled Water**
Chilled water generated centrally at the Fitzsimons campus Central Utility Plant will be delivered direct burial at 42º via the site loop system. The Research Complex 2 project is responsible to tie-into the system at vaults located along the utility corridors. A heat exchanger system is not anticipated in Research Complex 2 for the main mechanical system.
Site Utility/Power
Site power at 13.2 kV will be provided at pad mounted switches located just north of the building site. Research Complex 2 project is responsible to route power via concrete ductbank from the switches to (indoor or outdoor) transformers to support the building. Research Complex 2 is to have an independent emergency generator (diesel fuel) system.

Site Utility/Domestic and Fire Water
The site will provide domestic water for both building domestic water and fire water requirements. Research Complex 2 is responsible to tie into the site system as direct connections with a valve box. A new 10” domestic water incoming service from 19th Avenue is anticipated. Booster pumps within Research Complex 2 are anticipated to be required to meet water pressure needs for both domestic water and fire water systems.

Site Utility/Sewer
The site system is shallow with minimal slope. The sewer line planned in the north/south utility corridor (east of Research Complex 1) is at capacity from the Cancer Center and CAM facilities. An extension of a 15 inch sanitary sewer main in 19th Avenue from the west face of Building 500 to the west face of RC2 is required. Drains in the basement level will have to be pumped to the site system.

Site Utility/Stormwater
The existing storm sewer constructed with RC1 is designed to handle roof drainage and common areas east of RC2. Stormwater from the west of RC2 will be piped to the planned off-site retention basin near existing Buildings 408 and 409. The existing storm sewer outfall for the remaining military housing west of RC2 must be rerouted to either the existing RC1 storm system or the proposed retention pond.

Site Utility/Natural Gas
Natural gas had been coordinated for service needs to Research Complex 1. A pressurized pipeline routes up 17th Place between the North and South buildings of the RC-1 complex. This pipeline was installed through coordination with the local utility and has capacity for RC-2 buildings. Gas will route up from South of RC-2 and a regulator will be needed, expected to be at the North end of the building.

Site Utility/Telephone; Data and Security
The site will provide empty conduit to the building face. The Research Complex 2 project is to install copper for telephone service and fiber for data service to Building 500 head-end equipment.

6. Unique Site and Facility Requirements
Potential site features unique to Research Complex 2 are as follows:
a. A paved service yard will be required to support loading dock, material receiving and waste removal functions.

b. The site to be landscaped is considered to include 100’ from the facilities east/west walls and will continue the development of the courtyard begun under the RC1 project.

c. Pedestrian bridges will connect RC2 with RC1 to the east and the Faculty Office Complex to the south.

d. Pedestrian walkways are planned in the courtyard area east of the facility.

e. Site lighting is to be provided consistent with the Master Plan.

f. Imaging Facility expansion may occur to the west of RC2

g. **RC2 budgets will be evaluated to determine the potential for inclusion of basement shell space to accommodate future vivarium growth needs.**

The site is capable of future expansion consistent with UCHSC Master Plan. The design of RC2 will incorporate elements to allow the future connection to Research Complex 3 at both a vivarium level and at level two.

C. **Health, Life Safety and Code Issues**

1. **Laboratory and Animal – Health Safety Issues**

   The laboratory facilities are typically biosafety level (BSL) 2 with one BSL-3 suite. Remaining special spaces in the laboratory program include a radiation waste handling room and an iodination laboratory.

   Special building features to address health safety issues include:

   1. Use of 100% once-through outside air systems.

   2. Locate fresh air supply intakes and exhaust air systems remote from each other to minimize potential re-entrainment.

   3. Provide dedicated exhaust systems where BSL 3 and iodination laboratories are required. Use HEPA and/or carbon exhaust filters as required.

   4. Store flammable solvents in approved cabinets that vent through the fume hoods.

   5. Provide autoclaves and glassware washers to sanitize or sterilize laboratory materials.

   6. Place laboratories under negative air pressurization for containment purposes.
7. Provide emergency showers and eyewashes for access by lab users.

8. Provide fire extinguishers in laboratory areas.

9. Occupant load for Vivarium areas will be based on 300 sq. ft. per occupant based on the space functioning primarily for storage of animals.

The animal facility is to be designed as an Animal Biosafety Level (ABSL) 2 facility. Special design features relative to health safety issues for the ABSL 2 facility include:

100% once-through supply air for the facility (no recirculated air).

Air pressurization strategies to address containment and protection the health of animals and facility occupants.

Cleanable/washable/decontaminable building materials and finishes.

Use of biosafety cabinets for containment work.

Provision of sterilizers and other wash equipment to sanitize and sterilize material.

Operational procedures established by UCHSC to protect staff.

Appropriate signage and access controls for the facility.

Passage through two sets of doors for entry into the room/suite from an unrestricted corridor.

2. Laboratory and Animal – Life Safety and Codes

The design and construction of Research Complex (RC) 2 will be based on the final agreed upon design approach which was used for RC 1 and will comply with all applicable codes, regulations, laws and ordinances as well as standards adopted by the University of Colorado HSC, including but not limited to:

Uniform Building Code (UBC) – 1997, except for:

- Chapter 10 Means of Egress which is replaced with Chapter 10 of the International Building Code (IBC) 2000.

- Hazardous Materials quantities and their storage, use and handling will be in accordance with guidelines as directed by HCHSC Health and Safety Division.
Uniform Mechanical Code (UMC) – 1997
Uniform Plumbing Code (UPC) - 1997
Uniform Fire Code (UFC) – 1997
National Electrical Code (NFPA 70) – 1996
Standard on Fire Protection for Laboratories Using Chemicals (NFPA 45) -1996
National Fire Protection Association (NFPA) Standards as applicable
ANSI/ASME A17.1 –Safety Code for Elevators and Escalators – most current version
Colorado Revised Statutes (CRS) – 1995, as amended, Title 24-82-601, -602, Energy performance goal of 55,000 BTU/SF/YR for all State Buildings and improvements thereto.
Colorado Revised Statutes (CRS) Volume 3B – Title 9, Article 2 – Safety Glazing Materials
American Disabilities Act (ADA) – 1991, Guidelines Specifications for making buildings accessible to and usable by the physically handicapped.
Uniform Federal accessibility Standards (UFAS)
Fire Code (most recent) for local authority having jurisdiction

3. **Jurisdiction**

University of Colorado (UC) Health and Safety Division

4. **Project Review**

UCHSC will employ the services of an independent code consulting firm, to be responsible for review of the design and construction documents for compliance with the applicable codes and standards.
University of Colorado HSC Campus Building Official has overall jurisdiction for the project and will provide final interpretation on code issues.

5. Use Group/ Occupancy & Construction Type Options

The Uniform Building Code (UBC) identifies two occupancy classifications which were evaluated for applicability to this project. UCHSC plans to designate their laboratory and animal facility as Group B occupancy.

Group B – includes buildings, structures or portions thereof for office, professional or service-type transactions which are not classified as Group H Occupancies. Examples of Business occupancies include but are not limited to:

- Laboratories – Testing and research
- Educational Occupancies above the 12th Grade.
- Animal hospitals, kennels, pounds.

Group H (Hazardous) occupancy was evaluated, but not used as a general classification for the building, due to cost premiums and to the fact that the biomedical research work at UCHSC does not require H designation. The quantities of hazardous materials being stored, used and/or handled within this research facility will be maintained in accordance with the criteria as directed by UCHSC Health and Safety Division – see letter dated 7/19/2000 form Campus Building Official. In the event that quantities in localized areas, such as storage rooms, exceed the quantities as directed in this letter, High Hazard (Group H, Div. 3) these spaces may need to be classified as Use Group H3 occupancies.

The following table was prepared to evaluate options for the building construction type for each of these two Use Groups which will accommodate the building program. Final selection of construction type IFR or IIFR will be made in a future design phase.

<table>
<thead>
<tr>
<th>Use Group/Occupancy:</th>
<th>B</th>
<th>B-H-3</th>
<th>B-H-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Type:</td>
<td>IFR</td>
<td>II FR</td>
<td>IFR</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable Height – Stories (UBC Table 5-B)</td>
<td>UL</td>
<td>12</td>
<td>UL</td>
</tr>
<tr>
<td>Allowable Height - Stories with Sprinkler Increase.</td>
<td>UL</td>
<td>13</td>
<td>UL</td>
</tr>
<tr>
<td>Allowable Height in feet</td>
<td>UL</td>
<td>160</td>
<td>UL</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable (UBC Table 5-B)</td>
<td>UL</td>
<td>39,900</td>
<td>UL</td>
</tr>
<tr>
<td>Allowable with Sprinkler &amp; Open Separation Increases</td>
<td>UL</td>
<td>319,200</td>
<td>UL</td>
</tr>
<tr>
<td>Allowable with Separation Increases Only – Sprinkler Increase Taken for Height</td>
<td>UL</td>
<td>159,600</td>
<td>NA</td>
</tr>
<tr>
<td>Maximum Single Floor Area</td>
<td>UL</td>
<td>239,400</td>
<td>UL</td>
</tr>
<tr>
<td>Travel Distance:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UBC Section 1004.2.5.2</td>
<td>200</td>
<td>200</td>
<td>75</td>
</tr>
<tr>
<td>With up to 100 ft increase last portion of travel in 1hr rated corridor</td>
<td>300</td>
<td>300</td>
<td>175</td>
</tr>
</tbody>
</table>
Notes:
The above chart was based on the following:

a. fully sprinklered building

b. open yard on 4 sides with 40 foot clearance

c. Multi-story building

d. Sprinkler Increase to Area is not permitted if increase taken for Height AND Sprinkler Increase to Height is not permitted if increase taken for Area

e. Height Increase not permitted for Use Group H-3

f. UL is unlimited

The following chart identifies ratings associated with various construction types evaluated.

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Type I Fire-Resistive</th>
<th>Type II Fire-Resistive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing Walls – Interior</td>
<td>3 hr</td>
<td>2 hr</td>
</tr>
<tr>
<td>Nonbearing Walls – Exterior</td>
<td>4 hr or based on fire separation distance in Table 5-A</td>
<td>4 hr or based on fire separation distance in Table 5-A</td>
</tr>
<tr>
<td>Structural Frame</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Partitions - permanent</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shaft Enclosures</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Floors &amp; Floor-Ceilings</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Roofs &amp; Roof-Ceilings</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Exterior Doors &amp; Windows</td>
<td>Based on Separation Distance per section 503.2 and Table 5-A</td>
<td>Based on Separation Distance per section 503.2 and Table 5-A</td>
</tr>
<tr>
<td>Stairway Construction</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

The table below was prepared to evaluate the requirements of Use Group B and Use group H, Division 3 occupancy classifications. The project will proceed as a Use Group B Occupancy per the UBC. Flammable liquids quantity limitations will be in accordance with the criteria as directed by UCHSC Health and Safety Division – see letter dated 7/19/2000 from Campus Building Official. In the event that quantities in localized areas, such as storage rooms, exceed the quantities as directed in this letter, High Hazard (Group H, Div. 3) these spaces may need to be classified as Use Group H3 occupancies. This criteria incorporates aspects of NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals as well as the Uniform Fire Code (UFC). (See section on Control Areas and Maximum Exempt Quantities below)
<table>
<thead>
<tr>
<th>Use Group B</th>
<th>Use Group H, Division 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs separated from each other and other portions of the building by 1 hour fire-resistive occupancy separation (UBC 304.2.2.1)</td>
<td>No requirement for separation between labs.</td>
</tr>
<tr>
<td>Exit Access Corridor fire rating = 0 hours per IBC 1004.3.2.1</td>
<td>Exit Access Corridor fire rating = 1 hours per IBC 1004.3.2.1</td>
</tr>
<tr>
<td>Egress Width per Occupant per IBC 1003.2.3</td>
<td>Egress Width per Occupant per IBC 1003.2.3</td>
</tr>
<tr>
<td>0.2 in/occupant - Stairways</td>
<td>0.3 in/occupant - Stairways</td>
</tr>
<tr>
<td>0.15 in/occupant - Doors, Ramps and Corridors</td>
<td>0.2 in/occupant - Doors, Ramps and Corridors</td>
</tr>
<tr>
<td>Dead end = 50 ft. per IBC 1004.3.2.3.</td>
<td>Dead end = 20 ft. per IBC 1004.3.2.3.</td>
</tr>
<tr>
<td>Quantities of hazardous materials may not exceed UBC Tables 3-D or 3-E and UFC Tables 8001.15-A and B.</td>
<td>Quantities of hazardous materials in excess of UBC Tables 3-D or 3-E and UFC Tables 8001.15-A and B.</td>
</tr>
<tr>
<td>Class I, II, III-A liquids used, dispensed, or mixed requires H-2 design; 1 hr rating up to 150 SF; 2 hr rating &gt; 150 SF; not permitted in basement (UBC 307.1.3)</td>
<td></td>
</tr>
<tr>
<td>Class I, II, III-A liquids stored in closed containers requires H-3 design; 1 hr rating up to 150 SF; 2 hr rating &gt; 150 SF; Storage Rooms for Class I flammable liquids not permitted in basement (UBC 307.1.4)</td>
<td></td>
</tr>
<tr>
<td>Occupant load greater than 50 or travel distance in excess of 100 ft. IBC 1004.2.1 and 1004.2.5.</td>
<td>Occupant load greater than 3 or travel distance in excess of 25 ft. IBC 1004.2.1 and 1004.2.5.</td>
</tr>
<tr>
<td>Where Class I, II, or III-A liquids are used, mechanically operated exhaust ventilation shall be provided sufficient to produce 6 air changes per hour. Exhaust shall be taken from a point on or near the floor. (UBC 1202.2.2)</td>
<td>Flammable Liquid Storage Rooms and Dispensing Mixing Rooms &gt; 500 SF require exterior door (UBC 307.1.3 and 307.1.4)</td>
</tr>
<tr>
<td>Maximum of 4 control areas per floor (per criteria directed by UCHSC Health and Safety Division) with quantities per control area in accordance with UBC Table 3-D and UFC Table 8001.15-A.</td>
<td>Virtually unlimited if designed in accordance with all Use Group H-3 requirements.</td>
</tr>
</tbody>
</table>
6. Control Areas and Maximum Exempt Quantities

The UBC allows quantities of hazardous materials to be stored or used within Use Group B buildings based on the concept of Control Areas.

A Control Area is defined as a building or portion of a building within which the exempted amounts of hazardous materials may be stored, dispensed, handled or used.

Control Areas shall be separated from each other by not less than a one-hour fire-resistive occupancy separation. The number of control areas within a building shall not exceed a maximum of 4 control areas per floor (per criteria directed by UCHSC Health and Safety Division) with quantities per control area in accordance with UBC Table 3-D and UFC Table 8001.15-A.

A large portion of the hazardous materials which are used in research laboratories are “solvents”; generally Class IB flammable liquids. The table summarizes the maximum exempt amounts of Class IB as well as Class IA flammable liquids allowed per control area in accordance with UBC Table 3-D (and UFC Table 8001.15-A). The table identifies quantities for Storage, Closed Systems and Open Systems.

Closed system: The use of a solid or liquid hazardous material in a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system or piece of equipment, and reaction process operations.

Open system: The use of a solid or liquid hazardous material in a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.

The following table indicates quantities of liquids that can be stored per control area.

<table>
<thead>
<tr>
<th>Quantity of Flammable Liquids Per Control Area (UBC Table 3-D)</th>
<th>Storage</th>
<th>Closed System</th>
<th>Open System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1A</td>
<td>120 gal</td>
<td>60 gal</td>
<td>20 gal</td>
</tr>
<tr>
<td>Class 1B</td>
<td>240 gal</td>
<td>120 gal</td>
<td>30 gal</td>
</tr>
<tr>
<td>Class IC</td>
<td>360 gal</td>
<td>180 gal</td>
<td>40 gal</td>
</tr>
<tr>
<td>Combination Class IA, IB &amp; IC</td>
<td>480 gal</td>
<td>240 gal</td>
<td>60 gal</td>
</tr>
</tbody>
</table>

Notes:
1. The quantities shown in this table are based on the assumption that the building is:
   • Fully sprinklered
   • Storage is in approved storage cabinets, gas cabinets or exhausted enclosures
The UCHSC will design the project on the basis that within the laboratory areas, NFPA 45 “Standard on Fire Protection for Laboratories Using Chemicals” shall be used as the governing standard (in lieu of UBC/UFC) with regard to maximum quantities of Flammable and Combustible liquids.

Laboratories will be classified as Class “B”. A Class “B” laboratory is defined as a laboratory of Moderate Hazard. The table below identifies maximum quantities of flammable and combustible liquids for the various Laboratory Unit Hazard Classes. The limitations for Class “B” laboratories are shown in bold type.

<table>
<thead>
<tr>
<th>Lab Unit Fire Hazard Class</th>
<th>Flammable/ Combustible Liquid Class</th>
<th>Excluding Quantities in Storage Cabinets or Safety Cans</th>
<th>Including Quantities in Storage Cabinets or Safety Cans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max. Qty. per 100 SF of Lab Unit</td>
<td>Max. Qty. per Lab Unit</td>
</tr>
<tr>
<td>A</td>
<td>I</td>
<td>10 gal</td>
<td>600 gal</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>20 gal</td>
<td>800 gal</td>
</tr>
<tr>
<td>B</td>
<td>I</td>
<td>5 gal</td>
<td>300 gal</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>10 gal</td>
<td>400 gal</td>
</tr>
<tr>
<td>C</td>
<td>I</td>
<td>2 gal</td>
<td>150 gal</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>4 gal</td>
<td>200 gal</td>
</tr>
<tr>
<td>D</td>
<td>I</td>
<td>1.1 gal</td>
<td>75 gal</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>1.1 gal</td>
<td>75 gal</td>
</tr>
</tbody>
</table>

Per Table 3-1 (a) of NFPA 45 the construction and fire protection requirements for sprinklered Class “B” Laboratory Units are as follows:

<table>
<thead>
<tr>
<th>Area of Laboratory Unit</th>
<th>Fire separation from Non-Lab Areas or Lab Units of Equal or Lower Hazard Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Units up to 20,000 SF</td>
<td>Noncombustible or limited combustible (gypsum board) construction</td>
</tr>
<tr>
<td>Lab Units &gt; 20,000 SF</td>
<td>Not permitted to exceed 20,000 SF</td>
</tr>
</tbody>
</table>

No more than 2 gallons is permitted out on the benchtops in any lab work area at any one time per UCHSC Health and Safety standards.
The maximum quantity of solvent storage per approved flammable liquids cabinet is 120 gallons in accordance with NFPA 45 and NFPA 30.

UCHSC Health and Safety Div. wants to avoid the mixing, blending or dispensing of chemicals/solvents in the Research Complex.

7. Underwriter Requirements

The State of Colorado is self insured.

V. Systems Operating Analysis
An order of magnitude evaluation of energy operating costs was prepared to guide initial conclusions concerning HVAC air systems. Air systems (air conditioning) options were developed and evaluated based on energy operating costs.

Options considered were:

- Constant volume without heat recovery
- Variable volume (with variable frequency drives) without heat recovery
- Constant volume with heat recovery
- Variable volume (with variable frequency drives) with heat recovery

Utility rates used for this evaluation were:

- $0.0555/Kwh
- $0.151/Ton-Hr.
- $12.82/MLB steam

The analysis, which summarizes parameters, projected loads, projected costs, and charts the results in terms of annual energy usage and costs is presented below.

Initial conclusions suggest that while heat recovery will modestly reduce energy costs, the payback period does not make its installation cost effective. Also, significant energy cost savings will result in the use of variable air volume air systems in place of constant volume systems with energy costs reduced by up to 40%.
ANNUAL ENERGY USE

<table>
<thead>
<tr>
<th></th>
<th>BASE - No HR</th>
<th>Option 1 - NHR</th>
<th>BASE - HR</th>
<th>Option 1 - HR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage in Actual Energy Units</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling (Refrigeration)</td>
<td>TONHRS</td>
<td>3,669,399</td>
<td>2,398,912</td>
<td>3,784,854</td>
</tr>
<tr>
<td>Preheat</td>
<td>MB</td>
<td>30,058</td>
<td>20,315</td>
<td>206</td>
</tr>
<tr>
<td>Reheat</td>
<td>MB</td>
<td>44,282</td>
<td>19,600</td>
<td>44,282</td>
</tr>
<tr>
<td>Humidification</td>
<td>MB</td>
<td>41,560</td>
<td>27,653</td>
<td>41,560</td>
</tr>
<tr>
<td>Fans (Supply &amp; Exhaust)</td>
<td>KWH</td>
<td>12,299,172</td>
<td>7,156,745</td>
<td>14,401,503</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>MMBTU</td>
<td>201,909</td>
<td>120,781</td>
<td>180,702</td>
</tr>
</tbody>
</table>

**Costs**

|                |               |                |           |               |
| Cooling (Refrigeration) | $          | 554,079        | 362,235   | 571,512       | 371,624       |
| Preheat         | $          | 385,338        | 260,439   | 3,714         | 2,634         |
| Reheat          | $          | 557,699        | 251,279   | 557,699       | 251,279       |
| Humidification  | $          | 523,794        | 354,507   | 523,794       | 354,507       |
| Fans (Supply & Exhaust) | $          | 676,454        | 393,621   | 792,083       | 460,894       |
| **Totals**      | $          | 2,716,365      | 1,622,082 | 2,467,802     | 1,440,938     |

**Usage in MBTUs**

|                | MEITU        | 44,032,794     | 28,786,949 | 45,418,249    | 29,533,036    |
| Preheat         | MBITU       | 30,057,570     | 20,315,007 | 289,702       | 205,518       |
| Reheat          | MBITU       | 44,282,238     | 19,600,475 | 44,282,238    | 19,600,475    |
| Humidification  | MBITU       | 41,559,552     | 27,652,702 | 41,559,552    | 27,652,702    |
| Fans (Supply & Exhaust) | MBITU       | 41,977,075     | 24,425,972 | 49,152,329    | 28,600,574    |
| **Totals**      | MBITU       | 201,909,228    | 120,781,105| 180,702,070   | 105,592,307   |

**Usage in MBTU per SF**

|                | MBTU/SF      | 130.30         | 85.20      | 134.40        | 87.40         |
| Preheat         | MBTU/SF      | 88.90          | 60.10      | 9.60          | 9.60          |
| Reheat          | MBTU/SF      | 131.00         | 58.00      | 131.00        | 58.00         |
| Humidification  | MBTU/SF      | 123.00         | 81.80      | 123.00        | 81.80         |
| Fans (Supply & Exhaust) | MBTU/SF      | 124.20         | 72.30      | 145.40        | 84.60         |
| **Totals**      | MBTU/SF      | 597.40         | 357.30     | 534.60        | 312.40        |

**Significant Parameters**

| Area Of System(s) | SQ.FT.       | 338,000        | 338,000     | 338,000       | 338,000       |
| Normal Max. Airflow (CFM) | CFM        | 456,000        | 456,000     | 456,000       | 456,000       |
| Avg. Airlows; Occupied / Unoccupied | % MAX | 100% / 100% Unocc | 80% Occ / 33% Unocc | 100% / 100% Unocc | 80% Occ / 33% Unocc |
| Avg. Min. Airflows; Occupied / Unoccupied | % MAX | 100% / 100% Unocc | 25% Occ / 25% Unocc | 100% / 100% Unocc | 25% Occ / 25% Unocc |
| Avg. Fan BHP: Occupied / Unoccupied | % MAX | 100% / 100% Unocc | 73% Occ / 31% Unocc | 100% / 100% Unocc | 73% Occ / 31% Unocc |
| Avg. Reheat: Occupied / Unoccupied | % MAX | 51% Occ / 82% Unocc | 26% Occ / 9% Unocc | 51% Occ / 82% Unocc | 26% Occ / 9% Unocc |
| Occupied: Space / Hood "In Use" | % MAX | 100% / 100% / 100% | 60% / 60% / 60% | 100% / 100% / 100% | 60% / 60% / 60% |
| Unoccupied: Space / Hood "In Use" | % MAX | 100% / 100% / 100% | 10% / 10% / 10% | 100% / 100% / 100% | 10% / 10% / 10% |
| Fan Type / Supply SP / Exhaust SP | IN. WG. | IV / 8.0 in. / 7.0 in. | VFD / 8.0 in. / 7.0 in. | IV / 9.1 in. / 8.5 in. | VFD / 9.1 in. / 8.5 in. |
| Fan Static Efficiencies: Supply / Exhaust | % | 65.0% / 63.0% | 68.0% / 66.0% | 65.0% / 63.0% | 68.0% / 66.0% |
| Cooling Coil Discharge Air Temp. | DB / WB | 52.0°F / 51.8°F | 52.0°F / 51.8°F | 52.0°F / 51.8°F | 52.0°F / 51.8°F |
| Space Temp. (Climaing): Occupied / Unoccupied | °F / °F | 72.0°F / 72.0°F | 72.0°F / 72.0°F | 72.0°F / 72.0°F | 72.0°F / 72.0°F |
| Space Temp. (Heating): Occupied / Unoccupied | °F / °F | 70.0°F / 70.0°F | 70.0°F / 70.0°F | 70.0°F / 70.0°F | 70.0°F / 70.0°F |
| Space Relative Humidity (Winter Minimum) | % | 36% | 36% | 36% | 36% |
| Occupied: Days per Week / Hours Per Day | Days/Hrs | 7 Days / 24 Hours | 5 Days / 24 Hours | 7 Days / 24 Hours | 5 Days / 24 Hours |
| Holidays or Vacation Days per Year | Days | 0 days | 0 days | 0 days | 0 days |
| Min. Reheat as % Of Maximum Supply | % | 10.00% | 19.00% | 10.00% | 19.00% |
UCHSC - Research Center 2 (RC2)
AC for Basic Lab/Off

ANNUAL ENERGY USAGE in MMBTU / SF

CV, w/o Ht.Rec.
VAV, w/o Ht.Rec.
CV, w/ Ht.Rec.
VAV, w/ Ht.Rec.

Kling
UCHSC - Research Center 2 (RC2)  
Variable Volume (VFD), Water Cooled Chiller Plant, without Heat Recovery
VI. Project Cost Estimate

The project budget for the design and construction of Research Complex 2 at Fitzsimons is estimated to total $205.8 million.

Based upon the 400,000 gsf program for this facility, the current project cost estimate been established. Each of the primary elements of the project (building, bridges and tunnel, site) have been broken out and estimated separately. Each element has been further broken down into its construction components and systems. Although the design process for this project will occur in the future, anticipated materials and systems have been defined for the purpose of preparing the estimate and for projecting utility needs and costs. Assumptions related to materials and systems are documented in other sections of this document. Actual construction costs from the RC1 project currently underway have been used to inform the values for the work in the respective sections of the RC2 estimate. The project is intended to be built under a CM/GC format and the estimate incorporates the associated fees.

The project is proposed as an entirely cash funded project. Projected income sources will be comprised of ICR and Federal funds. The specific funding sources are provided in the following table: Projected Funding Sources for Capital Development.

A summary of anticipated campus operational costs for Research Complex 2 at Fitzsimons is provided in the following table: Projected Facility Operating Costs. The cost factors used to determine this estimate are based on historical cost values of similar functional type facilities.

<table>
<thead>
<tr>
<th>Project Component</th>
<th>Total Project Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Land Acquisition</td>
<td>$</td>
</tr>
<tr>
<td>B. Professional Services</td>
<td></td>
</tr>
<tr>
<td>(1) Master or Program Planning</td>
<td></td>
</tr>
<tr>
<td>(2) Arch/Engrs (Bldg)</td>
<td>$16,510,600</td>
</tr>
<tr>
<td>(3) Arch/Engrs Other</td>
<td></td>
</tr>
<tr>
<td>(4) Construction Management</td>
<td>$2,760,000</td>
</tr>
<tr>
<td>(5) Code Review</td>
<td>$233,398</td>
</tr>
<tr>
<td>(6) Site Information and Tests</td>
<td>$843,842</td>
</tr>
<tr>
<td>(7) Other</td>
<td>$356,132</td>
</tr>
<tr>
<td>(8) TOTAL PROFESSIONAL SERVICES</td>
<td>$20,703,972</td>
</tr>
</tbody>
</table>
C. Construction
(1) Building
   (a) New $ 149,265,750
   (b) Renovate
(2) Bridges and Tunnel $ 4,511,517
(3) Sitework $ 1,031,947
(4) Landscaping $ 925,000
(5) Utilities $ 1,350,000
(6) TOTAL CONSTRUCTION COSTS $ 157,084,214

D. Equipment and Furnishings
(1) Equipment $ 11,470,000
(2) Furnishings $ 2,671,995
(3) Communications $ 3,034,295
(4) TOTAL EQUIPMENT COSTS $ 17,176,290

E. Miscellaneous
(1) Relocation Costs $ 1,966,280
(2) Project Contingency $ 8,889,409
   5% of Sum of B(8)+C(6)
(3) TOTAL MISCELLANEOUS COSTS $ 10,855,689

F. TOTAL PROJECT COST
A+B(8)+C(6)+D(4)+E(3) $ 205,820,165

G. Source of Funds

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>CCF</th>
<th>CCF Exempt</th>
<th>CF (Cash)</th>
<th>CFE (Cash) Exempt</th>
<th>FF (Federal)</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gift Giving &amp; Federal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$205,820,165</td>
</tr>
<tr>
<td>Campus Reserves</td>
<td>$9,615,564</td>
<td>$46,968,853</td>
<td>$81,426,586</td>
<td>$9,613,561</td>
<td>$22,080,037</td>
<td>$31,695,601</td>
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</tbody>
</table>

Project Funding

<table>
<thead>
<tr>
<th>COFRS Fund</th>
<th>02-03</th>
<th>03-04</th>
<th>04-05</th>
<th>05-06</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gift Giving &amp; Federal</td>
<td></td>
<td>$36,115,564</td>
<td></td>
<td>$36,115,564</td>
<td></td>
</tr>
<tr>
<td>Campus Reserves</td>
<td>$9,615,564</td>
<td>$46,968,853</td>
<td>$81,426,586</td>
<td>$67,809,162</td>
<td>$205,820,165</td>
</tr>
</tbody>
</table>

| Totals | $9,615,564 | $46,968,853 | $81,426,586 | $67,809,162 | $205,820,165 |
### Projected Facility Operating Costs
April 10, 2003

<table>
<thead>
<tr>
<th>Description</th>
<th>$ Per GSF</th>
<th>RC2 GSF $</th>
<th>Total $</th>
<th>Yr 1 Jan-June</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
<th>Yr 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation Factor</td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Facility Maintenance</td>
<td>$1.81</td>
<td>400,000</td>
<td>$724,000</td>
<td>$362,000</td>
<td>$745,720</td>
<td>$768,092</td>
<td>$791,135</td>
<td>$814,869</td>
</tr>
<tr>
<td>Utilities</td>
<td>$3.50</td>
<td>400,000</td>
<td>$1,400,000</td>
<td>$700,000</td>
<td>$1,442,000</td>
<td>$1,485,260</td>
<td>$1,529,818</td>
<td>$1,575,713</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housekeeping</td>
<td>$0.79</td>
<td>400,000</td>
<td>$316,000</td>
<td>$158,000</td>
<td>$325,480</td>
<td>$335,244</td>
<td>$345,301</td>
<td>$355,660</td>
</tr>
<tr>
<td>Grounds</td>
<td>$0.23</td>
<td>400,000</td>
<td>$92,000</td>
<td>$46,000</td>
<td>$94,760</td>
<td>$97,603</td>
<td>$100,531</td>
<td>$103,547</td>
</tr>
<tr>
<td>EH&amp;S</td>
<td>$0.50</td>
<td>400,000</td>
<td>$200,000</td>
<td>$100,000</td>
<td>$206,000</td>
<td>$212,180</td>
<td>$218,545</td>
<td>$225,101</td>
</tr>
<tr>
<td>Police</td>
<td>$0.74</td>
<td>400,000</td>
<td>$296,000</td>
<td>$148,000</td>
<td>$304,880</td>
<td>$314,026</td>
<td>$323,447</td>
<td>$333,150</td>
</tr>
<tr>
<td>Insurance</td>
<td>$0.19</td>
<td>400,000</td>
<td>$76,000</td>
<td>$38,000</td>
<td>$78,280</td>
<td>$80,628</td>
<td>$83,047</td>
<td>$85,538</td>
</tr>
<tr>
<td>Subtotal Other</td>
<td>$2.45</td>
<td>400,000</td>
<td>$980,000</td>
<td>$490,000</td>
<td>$1,009,400</td>
<td>$1,039,681</td>
<td>$1,070,871</td>
<td>$1,102,996</td>
</tr>
<tr>
<td>Total</td>
<td>$7.76</td>
<td>400,000</td>
<td>$3,104,000</td>
<td>$1,552,000</td>
<td>$3,197,120</td>
<td>$3,293,033</td>
<td>$3,391,824</td>
<td>$3,493,578</td>
</tr>
<tr>
<td>Percent Increase</td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>
VII. Project Schedule

Research Complex 2 at Fitzsimons is 400,000 gsf of laboratories and research support space to be built in one structure. The design process is projected to begin in late June of 2003. Occupancy of the completed structure is projected for the end of 2007. The project is intended to be built under a CM/GC (General Contractor / Construction Manager) format with a GMP (Guaranteed Maximum Price) set prior to construction start. The design and construction process will be “fast track”, which means that the construction process and the design documentation process will be partially overlapped. This results in a foreshortening of the potential overall design and construction schedule.

The accompanying schedule has been built on a detailed breakdown of the design and design review processes inherent in a project of this type. The durations identified for the various activities have been informed by the actual processes and durations required in the RC1 project. Likewise, the construction duration is based on the actual schedule required to complete similar components of RC1.

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Schedule</th>
</tr>
</thead>
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<tr>
<td>Conceptual Design</td>
<td>July 2003 – September 2003</td>
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<td>Schematic Design</td>
<td>September 2003 – March 2004</td>
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<td>Design Development</td>
<td>March 2004 – October 2004</td>
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<td>Occupancy</td>
<td>December 2007</td>
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Appendix A
Major Equipment
Major Equipment

The following list of laboratory and vivarium equipment is intended to define major pieces of equipment or groups of multiple pieces of equipment which will comprise significant expenditures for the project. The list is not intended to be inclusive of all equipment needs for the total project. For example, it does not include laboratory casework. The list is based upon preliminary understanding of the functions and spaces defined in the programming discussions to date.
<table>
<thead>
<tr>
<th>Prgm No.</th>
<th>Space Description</th>
<th>Unit Cost</th>
<th>Unit Qty</th>
<th>Total Cost</th>
<th>Remarks</th>
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<tbody>
<tr>
<td></td>
<td><strong>Research Lab</strong></td>
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<tr>
<td></td>
<td>Environmental Rm w/casework</td>
<td>45,000</td>
<td>32</td>
<td>1,440,000</td>
<td>1/4 labs; 4C &amp; 4-37C</td>
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<tr>
<td></td>
<td>Glasswash Rm</td>
<td>-</td>
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<td></td>
<td>26x26x38 sterilizer (ST)</td>
<td>45,000</td>
<td>8</td>
<td>360,000</td>
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<tr>
<td></td>
<td>26x36x48 sterilizer (ST)</td>
<td>55,000</td>
<td>8</td>
<td>440,000</td>
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<tr>
<td></td>
<td>glasswasher/dryer (GWD)</td>
<td>40,000</td>
<td>16</td>
<td>640,000</td>
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</tr>
<tr>
<td></td>
<td>Darkrm</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>autoprocessor (XOMAT)</td>
<td>20,000</td>
<td>16</td>
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<td>Ice Flakers</td>
<td>2,500</td>
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<td><strong>Research Lab Subtotal</strong></td>
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<td></td>
<td><strong>Vivarium</strong></td>
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<tr>
<td></td>
<td>Animal Research Lab</td>
<td>-</td>
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<td></td>
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<tr>
<td></td>
<td>70-cage rack (RACK1)</td>
<td>14,000</td>
<td>-</td>
<td>-</td>
<td>vented microisolator w/autowatering</td>
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<tr>
<td></td>
<td>140-cage rack (RACK2)</td>
<td>21,000</td>
<td>-</td>
<td>-</td>
<td>vented microisolator w/autowatering</td>
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<tr>
<td></td>
<td>animal transfer station (ATS)</td>
<td>6,500</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Procedure Rm</td>
<td>-</td>
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<td></td>
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<tr>
<td></td>
<td>II/B2 bio safety cab (BSCB2)</td>
<td>8,500</td>
<td>16</td>
<td>136,000</td>
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<tr>
<td></td>
<td>Cage/Rack Wash</td>
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<td></td>
<td>72x84x84 sterilizer (LST)</td>
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<td></td>
<td>48x84x84 sterilizer (LST)</td>
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<td>ABSL3 decon</td>
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<td>index tunnel washer (ITW)</td>
<td>350,000</td>
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<td>350,000</td>
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<tr>
<td>Item</td>
<td>Cost 1</td>
<td>Qty</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------</td>
<td>-----</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cage/rack washer (CRW)</td>
<td>175,000</td>
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<td>auto cage handling system</td>
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<td>1,500,000</td>
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<td>in-line bedding dispenser</td>
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<td>in-line bedding disposal</td>
<td>12,000</td>
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<td>12,000</td>
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<td>Sterile Eqmt Hold</td>
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<tr>
<td>Aquatic Controlled Temperature Rm</td>
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<td>120,000</td>
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<td>Carcass Holding</td>
<td>30,000</td>
<td>1</td>
<td>30,000</td>
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<tr>
<td>Animal Ship/Rcvg</td>
<td>20,000</td>
<td>1</td>
<td>20,000</td>
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<tr>
<td>Lockers</td>
<td>12,000</td>
<td>2</td>
<td>24,000</td>
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**Vivarium Subtotal**  
2,952,000

**Core Facilities**

**BSL3 Suite**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Qty</th>
<th>Total</th>
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<tr>
<td>26x26x38 sterilizer</td>
<td>55,000</td>
<td>1</td>
<td>55,000</td>
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**Subtotal Core Labs**  
55,000
Appendix B
Utility and System Load Estimates
### Basic Data

<table>
<thead>
<tr>
<th>Building</th>
<th>GSF</th>
<th>Grossing Effic.</th>
<th>Ceiling Height</th>
<th>NSF</th>
<th>Net Volume</th>
<th>People</th>
<th>Scientists</th>
<th>Meals</th>
<th>Aspect Ratio</th>
<th>Wall &quot;U&quot; Value</th>
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</thead>
<tbody>
<tr>
<td>Labs incl. LER</td>
<td>161,103</td>
<td>72.5%</td>
<td>9.50</td>
<td>116,800</td>
<td>1,109,600</td>
<td>730</td>
<td>730</td>
<td>20</td>
<td>0.08</td>
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<tr>
<td>Lab Support</td>
<td>50,759</td>
<td>72.5%</td>
<td>9.00</td>
<td>36,800</td>
<td>331,200</td>
<td>108</td>
<td>104</td>
<td>2</td>
<td>0.45</td>
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<tr>
<td>Office / Admin Support</td>
<td>90,290</td>
<td>72.5%</td>
<td>9.00</td>
<td>65,460</td>
<td>589,140</td>
<td>381</td>
<td>0</td>
<td>291.5</td>
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<tr>
<td>Core Labs</td>
<td>13,793</td>
<td>72.5%</td>
<td>9.00</td>
<td>10,000</td>
<td>90,000</td>
<td>100</td>
<td>0</td>
<td>110</td>
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<tr>
<td>Bldg Support</td>
<td>18,703</td>
<td>72.5%</td>
<td>10.00</td>
<td>13,560</td>
<td>135,600</td>
<td>27</td>
<td>0</td>
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<tr>
<td>Corridors (non-Animal)</td>
<td>22,695</td>
<td>72.5%</td>
<td>10.00</td>
<td>16,454</td>
<td>164,541</td>
<td>15</td>
<td>0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Bridges</td>
<td>-</td>
<td>72.5%</td>
<td>10.00</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (incl. Auditor)</td>
<td>-</td>
<td>72.5%</td>
<td>10.00</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td>42,737</td>
<td>72.5%</td>
<td>9.00</td>
<td>30,984</td>
<td>278,856</td>
<td>8</td>
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</tr>
<tr>
<td>Total Areas</td>
<td>400,080</td>
<td>-</td>
<td>30,984</td>
<td>278,856</td>
<td>8</td>
<td>0</td>
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### AIRFLOWS

<table>
<thead>
<tr>
<th>Building</th>
<th>CFM</th>
<th>CFM / NSF</th>
<th>CFM / GSF</th>
<th>Outside Air</th>
<th>Room (°F)</th>
<th>Room RH</th>
<th>Room ACH</th>
<th>Eq. (W/SF) incl. Skin</th>
<th>Supply (°F)</th>
<th>Fan Heat (°F)</th>
<th>Add for Corr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs incl. LER</td>
<td>332,880</td>
<td>2.85</td>
<td>2.07</td>
<td>100%</td>
<td>72</td>
<td>53%</td>
<td>12</td>
<td>2.0</td>
<td>10.8</td>
<td>52.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Lab Support</td>
<td>76,176</td>
<td>2.07</td>
<td>1.50</td>
<td>100%</td>
<td>72</td>
<td>53%</td>
<td>12</td>
<td>2.0</td>
<td>7.0</td>
<td>52.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Office / Admin Support</td>
<td>98,190</td>
<td>1.50</td>
<td>1.09</td>
<td>10%</td>
<td>72</td>
<td>53%</td>
<td>6</td>
<td>1.6</td>
<td>5.1</td>
<td>52.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Core Labs</td>
<td>24,000</td>
<td>2.40</td>
<td>1.74</td>
<td>100%</td>
<td>72</td>
<td>53%</td>
<td>12</td>
<td>2.0</td>
<td>8.8</td>
<td>52.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Bldg Support</td>
<td>15,594</td>
<td>1.15</td>
<td>0.83</td>
<td>25%</td>
<td>72</td>
<td>53%</td>
<td>6</td>
<td>1.2</td>
<td>3.5</td>
<td>52.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>12,670</td>
<td>0.77</td>
<td>0.56</td>
<td>100%</td>
<td>72</td>
<td>53%</td>
<td>4</td>
<td>1.2</td>
<td>1.4</td>
<td>52.0</td>
<td>0.0</td>
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<tr>
<td>Bridges</td>
<td>-</td>
<td>2.83</td>
<td>2.05</td>
<td>15%</td>
<td>72</td>
<td>53%</td>
<td>6</td>
<td>0.8</td>
<td>9.4</td>
<td>56.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Education (incl. Auditor)</td>
<td>-</td>
<td>1.54</td>
<td>1.12</td>
<td>33%</td>
<td>72</td>
<td>50%</td>
<td>8</td>
<td>2.4</td>
<td>2.1</td>
<td>56.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Animals</td>
<td>104,726</td>
<td>3.38</td>
<td>2.45</td>
<td>100%</td>
<td>70</td>
<td>50%</td>
<td>17</td>
<td>1.6</td>
<td>3.2</td>
<td>49.0</td>
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<tr>
<td>Total &amp; Avg Airflows</td>
<td>664,236</td>
<td>2.29</td>
<td>1.66</td>
<td>84.9%</td>
<td>=========</td>
<td>=564,169</td>
<td>CFM Outside Air</td>
<td>Blow-thru</td>
<td></td>
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### CHILLED WATER

<table>
<thead>
<tr>
<th>Building</th>
<th>Tons</th>
<th>CFM / Tons</th>
<th>CFM / 1000 cfm</th>
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</thead>
<tbody>
<tr>
<td>Labs incl. LER</td>
<td>1.00</td>
<td>332,880</td>
<td>2.98</td>
</tr>
<tr>
<td>Lab Support</td>
<td>0.23</td>
<td>76,176</td>
<td>2.98</td>
</tr>
<tr>
<td>Office / Admin Support</td>
<td>0.19</td>
<td>98,190</td>
<td>1.89</td>
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<tr>
<td>Core Labs</td>
<td>0.08</td>
<td>24,000</td>
<td>2.98</td>
</tr>
<tr>
<td>Bldg Support</td>
<td>0.15</td>
<td>15,594</td>
<td>2.07</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>0.14</td>
<td>12,670</td>
<td>2.98</td>
</tr>
<tr>
<td>Bridges</td>
<td>-</td>
<td>-</td>
<td>1.17</td>
</tr>
<tr>
<td>Education (incl. Auditor)</td>
<td>-</td>
<td>-</td>
<td>1.25</td>
</tr>
<tr>
<td>Animals</td>
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<tr>
<td>SubTotal</td>
<td>1.96</td>
<td>664,236</td>
<td>2.95</td>
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### Research Complex 2 Program Plan

**University of Colorado Health Sciences Center**  
Fentress Bradburn - Kling - GPR Planners

#### Process loads

<table>
<thead>
<tr>
<th>Description</th>
<th>Tons</th>
<th>Based on a maximum of</th>
<th>of HVAC loads</th>
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<tr>
<td><strong>TOTAL Chilled Water</strong></td>
<td>2.060</td>
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#### STEAM (HEATING)

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<th>Lbs/Hr.</th>
<th>CFM</th>
<th>Basis</th>
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<tr>
<td>Preheat</td>
<td>40,400</td>
<td>648,642</td>
<td>Based on Entering, Leaving and Room Conditions shown below for Biology &amp; Animal areas only</td>
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<tr>
<td>Reheat</td>
<td>4,900</td>
<td>648,642</td>
<td>Based on 40% reheat for Biology, on 0% reheat for Support areas and 75% reheat for Animal areas</td>
</tr>
<tr>
<td>Building Heating</td>
<td>4,800</td>
<td>289,100</td>
<td>Based on a 110 x 291.5 ft. bldg. With 16 ft Floor-to-Floor and 20 floors [2 below grade]</td>
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<tr>
<td>Domestic HW</td>
<td>5,600</td>
<td>7,100</td>
<td>Based on Water Flow Rates shown below for Domestic, Laboratory, Animal and Food Service</td>
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<tr>
<td>Process</td>
<td>6,800</td>
<td>14,300</td>
<td>Moisture added based on Entering, Leaving and Room Conditions shown below</td>
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<td><strong>TOTAL Steam</strong></td>
<td>79,400</td>
<td>197.96</td>
<td>Steam requirements assume 950 Btu / Lb. Steam and 5% system losses.</td>
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#### CITY WATER

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<thead>
<tr>
<th>Description</th>
<th>GPM</th>
<th>GPD</th>
<th>Based on Water Flow Rates shown below for Domestic, Laboratory, Animal and Food Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>86</td>
<td>20,600</td>
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</tr>
<tr>
<td>Lab</td>
<td>209</td>
<td>50,100</td>
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<tr>
<td>Animal / Cagewash</td>
<td>34</td>
<td>8,200</td>
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<tr>
<td><strong>SubTotal</strong></td>
<td>329</td>
<td>78,900</td>
<td></td>
</tr>
<tr>
<td>Cooling Tower Make-up</td>
<td>87</td>
<td>34,700</td>
<td>Based on Make-up Water Flow Rates shown below for Condenser Water</td>
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<tr>
<td><strong>TOTAL WATER</strong></td>
<td>416</td>
<td>113,600</td>
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#### Sanitary Sewer

<table>
<thead>
<tr>
<th>Description</th>
<th>GPD</th>
<th>Based on Blow-down Make-up Water Flow Rates shown below but excluding Evaporation from Cooling Towers</th>
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</thead>
<tbody>
<tr>
<td>Sanitary Sewer</td>
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</tbody>
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#### POWER

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<tr>
<th>Description</th>
<th>KVA</th>
<th>Watts / NSF</th>
<th>Watts / GSF</th>
<th>Based on Power Densities shown below</th>
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<tr>
<td>Normal</td>
<td>5,800</td>
<td>20,00</td>
<td>14.50</td>
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<tr>
<td>Emergency / Standby</td>
<td>1,100</td>
<td>3.79</td>
<td>2.75</td>
<td>Based on Emergency Densities shown below. Mostly for Animals esp. HVAC AHUs and Ch. Water.</td>
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#### General Assumptions

<table>
<thead>
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<th>Description</th>
<th>Winter</th>
<th>Summer</th>
<th>Basis</th>
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<tbody>
<tr>
<td><strong>Environmental</strong></td>
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<tr>
<td>Ambient Conditions</td>
<td>DB</td>
<td>Rel.Hum</td>
<td>Hum.Ratio</td>
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<td>Labs incl. LER</td>
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<td>20%</td>
<td>0.000085</td>
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<tr>
<td>Lab Support</td>
<td>-15</td>
<td>20%</td>
<td>0.000085</td>
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<tr>
<td>Office / Admin Support</td>
<td>-15</td>
<td>20%</td>
<td>0.000085</td>
</tr>
<tr>
<td>Core Labs</td>
<td>-15</td>
<td>20%</td>
<td>0.000085</td>
</tr>
<tr>
<td>Bldg Support</td>
<td>-15</td>
<td>20%</td>
<td>0.000085</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>-15</td>
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<td>0.000085</td>
</tr>
<tr>
<td>Bridges</td>
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</tr>
<tr>
<td>Education (incl. Auditor.)</td>
<td>-15</td>
<td>20%</td>
<td>0.000085</td>
</tr>
<tr>
<td>Animals</td>
<td>-15</td>
<td>20%</td>
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</table>
### Room Conditions

<table>
<thead>
<tr>
<th></th>
<th>DB</th>
<th>Rel.Hum</th>
<th>Hum.Ratio</th>
<th>DB</th>
<th>Rel.Hum</th>
<th>Enthalpy</th>
<th>Hum.Ratio</th>
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<tbody>
<tr>
<td>Labs incl. LER</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
</tr>
<tr>
<td>Lab Support</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
</tr>
<tr>
<td>Office / Admin Support</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
</tr>
<tr>
<td>Core Labs</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
</tr>
<tr>
<td>Bldg Support</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>70</td>
<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
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</tr>
<tr>
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<td>30%</td>
<td>0.005664</td>
<td>72</td>
<td>53%</td>
<td>29.08</td>
<td>0.010798</td>
<td>54.02</td>
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<tr>
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<td>50%</td>
<td>28.40</td>
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### Supply Air Conditions

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<th>Hum.Ratio</th>
<th>WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs incl. LER</td>
<td>52</td>
<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
<td>Lab Support</td>
<td>52</td>
<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
<td>Office / Admin Support</td>
<td>52</td>
<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
<td>Core Labs</td>
<td>52</td>
<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
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<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>52</td>
<td>98.81%</td>
<td>23.23</td>
<td>0.009917</td>
<td>51.8</td>
</tr>
<tr>
<td>Bridges</td>
<td>56</td>
<td>97.78%</td>
<td>25.80</td>
<td>0.011386</td>
<td>55.6</td>
</tr>
<tr>
<td>Education (incl. Auditor)</td>
<td>56</td>
<td>97.78%</td>
<td>25.80</td>
<td>0.011386</td>
<td>55.6</td>
</tr>
<tr>
<td>Animals</td>
<td>49</td>
<td>98.75%</td>
<td>21.34</td>
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<td>48.8</td>
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</tbody>
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### WATER

#### Gallons per Day (GPD)

<table>
<thead>
<tr>
<th></th>
<th>Domestic / Person</th>
<th>Laboratory / Scientist</th>
<th>Food Serv / Meal</th>
<th>Wash / SF Animal</th>
<th>Peak Hour % Daily</th>
<th>Hot Water EWT °F</th>
<th>LWT °F</th>
<th>Cond.Water % Daily</th>
<th>Cooling Tower Make-up Water GPM / TON</th>
<th>Peak Day FLH / Day</th>
<th>% Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water</td>
<td>15.0</td>
<td>60.0</td>
<td>2.0</td>
<td>0.600</td>
<td>25%</td>
<td>50</td>
<td>140</td>
<td>0.75%</td>
<td>2.8</td>
<td>10</td>
<td>15%</td>
</tr>
<tr>
<td>Hot Water</td>
<td>2.0</td>
<td>5.0</td>
<td>1.0</td>
<td>0.500</td>
<td>25%</td>
<td>50</td>
<td>140</td>
<td>0.25%</td>
<td>2.8</td>
<td>10</td>
<td>15%</td>
</tr>
</tbody>
</table>

### POWER

#### Normal (Density)

<table>
<thead>
<tr>
<th></th>
<th>Misc.Power / Person</th>
<th>Lighting / Watts / NSF</th>
<th>AHUS, etc / KVA</th>
<th>Central Plant / kW / Ton</th>
<th>Misc.Power / Person</th>
<th>Lighting / Watts / NSF</th>
<th>AHUS, etc / KVA</th>
<th>Central Plant / KVA</th>
<th>Totals / KVA</th>
<th>% Normal</th>
<th>Misc.Power / Person</th>
<th>Lighting / Watts / NSF</th>
<th>AHUS, etc / KVA</th>
<th>Central Plant / KVA</th>
<th>% Normal</th>
<th>% Normal</th>
<th>% Normal</th>
<th>% Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs incl. LER</td>
<td>12.5</td>
<td>2.5</td>
<td>9.0</td>
<td>0.250</td>
<td>1,460</td>
<td>292</td>
<td>1,051</td>
<td>250</td>
<td>3,053</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Lab Support</td>
<td>10.0</td>
<td>2.5</td>
<td>8.0</td>
<td>0.250</td>
<td>1,368</td>
<td>294</td>
<td>1,100</td>
<td>200</td>
<td>3,053</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Office / Admin Support</td>
<td>3.0</td>
<td>2.0</td>
<td>5.0</td>
<td>0.250</td>
<td>131</td>
<td>293</td>
<td>129</td>
<td>100</td>
<td>2,053</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Core Labs</td>
<td>12.5</td>
<td>2.5</td>
<td>10.0</td>
<td>0.250</td>
<td>125</td>
<td>25</td>
<td>200</td>
<td>100</td>
<td>2,053</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Bldg Support</td>
<td>5.0</td>
<td>1.5</td>
<td>5.0</td>
<td>0.250</td>
<td>82</td>
<td>20</td>
<td>82</td>
<td>100</td>
<td>1,053</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Corridors (non-Animal)</td>
<td>0.5</td>
<td>1.5</td>
<td>3.0</td>
<td>0.250</td>
<td>8</td>
<td>25</td>
<td>49</td>
<td>10</td>
<td>92</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

---

Because of low ambient humidity and because airflow is load driven, units are Blowthru.
| Bridges | 0.5 | 1.0 | 3.0 | 0.250 | - | - | - | - | - | 0% | 5% | 0% | 0% |
| Education (incl. Auditor) | 3.0 | 3.0 | 5.0 | 0.250 | - | - | - | - | - | 0% | 5% | 0% | 0% |
| Animals | 4.0 | 2.0 | 10.0 | 0.250 | 124 | 62 | 310 | 95 | 591 | 100% | 100% | 100% | 100% |

| Lbls incl. LER | Normal (Density) | Watts / NSF | Normal (Loads) | Emergency (Loads) |
| Lab Support | 26.14 | 9.38348031 | 146 | 29 | 210 | 25 |
| Office / Admin Support | 22.06 | 11.73 |
| Core Labs | 27.00 |
| Bidg Support | 12.24 | 5.61 | 1 |
| Corridors (non-Animal) | 19.07 | 6.1 |
| Bridges | #DIV/0! |
| Education (incl. Auditor) | #DIV/0! |
| Animals | #DIV/0! |
| TOTALS | 2,349 | 647 | 2,265 | 490 | 5,752 | 270 | 93 | 520 | 120 |
Appendix C
Space Layouts
Space Layout - Table of Contents

Research – Lab Support
Entry / Glassware Alcove
Equipment Alcove
Fumehood Alcove
Tissue Culture Alcove
Microscopy Alcove
Procedure Room
Glasswash
Environmental Room
Dry Darkroom

Research – Office / Amenity
Office

Core Lab
BSL3 Suite
Iodination room

Vivarium
Typical Suite
Animal Research Lab (16x22)
Animal Research Lab (10x22)

Vivarium – Procedure
Procedure Room

Vivarium – Animal Support
Cage / Rack Wash
Animal Dock
Animal Receiving

Vivarium – Office / Amenity
DVM Office
Administrative Support
Break / Conference
Locker Room
Building Amenities
Lobby / Prefunction
Warming Kitchen

Building Support
Loading Dock
Infectious Waste Hold
Research -
Lab Support
Entry/Glassware Alcove

Architecture
- Floor: vinyl composition tile
- Walls: enamel painted
- Ceiling: vinyl clad, acoustic tile
- Doors: 30/16 pair casework: wood

Mechanical
- Temperature: 72°F ± 2°F
- Humidity: 30-55% ± 5%
- Air changes: 10-12/hour
- Air circulation: 100% fresh air
- Hours of operation: 24 hrs/day
- Pressure: negative
- Hoods: none

Plumbing
- Hot water: none
- Piped services: none
- Other gases: none
- Drains: none
- Safety shower: none
- Eyewash: none

Electrical
- Voltage: 110V 20a 15A
- Emergency power: no
- Voice/data ports: yes
- Lighting: fluorescent: 80 fc

Scientific Equipment (of note)
- Varies by user

Remarks

Dimensions/Specs
- Nominal area: 100
- Linear feet bench: 0
- Linear feet shelves: 0
- Linear foot storage: 10
- No. of sinks: 0

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Research Lab Support
Equipment Alcove

- architecture
  - floor: vinyl composition tile
  - walls: enamel painted gypsum wall board
  - ceiling: vinyl clad acoustic tile
  - doors: none casework: none

- mechanical
  - temperature: 74°F +/- 2°F
  - humidity: 30-55% +/- 5%
  - air changes: 10-12/hr
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: positive

- electrical
  - voltage: 110V 20a
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent: 80 fc

- plumbing
  - hv/0: none
  - piped services: none
  - other gases: none
  - drains: none
  - safety shower/eyewash: none

- sci. equip (ofoi)
  - varies by user

- remarks

- dimensions/specs
  - nominal area: 100
  - linear feet bench: 0
  - linear feet shelves: 0
  - linear feet storage: 0
  - no. of sinks: 0

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Research Lab Support
Equipment Alcove

- **architecture**
  - floor: vinyl composition tile
  - walls: enamel painted
  - ceiling: vinyl cld. acoustic tile
  - doors: none
  - casework: none

- **electrical**
  - voltage: 110V 20a 16
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent: 80 ft

- **sci. equip (ofoi)**
  - varies by user

- **mechanical**
  - temperature: 74c +/- 20f
  - humidity: 30-55% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - positive pressure: none
  - hoods: none

- **plumbing**
  - piped services: none
  - other gases: none
  - drains: none
  - safety shower/eyewash: none

- **dimensions/specs**
  - nominal area: 100
  - linear feet bench: 0
  - linear feet shelves: 0
  - linear feet storage: 0
  - no. of sinks: 0

---

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Research - Lab Support
Tissue Culture Alcove

- architecture
  floor: vinyl composition tile
  walls: enamel painted
  gypsum wall board
  ceiling: vinyl cltid. acoustic tile
  doors: none
casework: wood

- mechanical
  temperature: 72°F +/- 2°F
  humidity: 30-55% +/- 5%
  air changes: 19-12/hour
  air circulation: 100% fresh air
  hours of operation: 24 hrs/day
  pressure: positive
  hoods: 6’ biological hood

- electrical
  voltage: 110V 20a 1Ø
  208V 30a 3Ø
  emergency power: no
  voice/data ports: yes
  lighting: fluorescent: 80 ft

- sci. equip (ofi)
  - incubator

- plumbing
  h0: available
  piped services: available
  other gases: none
  drains: none
  safety shower/eyewash: none

- dimensions/specs
  nominal area: 100
  linear feet bench: 6
  linear feet shelves: 6
  linear feet storage: 4
  no. of sinks: 0

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## Research -
Lab Support
Microscopy Alcove

### Architecture
- **Floor:** vinyl composition tile
- **Walls:** enamel painted gypsum wall board
- **Ceiling:** vinyl ctd. acoustic tile
- **Doors:** sliding casework
- **Cabinets:** movable tables

### Electrical
- **Voltage:** 110V 20a 10 208V 30a 39
- **Emergency power:** no
- **Voice/data ports:** yes
- **Lighting:** fluorescent 80 fc

### Mechanical
- **Temperature:** 72c +/- 2f
- **Humidity:** 30-55% +/- 5%
- **Air Changes:** 10-12/hour
- **Air Circulation:** 100% fresh air
- **Hours of Operation:** 24 hrs/day
- **Positive Pressure:** none
- **Hoods:** none

### Plumbing
- **Hot:** none
- **Piped Services:** none
- **Other Gases:** none
- **Drains:** none
- **Safety Shower/Eyewash:** none

### Sci. Equip (ofic)
- **Microscopes**

### Dimensions/Specs
- **Nominal Area:** 100
- **Linear Feet Bench:** 21
- **Linear Feet Shelves:** 21
- **Linear Feet Storage:** 0
- **No. of Sinks:** 0

### Remarks
- Light dimming capability
Research -
Lab Support
Procedure Room

- architecture
  - floor: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-resist, gypsum board with epoxy paint
  - doors: 40 casework: phenolic

- electrical
  - voltage: 110V 20a 16
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent: 80 fc vapor resistant

- mechanical
  - temperature: 700f
  - humidity: 30-55% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: adjustable/variable
  - hoods: bio-safety cabinets

- plumbing
  - h2o: hot/cold
nenamed services: gas/vac
  - other gases: cylinders
  - drains: sink
  - safety shower/eyewash: none

- sci. equip (ofoi)
  - varies by user

- remarks

- dimensions/specs
  - nominal area: 200
    - linear feet bench: 16
    - linear feet shelves: 22
    - linear feet storage: 0
    - no. of sinks: 1

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Research - Lab Support
GlassWash

- architecture
  floor: seamless vinyl
  walls: cement board w/ epoxy paint
  ceiling: lay-in fiberglass panels
  doors: 36 casework: phenolic resin

- mechanical
  temperature: 72°C +/- 2°F
  humidity: 30-55% +/- 5%
  air changes: 10-12/hour
  air circulation: 100% fresh air
  hours of operation: 24 hrs/day
  pressure: positive
  hoods: canopy hood

- electrical
  voltage: 110 20a 10/208 30a 3ph
  emergency power: no
  voice/data ports: yes
  lighting: fluorescent, vapor resistant

- sci. equip (ofoi)
  - varies by user

- plumbing
  hot/cold: 80 psi steam,
  purified water
  other gases: none
  drains: double sink, fr. sink
  safety shower/eyewash: yes

- remarks

- dimensions/specs
  nominal area: 400
  linear feet bench: 20
  linear feet shelves: 10
  linear feet storage: 0
  no. of sinks: 2

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Research
Lab Support
Enviromental Room

- architecture
  floor: seamless vinyl en insulated panels
  walls and ceiling: insulated panels w/baked-en polyester
  doors: 3x casework: stainless steel

- mechanical
  temperature: 4-37°C +/- 5°C
  humidity: 30-65% +/- 5%
  air changes: 0.5 cfm/ft²
  air circulation: 100% fresh air
  hours of operation: 24 hrs/day
  pressure: neutral
  hoods: none

- electrical
  voltage: 110V 20a 16
  emergency power: yes
  voice/data ports: yes
  lighting: fluorescent vapor proof
  gas: none
  conduits: 1

- plumbing
  hot water: 120°F
  cold water: 100°F
  toilets: 2
  other gases: none
  drains: safety shower/eyewash
  sink: none

- sci. equip (ofol)
  - varies by user

- remarks

- dimensions/specs
  nominal area: 100 linear feet bench: 21 linear feet shelves: 19 linear feet storage: 0 no. of sinks: 1

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Research -
Lab Support
Dry Darkroom

- architecture
  - floor: seamless vinyl
  - walls: gyp. bd./epoxy
  - ceiling: water-prf gyp. bd/plhd.
  - doors: light tight door
  - casework: wood

- mechanical
  - temperature: 72°c +/- 2°f
  - humidity: 30%-56% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - positive hoods: none

- electrical
  - voltage: 110V 20a 1φ
  - 208V 30a 3φ
  - emergency power: no
  - voice/data ports: yes
  - lighting: incandescent, safe light

- sci. equip (ofoi)
  - x-omat

- plumbing
  - h/c: hot/cold
  - piped services: none
  - other gases: none
  - drains: floor
  - safety shower/eyewash: none

- dimensions/specs
  - nominal area: 50
  - linear feet bench: 10
  - linear feet shelves: 10
  - linear feet storage: 0
  - no. of sinks: 0

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Core Lab -
Iodination Room

architecture
- floor: seamless vinyl
- walls: epoxy painted
- ceiling: epoxy ptd. gyp. bd.
- doors: std.
- casework: wood

mechanical
- temperature: 72°C +/- 2°F
- humidity: 30-55% +/- 5%
- air changes: 10-12/hour
- air circulation: 100% fresh air
- hours of operation: 24 hrs/day
- pressure: negative
- hoods: one dedicated/filtered exhaust

plumbing
- hot/cold piping services: gas/vac/air
- other gases: cylinders
- drains: sink, cup sink
- safety shower/eyewash: none

electrical
- voltage: 110V 20a 1φ
- 208V 30a 3φ
- emergency power: yes
- voice/data ports: yes
- lighting: fluorescent: 80 fc
- sci. equip (ofoi) - varies by user
- remarks

dimensions/specs
- nominal area: 200
- linear feet bench: 35
- linear feet shelves: 35
- linear feet storage: 0
- no. of sinks: 1

University of Colorado Health Science Center, Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects Kling Lindquist
07 April 2003
Vivarium -
Typical Suite
(includes Aquatics, Animal)

- architecture
  - floors: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-realt, gypsum
  - doors: varies
  - casework: solid melamine

- mechanical
  - temperature: 70°F
  - humidity: 30-55% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: adjustable/variable
  - hoods: bio-safety cabinet

- electrical
  - voltage: 110V 20a 1φ
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent; 80 fc
  - vapor resistant

- sci. equip (ofoi)
  - cage racks

- plumbing
  - hot/cold piped services: gas/vac
  - other gases: cylinders
  - drains: sink/scrub sink
  - safety shower/eyewash: none

- dimensions/specs
  - nominal area: 2100
  - linear feet bench: 22
  - linear feet shelves: 22
  - linear feet storage: 0
  - no. of sinks: 3

University of Colorado Health Science Center. Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects King Lindquist
(07 April 2003)
Vivarium -
Animal Research Lab (16x22)

- architecture
  - floor: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-resist, gypsum
  - board with epoxy paint
  - doors: 3'-6" casework: phenolic

- mechanical
  - temperature: adjustable, 66-84°F
  - humidity: 30-70% +/- 5%
  - air changes: 15/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: adjustable/variable
  - hoods: none

- electrical
  - voltage: 110V 20A 1Ø
  - emergency power: yes
  - voice/data ports: yes
  - lighting: 3 systems: programmable, fluorescent, red

- plumbing
  - hot/cold
  - piped services: none
  - other gases: none
  - drains: sink, floor
  - safety shower/eyewash: none

- sci. equip (ofoil)
  - cage racks
  - animal racks

- remarks

- dimensions/specs
  - nominal area
  - linear feet bench: 0
  - linear feet shelves: 0
  - linear feet storage: 0
  - no. of sinks: 1

University of Colorado Health Science Center, Fentress Bradburn Architects, Kling Lindquist
07 April 2003
Vivarium -
Animal Research Lab
(10x22)
**Vivarium - Procedure**

**Procedure Room**

- **architecture**
  - floor: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-resist gypsum board with epoxy paint
  - doors: 40 casework
  - phenolic

- **electrical**
  - voltage: 110V 20a 1p
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent: 80 fc vapor resistant

- **mechanical**
  - temperature: 700f
  - humidity: 30-55% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: adjustable/variable
  - hoods: bio-safety cabinet

- **plumbing**
  - hot/cold services: gas/vac
  - other gases: cylinders
  - drains: sink
  - safety shower/eyewash: none

- **sci. equip (ofoi)**
  - varies by user

- **dimensions/specs**
  - nominal area: 220
  - linear feet bench: 22
  - linear feet shelves: 22
  - linear feet storage: 0
  - no. of sinks: 1

---

University of Colorado Health Science Center - Research Complex 2 at Fitzsimons
GPR Planners Collaborative Inc. - Fentress Bradburn Architects - Kling Lindquist
07 April 2003

Research Complex 2 Program Plan
University of Colorado Health Sciences Center
Fentress Bradburn - Kling - GPR Planners
**Vivarium - Animal Support**

Cage/Rack Wash Room

- architecture
  - floor: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-resist. gypsum board with epoxy paint
  - doors: 40 casework: none

- mechanical
  - temperature: 68-72°F
  - humidity: 30-70% +/- 5%
  - air changes: 10-12/hr
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: soiled: negative clean: positive
  - hoods: canopy hoods

- electrical
  - voltage: 110V 20a 1φ
  - as required for equipment
  - emergency power: yes
  - voice/data ports: yes
  - lighting: fluorescent

- sci. equip (ofoi)
  - cage racks
  - animal cages

- plumbing
  - h2o: hot/cold
  - piped services: none
  - other gases: none
  - drains: floor sinks
  - floor trenches

- dimensions/specs
  - nominal area: 1000
    - linear feet bench: 10
    - linear feet shelves: 10
    - linear feet storage: 0
    - no. of sinks: 2

---

University of Colorado Health Science Center

Research Complex 2 At Fitzsimons

GPR Planners Collaborative Inc.  Fentress Bradburn Architects  Kling Lindquist

07 April 2003
Vivarium -
Animal Support
Animal Dock

- architecture
  - floor: sealed concrete
  - walls: cmu
  - ceiling: none
  - doors: std.
  - casework: none

- mechanical
  - temperature: std.
  - humidity: std.
  - air changes: code
  - air circulation: code
  - hours of operation: 24 hrs/day
  - pressure: neutral
  - hoods: none

- electrical
  - voltage: 110V 20a 1Φ
  - emergency power: no
  - voice/data ports: yes
  - lighting: fluorescent, natural daylight

- plumbing
  - h2O: none
  - piped services: none
  - other gases: none
  - drains: none
  - safety shower/eyewash: none

- sci. equip (ofoi)

- remarks

University of Colorado Health Science Center. Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects Kling Lindquist
07 April 2003
### Vivarium - Animal Support
#### Animal Receiving

**Carcass Holding**

<table>
<thead>
<tr>
<th><strong>architecture</strong></th>
<th><strong>electrical</strong></th>
<th><strong>sci. equip (ofoi)</strong></th>
<th><strong>remarks</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>floor: sealed concrete walls</td>
<td>voltage: 110V 20a 10</td>
<td>emergency power: no</td>
<td></td>
</tr>
<tr>
<td>ceiling: acoustic tile</td>
<td>emergency power: no</td>
<td>voice/data ports: yes</td>
<td></td>
</tr>
<tr>
<td>doors: std. casework</td>
<td>lighting: fluorescent</td>
<td>natural daylight</td>
<td></td>
</tr>
<tr>
<td><strong>mechanical</strong></td>
<td><strong>plumbing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature: std. humidity: std.</td>
<td>hot/cold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>air changes: code</td>
<td>piped services: none</td>
<td></td>
<td></td>
</tr>
<tr>
<td>air circulation: code</td>
<td>other gases: none</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hours of operation: 24 hrs/day</td>
<td>drains: safety shower/eyewash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pressure: neutral hoods: none</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>dimensions/specs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nominal area: 300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>linear feet bench: 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>linear feet shelves: 25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>linear feet storage: 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no. of sinks: 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

University of Colorado Health Science Center.  Research Complex 2 at Fitzsimons  GPR Planners Collaborative Inc.  Fentress Bradburn Architects  Kling Lindquist  07 April 2003
Vivarium - Office/Amenity
DVM Office

- architecture
  - floor: carpet
  - walls: painted gypsum board
  - ceiling: acoustic tile
  - doors: std.
  - casework: wood

- mechanical
  - temperature: std.
  - humidity: std.
  - air changes: code
  - air circulation: code
  - hours of operation: 24 hrs/day
  - pressure: neutral
  - hoods: none

- electrical
  - voltage: 110V 20a 19
  - emergency power: no
  - voice/data ports: yes
  - lighting: fluorescent, natural daylight

- sci. equip (ofoi)
  - computers

- plumbing
  - h20: none
  - piped services: none
  - other gases: none
  - drains: none
  - safety shower/eyewash: none

- dimensions/specs
  - nominal area: 120
  - linear feet bench: 0
  - linear feet shelves: 0
  - linear feet storage: 0
  - no. of sinks: 0

---

University of Colorado Health Science Center - Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc - Fentress Bradburn Architects - Kling Lindquist
07 April 2003
### Vivarium - Office/Amenity
Admin. Support

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Electrical</th>
<th>Sci. Equip (OFO)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>floor: carpet walls: painted gypsum board</td>
<td>voltage: 110V 20a 16</td>
<td>-computers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical</th>
<th>Plumbing</th>
<th>Dimensions/Specs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature: std. humidity: std. air changes: code air circulation: code hours of operation: 24 hrs/day pressure: positive hoods: none</td>
<td>piped services: none other gases: none drains: none safety shower/ eyewash: none</td>
<td>nominal area: 120 linear feet bench: 0 linear feet shelves: 0 linear feet storage: 0 no. of sinks: 0</td>
<td></td>
</tr>
</tbody>
</table>

---

University of Colorado Health Science Center, Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects Kling Lindquist
07 April 2003
Vivarium -
Office Amenity
Locker Room

- architecture
  - floor: monolithic epoxy
  - walls: CMU, epoxy paint
  - ceiling: water-resistant, gypsum board with epoxy paint
  - doors: 3'-0" casework, solid melamine

- electrical
  - voltage: 110V 20a 1Ø
  - emergency power: no
  - voice/data ports: yes
  - lighting: fluorescent

- sci. equip (ofoi)
  - -lockers
  - -drop down bench

- mechanical
  - temperature: 66-72°F
  - humidity: 30-70% +/- 5%
  - air changes: 10-12/hour
  - air circulation: 100% fresh air
  - hours of operation: 24 hrs/day
  - pressure: positive
  - hoods: none
  - other gases: none
  - drains: sealed flr drain shower stall

- plumbing
  - hot/cold
  - piped services: none

- dimensions/specs
  - nominal area: 300
  - linear feet bench: 6
  - linear feet shelves: 0
  - linear feet storage: 8
  - no. of sinks: 0

University of Colorado Health Science Center
GPR Planners Collaborative Inc. • Fentress Bradburn Architects • King Lindquist

17 April 2000
### Building Amenities

#### Lobby/Prefunction

<table>
<thead>
<tr>
<th>architectural features</th>
<th>electrical features</th>
<th>sci. equip (ofoi)</th>
<th>remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>floor: stone special</td>
<td>voltage: 110V 20a 1ф</td>
<td>- varies by user</td>
<td></td>
</tr>
<tr>
<td>walls: special</td>
<td>emergency power: no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ceiling: special</td>
<td>voice/data ports: yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>doors: 72&quot;, none</td>
<td>lighting: fluorescent, incandescent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>casework: none</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mechanical features</th>
<th>plumbing features</th>
<th>dimensions/specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature: std.</td>
<td>h2O: none</td>
<td>nominal area: 2000</td>
</tr>
<tr>
<td>humidity: std.</td>
<td>piped services: none</td>
<td>linear feet bench: 0</td>
</tr>
<tr>
<td>air changes: code</td>
<td>other gases: none</td>
<td>linear feet shelves: 0</td>
</tr>
<tr>
<td>air circulation: code</td>
<td>drains: none</td>
<td>linear feet storage: 0</td>
</tr>
<tr>
<td>hours of operation: std.</td>
<td>safety shower/</td>
<td>no. of sinks: 0</td>
</tr>
<tr>
<td>pressure: neutral</td>
<td>eyewash: none</td>
<td></td>
</tr>
<tr>
<td>hoods: none</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

University of Colorado Health Science Center. Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects. Kling Lindquist
17 May 1999
Building Amenities
Warming Kitchen

- Architecture
  - Floor: vinyl composition tile
  - Walls: painted gypsum board
  - Ceiling: vinyl std. acoustic tile
  - Doors: std.
  - Casework: wood

- Electrical
  - Voltage: 110V 20a 1Φ
  - Emergency power: no
  - Voice/data ports: yes
  - Lighting: fluorescent

- Mechanical
  - Temperature: std.
  - Humidity: std.
  - Air changes: code
  - Air circulation: code
  - Hours of operation: std.
  - Pressure: neutral
  - Hoods: none

- Plumbing
  - Hot: none
  - Cold: none
  - Piped services: none
  - Other gases: none
  - Drains: Sink
  - Safety shower/eyewash: none

- Sci. Equip (ofoi)
  - Refrigerator

- Remarks

- Dimensions/Specs
  - Nominal area: 200
  - Linear feet/bench: 28
  - Linear feet shelves: 28
  - Linear foot storage: 28
  - No. of sinks: 1

University of Colorado Health Science Center - Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. - Fentress Bradburn Architects - Kling Lindquist
07 April 2003
Building Support
Infectious Waste Hold

- **architecture**
  - floor: sealed concrete
  - walls: painted gypsum board
  - ceiling: acoustic tile
  - doors: std.
  - casework: none

- **electrical**
  - voltage: 110V 20a 1φ
  - emergency power: no
  - voice/data ports: yes
  - lighting: fluorescent, natural daylight

- **mechanical**
  - temperature: std.
  - humidity: std.
  - air changes: code
  - air circulation: code
  - hours of operation: 24 hrs/day
  - pressure: neutral
  - hoods: none

- **plumbing**
  - h20: none
  - piped services: none
  - other gases: none
  - drains: none
  - safety shower/eyewash: none

- **sci. equip (ofo)**

- **dimensions/specs**
  - nominal area: 100
  - linear feet bench: 0
  - linear feet shelves: 0
  - linear feet storage: 0
  - no. of sinks: 0

---

University of Colorado Health Science Center. Research Complex 2 At Fitzsimons
GPR Planners Collaborative Inc. Fentress Bradburn Architects Kling Lindquist
07 April 2003

Research Complex 2 Program Plan
University of Colorado Health Sciences Center
Fentress Bradburn - King - GPR Planners

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Appendix D
Project Cost Model Detail

A copy of this material is available in the Office of Institutional Planning at the University of Colorado Health Sciences Center, 13001 E. 17th Place, Aurora, CO 80045-0508.
Appendix E

Laboratory-Functional and Technical Criteria
LABORATORY FUNCTIONAL AND TECHNICAL CRITERIA

1.0 ARCHITECTURAL

1.1 TYPICAL PLANNING MODULE. A typical laboratory planning module is the smallest practical laboratory environment and is the basis for all other laboratory sizes. Laboratory planning modules can be combined and/or subdivided to create the appropriate sized laboratory based on head count and/or function. The planning module for this project is dimensioned as follows (*: dimension inclusive of 6” nominal partition):

<table>
<thead>
<tr>
<th>Module Type</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Module</td>
<td>10’-6” o.c.</td>
<td>36’-0” clear</td>
</tr>
<tr>
<td>Laboratory Support Module</td>
<td>10’-6” o.c.</td>
<td>20’-0” clear</td>
</tr>
<tr>
<td>Office Module</td>
<td>10’-6” o.c.</td>
<td>12’-0” clear</td>
</tr>
</tbody>
</table>

1.2 CEILING HEIGHT. The recommended minimum clear obstruction height is 9’-6’. A hung ceiling is recommended for this facility to reduce HVAC loads (volume reduction) and dust accumulation (exposed pipes, ducts, pendant mounted lighting fixtures and spray-on fireproofing if required). The building floor to floor height of 16’-0” is recommended.

1.3 FLOOR LOADING. The recommended live load capacity for the laboratory and laboratory support portions of the building is 125 psf. (Local codes shall govern the design live load selection for the building).

1.4 CLEARANCES. For purposes of safe passage of occupants past people and equipment in aisles, the minimum recommended clearance between benches, or between a bench and a designated equipment area, is 5’-0” in the laboratories. The recommended clear corridor width leading into a laboratory is 6’-0”.

1.5 PERSONNEL/EQUIPMENT ACCESS. Provide a 42” door with between corridor and laboratory to facilitate personnel and equipment access. Provide a 42” wide door between laboratory and procedure spaces. All laboratories will have at least two (2) means of egress unless the functional laboratory unit is sufficiently small (e.g.: Cold Room, Dark Room, Single Module Lab, etc.).

1.6 ADA REQUIREMENTS (ACCESS AND WORKSTATION). Access to and within all laboratory areas shall meet ADA requirements. Provide the ability to modify all workstations that meet ADA requirements in all laboratory modules on a need basis in the future. To meet the disabled workstation requirements, we recommend the following:

   a. Counter top at standard low bench height of 31” A.F.F.
b. Knee space at least 32" wide with a clear height of at least 29" to underside of nearest obstruction (typically front apron). Provide 6" wide and 10" high toe space on at least one side of workstation.

c. Service fixtures located maximum 18" from front edge of counter top. Fixtures can be either standard or remote control type.

d. Sink drops shall occur at least 8" from front edge of counter top and trap shall be minimum 9" A.F.F. Provide two (2) sinks per floor.

e. Provide one (1) Fume hood per floor to meet ADA requirements.

1.7 NOISE. Ambient noise level in the laboratories shall meet RC40 (Room Criterion 40). Quality Assessment Index (QAI) shall not exceed 5 dB. Prevent acoustic levels due to intermittent activity occurring outside the laboratory from exceeding ambient noise level by more than 5 dB.

1.8 ARCHITECTURAL FINISHES. The following is a list of recommended architectural finishes for typical laboratory areas.

a. Typical Laboratory

   Floor: Vinyl composite tile (VCT) with 4" high vinyl coved base.
   Wall: 5/8" Gypsum wall board (GWB) with water-based, washable, low-luster paint. When wall is rated provide 5/8"X Gypsum wall board.
   Ceiling: 5/8" vinyl coated acoustic lay-in tile.
   Casework: Plastic laminate with epoxy or phenolic resin counter top and stainless steel or epoxy resin underside sink with integral overflow.

b. Glasswash

   Floor: Trowel-on epoxy with integral 4" high 1/8" radius coved based.
   Wall: 5/8" cement-board with water-based epoxy paint and isolation. Extend partitions to underside of structural slab.
   Ceiling: 2'-0"x 4'-0" lay-in fiberglass panels and grid equal to Kemlite. Provide soffit or canopy hood above washing and sterilizing equipment.
   Casework: Phenolic resin with type 316L stainless steel counter top and sink.
c. **Photographic Dark Room**

- **Floor**: Gray seamless vinyl with welded seams equal to Armstrong Medintech or trowel-on epoxy with integral 4” high ½” radius coved base.
- **Wall**: 5/8” cement-board with water based flat gray epoxy paint.
- **Ceiling**: 5/8” waterproof GWB with water-based flat gray epoxy paint.
- **Casework**: Plastic laminate equal to Kreonite with epoxy or phenolic resin counter top. Processing sinks should be molded fiberglass equal to Kreonite.

d. **Tissue Culture/Procedure Room/Microscopy**

- **Floor**: VCT with 4” high vinyl coved based.
- **Wall**: 5/8” GWB with water-based, washable, low-luster paint.
- **Ceiling**: 5/8” vinyl coated acoustic lay-in tile.
- **Casework**: Plastic laminate with epoxy or phenolic resin counter top and stainless steel or epoxy resin underside sink with integral overflow.

e. **Radioisotope Laboratory**

- **Floor**: Seamless vinyl with welded seams equal to Armstrong Medintech [or 1/8”-3/16” thick high-solids troweled-on epoxy; 1/8” thick methyl methacrylate (MMA)] with integral 4” high ½” radius coved based.
- **Wall**: 5/8” GWB with water-based epoxy paint.
- **Ceiling**: 5/8” GWB with water-based epoxy paint.
- **Casework**: Wood with stainless steel counter top and sink.

f. **Environmental Room (4 C/4-37C)**

- **Floor**: Prefabricated 2” thick metal clad insulated panels with seamless vinyl and integral 4” high ½” radius coved base. Depress structural floor slab 2” for recessed installation or provide ramp at entrance.
- **Wall**: Prefabricated 4” thick metal clad insulated panels with baked-on white polyester finish on galvanized steel.
- **Ceiling**: Prefabricated 4” thick metal clad insulated panels with baked-on white polyester finish on galvanized steel.
- **Casework**: Stainless steel base, counter top, sink and adjustable shelving.

1.9 **NATURAL LIGHT.** Laboratories shall have direct access to natural light. Window treatment (shades or blinds) shall be provided where appropriate to vary the amount of natural light entering the laboratory or office. Darkrooms, Tissue Culture Rooms, Cold Rooms and Warm Rooms shall avoid access to natural light.
1.10 LABORATORY UNIT HAZARD CLASSIFICATION. Laboratories will be Class C: Low Hazard as per NFPA 45 and quantities of flammable or Liquid Class I, II and IIA combustible liquids shall not exceed 8 gallons per 100 square feet of laboratory unit or 400 gallons in a sprinklered laboratory unit. These quantities are superseded by UCHSC standards for flammable liquids in laboratories. A typical 36” wide flammable storage cabinet located under fume hoods can hold up to 22 gallons. According to NFPA 45, Class C laboratory doors do not have to swing in the direction of egress and laboratory partitions do not have to be fire rated.

1.11 VIBRATION CRITERIA. Limit center bay vibration velocity to 2000 microinches/second due to building resonance and footfall induced vibration including slow walking speed within labs and moderate walking speeds in adjacent corridors. Regions within 5 feet of columns shall be restricted to a vibration velocity of 600 microinches / second with inducer located at center of bay. This will provide a laboratory environment where approximately 45% of the lab is 500 and 1000 microinches/ second; approximately 10% is between 1000 and 1500 microinches/second; and only 20% is between 1500 and 2000 microinches/second.

For vibrations induced by mechanical equipment, structural slabs between lab and mechanical spaces shall be constructed to a minimum mass of 350 Kg/M² in order to provide an appropriate base for equipment isolators to work against. The design approach will then be to provide equipment isolation to preclude vibrations from being transferred into the structure.

1.12 SEISMIC DESIGN. Building is located in (local code) Earthquake Zone 1. Earthquake Zones 2B, 3 and 4 shall require shelving, cabinet and equipment restraints/tie downs.

1.13 BSL3 (BIOSAFETY LEVEL 3) SUITE SPECIAL ARCHITECTURAL CRITERIA. The following criteria is specific to this area:

a. General. Regulations require passage through two sets of doors for entry into the suite from an unrestricted corridor (this may also include a clothes-change room and shower). A sterilizer within the suite is recommended.

b. Personnel/Equipment Access. Provide Ante Room/Air Lock between Suite and corridor consisting of two sets of doors. Space for clothes-change area should be provided; a shower is not required by current regulations.

c. Doors and Hardware. Doors shall be provided with automatic closers [and closed cell neoprene gaskets on all three sides and a surface mounted automatic drop seal to facilitate gas decontamination procedures].
d. View Windows. View windows shall be closed and silicone sealed.

e. Architectural Finishes.
   Floor: Seamless vinyl with welded seams equal to Armstrong Medintech with integral 4” high ½” radius coved based.
   Wall: 5/8” GWB with water-based epoxy paint and minimum 1/2” radius coved corners.
   Ceiling: 5/8” GWB with water-based epoxy paint and minimum 1/2” radius coved corners.
   Casework: Plastic laminate with epoxy or phenolic resin counter top and stainless steel or epoxy resin underside sink with integral overflow.
   Perimeter ledge: Shall be fabricated of 5/8” GWB finished to match adjacent walls. All seams and joints shall be sealed with silicone

f. Penetrations. Penetrations in walls, floors and ceilings shall be silicone sealed or capable of being sealed to facilitate decontamination.

g. Decontamination. Chemical decontamination shall be employed.

h. Room Construction.
   1) Chemical Decontamination. Quality room construction with special consideration given to joints, finishes and penetrations.

i. Signage. Provide appropriate signage (universal biohazard symbol) at doors leading into BLS3 facilities.

j. Sterilizer. Double door (pass-through), high vacuum sterilizer shall be specified with cross-contamination seal and integral effluent decontamination. Enclosed equipment area for sterilizer should be highly ventilated to prevent build-up of heat and moisture.

NOTE: Systems and the validation process must begin at the start of the design process.

1.14 FLOOD PREVENTION. Allow for water to flow down stair and elevator shafts by requiring all slab penetrations to have a 2” above floor slab sealed sleeve and automatic duplex sump pumps in elevator wells.
2.0 HEATING, VENTILATING AND AIR CONDITIONING

2.1 GENERAL. The mechanical design shall be developed to meet the requirements of the new OSHA Laboratory standard, ASHRAE and the ANSI Laboratory Ventilation Standard # Z9.5.

2.2 SPACE TEMPERATURE AND HUMIDITY CRITERIA. The following inside design temperature (degrees Dry Bulb) and humidity (% Relative Humidity) conditions are recommended for all laboratory areas. Provide one thermostat per double module laboratory and office.

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp</td>
<td>Humidity</td>
</tr>
<tr>
<td>a. Typical Laboratory</td>
<td>72</td>
<td>55</td>
</tr>
<tr>
<td>b. Equipment Rms.</td>
<td>74</td>
<td>55</td>
</tr>
<tr>
<td>c. Procedure Rms.</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>d. BSL3 Suite</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>e. Offices/Amenities</td>
<td>72</td>
<td>55</td>
</tr>
</tbody>
</table>

2.3 VENTILATION CRITERIA. One hundred percent of the air supplied to the laboratory areas shall be exhausted. There shall be no recirculating of laboratory air. Supply air quantities shall be based upon heat loads, minimum dilution/ventilation requirements, and/or required make-up air for exhaust systems, whichever is greatest.

2.4 AIR CHANGE CRITERIA. While occupied, a minimum of 10-12 air changes per hour (ACPH) for dilution and/or removal of odors in laboratories shall be provided. Engineer shall calculate actual ACPH requirements based on exhaust device requirements and heat loads generated by equipment, people, lighting and solar heat gain. While unoccupied, the minimum ACPH in laboratories can be reduced to 5-6 if acceptable environmental (temperature and humidity) parameters can be maintained.

2.5 PRESSURIZATION CRITERIA. All laboratories shall be negative with respect to the corridor or adjacent space, unless otherwise noted. The overall building shall be positive to atmosphere to avoid infiltration. The level of pressure differential shall be established by the Engineer.

2.6 FILTRATION/DEDICATED EXHAUST CRITERIA. All laboratory areas shall be supplied with air through 30% ASHRAE (atmospheric dust spot efficiency) efficient pre-filters and 95% DOP efficient final filters. Laboratories or equipment which require dedicated and/or special filtration of supply or exhaust air are listed below:
a. Radio-Chemical (also known as Radioisotope or Iodination) Fume Hoods require a dedicated exhaust (recommended material: welded type 316L stainless steel) with carbon and HEPA filters (HEPA down stream of carbon to trap particles).

b. Class II, Type B2 Biological Safety Cabinets (100% exhaust) may require a dedicated exhaust due to high static pressure of 1.4-2.0" WC for 6 ft unit or 1.0-1.4" WC for a 4 ft unit.

d. Environmental and cold rooms used as warm or cold laboratories will be ventilated at 0.5 CFM/square foot.

2.7 BUILDING OPERATING SCHEDULE. All laboratory M.E.P. systems shall be operable 24 hours, 7 days a week with varying degrees of occupancy in a 24 hour period.

2.8 FLEXIBILITY CRITERIA. Air distribution systems shall be designed to afford flexibility for future redesign, primarily by providing accessibility to the duct systems throughout the facilities and, where feasible, by applying a modular layout of air distribution devices and by providing symmetry and uniformity to the branch duct layout. Provisions shall be made to allow connection of up to 16 chemical fume hoods per floor. 50% of the laboratory modules (to be determined) might require two exhaust devices per laboratory module during the life of the building and the HVAC system shall be designed for this contingency.

2.9 WATTS/SQUARE FOOT. The HVAC System Shall Be Sized To Compensate For The Following Equipment Heat Loads (Not Including Lights Or People):

<table>
<thead>
<tr>
<th>Space</th>
<th>Watts/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Typical Laboratory</td>
<td>10</td>
</tr>
<tr>
<td>b. Equipment Room</td>
<td>16</td>
</tr>
<tr>
<td>c. Tissue Culture/Procedure Room</td>
<td>16</td>
</tr>
<tr>
<td>d. Analytical Laboratory</td>
<td>16</td>
</tr>
<tr>
<td>e. BSL3 Lab</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: Any room exceeding these values will be serviced with a local chilled water fan coil unit that will recirculate and cool the room air.

2.10 NOISE CRITERIA. Ambient noise levels from the HVAC system shall not exceed NC45 in laboratories. Noise levels shall not exceed NC50 at 36" from the center of a fume hood with the sash 50% open.
2.11 HVAC CONCEPT. The following HVAC concept is proposed for this facility:

a. Supply Location. Supply air diffusers shall be located so as not to create drafts or turbulence at fume hoods or biological safety cabinets.

b. Exhaust Location. Each alcove shall be exhausted at a common location and can accommodate an initial or future 5' fume hood, two 4' biological safety cabinets (Class II/Type A) or room exhaust register.

c. Manifold System. All laboratory exhaust (fume hoods and registers) shall be exhausted through a common exhaust duct, also referred to as a manifold system. Only specialty hoods (radio-chemical, perchloric or Class II Type B2 biological safety cabinet) or equipment that requires direct venting will have a dedicated exhaust and fan.

d. Exhaust Fan Redundancy. Manifolded exhaust system shall be on multiple fans, minimum two, each rated for 67% of the total load to compensate for maintenance or partial system failure.

e. Controls. All controls shall be DDC with electronic [or pneumatic] actuators.


1. Horizontal/Vertical restricted sash fume hoods shall be utilized to reduce overall building exhaust requirements (550 vs. 1,100 CFM per 5'-0" fume hood) and provide a safer work environment by reducing the sash opening (50% vs. 100%). Provide 100-cfm face velocity.

2. Heat Recovery. Heat recovery may be employed with either a glycol loop or a desiccant-based total-energy-recovery wheel (equal to Semco Corp.). To be evaluated by Engineer.

g. Supply/Exhaust System. (To be evaluated by Engineer.)

1. [Option 1] Two-Position Constant Volume. The supply and exhaust system shall be constant volume with a reduced constant volume when the laboratory is unoccupied. For planning purposes the unoccupied reduced volume shall be 50% with thermostat override. The primary components of this system are two-position constant volume boxes on the supply and exhaust from the laboratory module and fans connected to the manifolded system that can respond to an infinitely variable airflow.

2. [Option 2] Variable Air Volume (VAV): The supply and exhaust system shall be variable air volume with minimum air change criteria established for occupied and unoccupied times. During
occupied and unoccupied times, the air volume should be thermostat controlled and provide at least the minimum air change criteria. The primary components of this system are VAV boxes on the supply and exhaust from the laboratory module and fans connected to the manifolded system that can respond to an infinitely variable air flow.

h. Humidification. Amine-free steam should be used for all humidification applications.

2.12 FUME AND EXHAUST HOOD CRITERIA. Chemical fume hoods shall typically be 5'-0" bench type with horizontal/vertical restricted sashes, one 30" wide flammable base cabinet, one 18" wide corrosive acid base cabinet and one 12" wide base cabinet to conceal cup sink waste piping. Base cabinets will be vented behind the fume hood baffle and 12" above the counter top. Fume hoods shall have an average face velocity of 100 feet per minute. Fume hoods and biological safety cabinets will be equipped with an air flow monitor/audible-visual alarm. The following criteria have been provided for mechanical system planning:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description/Exhaust Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>FUM5 5'-0&quot; restricted sash (horizontal/vertical) bench hood: 650 CFM @ .22&quot; WC.</td>
</tr>
<tr>
<td>b.</td>
<td>BSC6 6'-0&quot; Class II, Type A biological safety cabinet.</td>
</tr>
<tr>
<td>c.</td>
<td>BSC4 4'-0&quot; Class II, Type A biological safety cabinet.</td>
</tr>
<tr>
<td>d.</td>
<td>BSC6X 6'-0&quot; Class II, Type B2 (100% exhaust) biological safety cabinet: 1,148 CFM +/-5% @ 2.0&quot; WC.</td>
</tr>
<tr>
<td>e.</td>
<td>BSC4X 4'-0&quot; Class II, Type B2 (100% exhaust) biological safety cabinet: 702 CFM +/-5% @ 1.4&quot; WC.</td>
</tr>
<tr>
<td>f.</td>
<td>PE4 4&quot; point exhaust: 100-150 CFM.</td>
</tr>
<tr>
<td>g.</td>
<td>CNPY Canopy hood: 100 FPM/SF depending upon application.</td>
</tr>
<tr>
<td>h.</td>
<td>Down Downdraft surfaces: 100 cfm/sf down draft velocity at table surface for 100% smoke capture 12&quot; above the table.</td>
</tr>
</tbody>
</table>

2.13 ACCESS TO MECHANICAL EQUIPMENT. If building design includes an elevator, provisions shall be made to include a stop at the location of MEP equipment.
2.14 BSL3 SUITE SPECIAL HVAC CRITERIA. The following criteria is specific to this area:

a. Airflow/Pressurization Criteria. System for suite shall create directional airflow that draws air into the laboratory through the entry area. Personnel must verify that the direction of airflow is proper (typically accomplished by placing magnehelic gauge or other visual device next to each door) before opening a door. Controls to maintain pressure gradients should be active in this area. Relative pressure shall be maintained as follows:
   1) Ante Room/Air Lock: Negative to Linear Equipment Room and positive to Laboratories.
   2) Laboratories: Negative to Ante Room/Air Lock.

b. Exhaust Criteria. Dedicated exhaust system with 100% redundancy.

c. Filtration Criteria. Current regulations allow exhaust air from the laboratory room and HEPA filtered air from Class II biological safety cabinets to be discharged through a non-recirculating (100% exhaust) building exhaust system, without filtration prior to discharge to atmosphere; a dedicated exhaust is not required. We recommend a dedicated exhaust system for the BSL3 Suite designed to accommodate a future 100% redundant HEPA filtration system (including, but not limited to, bag-in/bag-out cabinets and fan sized for additional static load generated by HEPA filter) to accommodate potential regulation changes. Location of the future HEPA filter shall be carefully selected and dedicated to facilitate in-place filter decontamination, replacement and general maintenance.

d. Decontamination.
   [OPTION 1] Chemical Decontamination. No special provisions required.
   [OPTION 2] Gas Decontamination. The ability to isolate individual rooms in the BSL3 Suite for gas decontamination should be provided by employing user accessible, automatic or manual bubble-tight dampers. The controls should be located outside of rooms. Prior to decontamination, the supply damper should be closed first followed by the exhaust damper to prevent positively pressuring the room. After decontamination, the exhaust damper should be opened first, then the supply to prevent positively pressuring the room. A remotely operated, timer controlled electrical outlet for the formaldehyde frying pan is highly recommended.

3.0 ELECTRICAL

3.1 PRIMARY VOLTAGE. Laboratory areas will require 208/120 volt, 3-phase, 4 wire service for receptacles, small appliances and small (1/3 horsepower or less) motors. Elevators shall incorporate "Soft" starters to minimize any adverse effect on the power source.
3.2 SERVICE DISTRIBUTION. Each double module laboratory shall have an individual circuit breaker panel. Each panel shall have at least 25% spare breaker capacity above initial requirements. Each 120V/20A circuit shall not exceed four (4) receptacles. Alternate circuiting of adjacent duplex receptacles to minimize outages. It is recommended that electrical distribution be via surface mounted twin compartment (electrical and data; similar to Isoduct or Wiremold) electrical raceways at wall benches and peninsula benches. Factory pre-wiring of electrical raceways compared to field-wiring shall be explored for cost and scheduling implications. Duplex outlets shall be provided at a maximum of 2'-0" O.C., unless otherwise noted. Ground fault protection will be provided for outlets within 6'-0" (distance to be confirmed by electrical engineer based on local codes) of a sink edge. Circuits shall be confined to one side of the bench to facilitate identification if the laboratory is subdivided or enlarged in the future. Special attention shall be paid to the unusual number of dedicated circuits and outlets that will be required in the Analytical Laboratories.

3.3 EMERGENCY (STAND-BY) POWER. It is recommended that the following items be placed on emergency (stand-by) power, and this shall not be confused with Life Safety requirements:

a. Laboratory manifold exhaust system (at least one fan) to maintain relative negative pressure of labs, exhaust from fume hoods (sash shall be completely closed in a power outage), vented base cabinets (acid and flammable) under the hood and thimble exhaust above biological safety cabinets.

b. Biological safety cabinets.

c. Fume hood airflow monitor/audible-visual alarm.

d. Dedicated exhaust from radio-chemical fume hoods and perchloric acid fume hoods and Class II B2 100% exhaust biological safety cabinets.

e. Environmental rooms (Warm, Cold).

f. DDC panels

g. Although specific laboratory equipment cannot be identified at this time, assume the following:

1) Typical Laboratory: two (2) 120V duplex receptacles per module (one per bench side).
2) Equipment Rooms: two (2) 120V duplex receptacles per module
3) Tissue Culture Room: one (1) 120V duplex receptacle per room.
4) Procedure Rooms: two (2) 120V duplex receptacles per room

3.4 UPS SYSTEM. A central UPS system is not recommended for this building. Users will be responsible to provide local UPS systems for equipment requiring this service. Emergency generator will accept load transfer within 10 seconds.
3.5 **VOICE/DATA SYSTEM.** Voice/data outlets shall to be provided at each workstation and lab office, in each alcove and procedure room, and at the benches in the open lab. Provide cable tray in central corridor or linear equipment room. The Analytical Laboratory may require additional outlets if a LIMS system is anticipated.

3.6 **ARTIFICIAL LIGHTING.** The recommended illumination level to be achieved in all laboratory areas at the work surface (37" A.F.F) is 100 foot-candles. Provide plug-in or hard-wired task lights at all desks and above all fixed laboratory benches. Fluorescent lighting with T8 electronic ballasts will be acceptable in all laboratory areas except Dark Rooms (incandescent). It is preferable to have dimmer capability in PC Rooms. Direct/indirect lighting fixtures are preferred in the laboratories.

3.7 **SPECIAL WIRING IN HAZARDOUS AREAS.** Hazardous areas and equipment shall be equipped with explosion-proof lighting fixtures, power outlets and switches as follows (provide grounding as necessary to prevent static build-up):

a. Solvent Storage Room.

b. Solvent dispensing fume hood located in Solvent Storage Room.

3.8 **BSL3 SUITE SPECIAL ELECTRICAL CRITERIA.** The following criteria is specific to this area:

a. Doors. Card readers and electronically interlocked doors shall be provided at ante room/air lock to prevent contamination.

b. Electrical Fixtures. All electrical fixtures (electrical receptacles, data/telephone jacks, lighting fixtures, light switches, etc.) shall be recessed mounted, sealed and designed for "wash down/wipedown" with gasketed coverplates.

c. HVAC. Supply and exhaust systems for BSL3 laboratories should be placed on emergency power.

4.0 **PIPED SERVICES**

4.1 **GENERAL.** Piped services shall be available for potential distribution to all individual laboratories. System sizing and diversity factor to be determined by Engineer. Vacuum breakers will be furnished on all domestic water fixtures including eye/face drench hose.
4.2 COLD WATER SYSTEM. A potable cold water system shall be provided to laboratory sinks, cup sinks, safety stations (combination safety shower and eye/face wash), safety showers and eye/face wash stations. Capacity will be based on one sink outlet (3 gpm/35-40 psig) and one cup sink outlet (1 gpm/35-40 psig) per laboratory module. Usage factor (% of total demand): 20%.

4.3 HOT WATER SYSTEM. A potable [non-potable] 1108F hot water system shall be provided to laboratory sinks. Capacity will be based on 1 sink outlet (3 GPM) per double laboratory module. Provisions for supplying water at higher temperatures for individual pieces of equipment shall be provided by dedicated steam [electric] boosters that will be supplied with the equipment.

4.4 NATURAL GAS. Natural gas shall be provided in each laboratory. Capacity will be based on 4 outlets (3 CFH/outlet per laboratory module and 1 outlet per biological safety cabinet (3 CFH/outlet).

4.5 SPECIALTY GASES. Laboratory gases (i.e. N2, H2, He, Instrument Air, NO2, O2, etc.) require all piping components (Copper tubing for nonflammable gases and stainless steel tubing for oxidizers and flammables is recommended). Outlet pressure shall be 150 psig with line pressure not to exceed 200 psig. Fixtures to be: lubricated, cleaned, capped, protected, and delivered certified for "Oxygen" service and shall be supplied as follows:

a. Gases delivered, handled and distributed from cylinders and manifolded to the point of use (fixture or equipment) on a local basis. Owner will furnish and install all piping, regulators, gauges, cylinders, alarms, control valves, etc.

4.6 COMPRESSED AIR SYSTEM. Oil free, compressed air at 60 psig with –40F dew point centrally distributed as a building system may be provided. To be determined.

4.7 VACUUM SYSTEM. A dry vacuum system capable of providing at least 26” Hg at the furthest outlet is recommended. Capacity will be based on four outlets per laboratory module (.5 scfm/ outlet). Pipe risers installed with drain points and cleanout capability. Liquid separator at central equipment required. Usage factor (% of total demand): 20%.

4.8 TYPE III REAGENT GRADE WATER SYSTEM. A centralized water system with a continuous loop design to the tip of the faucet capable of providing type III reagent grade water (CAP/NCCLS or ASTM) is recommended for this facility. Capacity will be based on one outlet per double module laboratory (.5 gal per hour / outlet at 25-60 psig) plus specific equipment consumption rates (glassware washers and local water polishers). Polypropylene pipe with fused joints is recommended. Local in-laboratory polishing units will be utilized to increase the quality of the type III reagent grade water to type I. Fixtures that recirculate to the outlet will be specified to eliminate dead-legs. The diversity of
consumption criteria shall be 50% for faucets and 100% for hard connected equipment Type III reagent grade water basic specifications:

<table>
<thead>
<tr>
<th>Professional Association:</th>
<th>CAP/NCCLS</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Resistivity (megohms/cm):</td>
<td>0.1</td>
<td>1.0*</td>
</tr>
<tr>
<td>b. Conductivity (microhms/cm):</td>
<td>10.0</td>
<td>1.0</td>
</tr>
<tr>
<td>c. Silicate (microg/L):</td>
<td>1000</td>
<td>500</td>
</tr>
<tr>
<td>d. Total Organic Carbon (microg/L):</td>
<td>N/A</td>
<td>200</td>
</tr>
<tr>
<td>e. Sodium (microg/L)</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>f. Chlorides (microg/L)</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

* We acknowledge that the current ASTM standard for Type III water is 4. However this lower criteria was established to minimize the equipment's life cycle cost

4.9 TYPE I REAGENT GRADE WATER. A type I reagent grade water system, centrally distributed as a building system, shall not be provided. Type I reagent grade water will be delivered via Owner furnished and installed local polishing units fed by the type III reagent grade water system. These units are typically located over sinks.

4.10 STEAM.

a. Process Steam: High-pressure (80 PSI) process steam shall be provided to glassware washers and other equipment with built-in steam-fired hot water temperature boosters. If not available as a central service, provide a local electric steam generator where required.

b. Clean steam. High pressure (80 PSI) clean steam (generated with RO water and free of all boiler additives) shall be provided to sterilizers through the use of a steam fired boiler.

4.11 CHILLED/PROCESS/CONDENSER WATER.

a. Process or condenser water supply and return shall be provided to all floors and may be used for water-cooled Environmental Room condensing units and specific laboratory equipment identified by owner. Chilled water for Dark Room processing sinks and automated processors will be provided by a local chiller typically located within the processing sink cabinet.
b. Chilled water (45-55 F) supply and return shall be provided to all water cooled Environmental Room condensing units that may be located on roof of unit or remote units and specific laboratory equipment identified by owner. Chilled water for dark room processing sinks automated processors will be provided by local chiller typically part of dark room equipment package.

4.12 FLOOR DRAINS. Floor drains shall not be provided in laboratory areas except in Glass Wash Rooms, Photographic Dark Rooms and at specific equipment locations (i.e.: sterilizers, glassware washers, ice machines). Environmental Room condensate will drain into floor drain located exterior to room and easily accessible. Floor drains at safety showers shall not be provided.

4.13 SILVER RECOVERY. A local silver recovery system (electrolytic or cartridge depending upon PPM requirement) may be provided for all Photographic Dark Room processing sinks and automated processors upon user request. Engineer to determine allowable silver PPM based on local codes.

4.14 LABORATORY WASTE (DRAIN) SYSTEM. Policy and procedure will be to segregate and dispose of any toxic, radioactive or high concentration wastes through local "in-lab" safety containers, without the use of a piped waste system. Polypropylene is recommended for all branches from fixture to riser.

4.15 NEUTRALIZATION/MONITORING. Make no provision for neutralization.

4.16 SPRINKLER SYSTEM. All laboratory areas shall be provided with automatic wet sprinkler system protection. The system shall be designed with provisions that permit replacement of sprinkled areas with specialized local systems such as pre-action as warranted by special requirements. If a dry system is required, provide an FM 200 system in lieu of a Halon #1301 system which is not recommended in any area of the building.

4.17 BSL3 SUITE SPECIAL PLUMBING CRITERIA. The following criteria is specific to this area:

a. Sinks. Regulations require wrist blade and foot pedals or automatic operation of hand wash sink located near the laboratory exit door. Automatic (infrared proximity) controls with thermal mixing valves and manual overrides are recommended.

b. Hot/Cold Water. Hot and cold potable water should be supplied through a double check valve.

c. Atmospheric Drains. The atmospheric contained drain system typically services sink and floor drains. Regulations require that drain traps are always filled with water or a suitable liquid disinfectant. Traps within this system should have extra depth, a total of 2” WG greater than the
maximum static pressure generated by the HVAC supply or exhaust, to
prevent the trap from being cleared in the event of HVAC/exhaust system
malfunction. Drain vents should be HEPA filtered.

d. Pressurized Drains. The pressurized contained drain system typically
services the hot condensate from sterilizers and should be constructed of a
suitable material to accept drain discharges of 140 F, or less. This system
must be separate from the atmospheric drain to prevent blow out in case of
vent clogging. Drain vents should be HEPA filtered. This system can be
deleted if the sterilizer is equipped with an integral effluent sterilization
system and a gap connection is employed at the floor drain for hot
condensate.

e. Laboratory Vacuum. Provide dedicated local vacuum system for this area.
Regulations require HEPA filters and liquid disinfectant traps on vacuum
lines. Provide local HEPA filters and liquid disinfectants trap for all
vacuum outlets. Local filters and traps will avoid line contamination.
Locate HEPA filters up stream of liquid disinfectant traps to avoid getting
filter wet. A disposable HEPA filter should be installed on the vacuum
line just prior to the vacuum pump.

f. Effluent Sterilization System. Current regulations do not require effluent
sterilization (heat or chemical kill tank) for waste discharged into the
sanitary sewer from BSL3 facilities. High vacuum steam sterilizers
should be specified with integral effluent sterilization system.

g. Specialty Gas Manifold. Provide dedicated specialty gas manifold
exterior to this area to eliminate the need to bring cylinders into the BSL3
laboratory.

h. All piped services shall penetrate the room and terminate with a cap and
valve assembly. Penetrations shall be silicone sealed.

5.0 SAFETY

5.1 GENERAL. It is recommended that the following safety features be provided in or
accessible to each laboratory and meet OSHA and/or ANSI requirements for
configuration, operation and location.

5.2 SAFETY STATIONS. Provide a minimum of two (2) safety stations, consisting
of a deluge shower and eye/face wash, in each laboratory corridor within 10
seconds travel distance of any laboratory. The specific number should be driven
by building configuration, code or owner's standard, whichever is more stringent.
Eye/face wash to operate independently of deluge shower. Height of eye/face
washbasin, deluge shower pull ring and deluge showerhead should meet ADA and ANSI requirements.

5.3 **EYE/FACE WASH.** A counter top mounted eye, face wash unit should be provided at every laboratory sink. Stand alone safety showers and combination eye wash/safety showers shall be supported with a source of tempered potable water. The number of units and their specific location shall meet all national codes and local regulations or client standards whichever is more stringent.

5.4 **FIRE EXTINGUISHERS.** Fire extinguishers should be located in each laboratory suite and adjacent corridor. The specific number should be driven either by code or owner's standard, whichever is more stringent.

5.5 **EMERGENCY COMMUNICATIONS.** A telephone should be located in each laboratory to summon appropriate safety personnel or emergency aid.

5.6 **SIGNAGE.** Appropriate signage indicating, but not limited to, Radioisotope, Flammable, Caustic, Microwave or Biological Hazard, should be posted on each appropriate laboratory entry door. Signage to be furnished by Owner or accommodated in the wall mounted room name/occupants signage system.

5.7 **SAFETY CLOSET OR EMERGENCY RESPONSE TEAM ROOM.** A central Emergency Response Team (ERT) Room will be provided. Equipment will be furnished by Owner and typically consists of the following:

a. Fire Blanket  
b. First Aid Kit  
c. Self Contained Breathing Apparatus  
d. Safety Stretcher  
e. Decontamination Equipment  
f. HEPA filtered, explosion proof, wet/ dry vacuum

5.8 **EMERGENCY ELECTRICAL SHUT-OFF.** Not recommended for biomedical research buildings.
Appendix F

Vivarium-Functional and Technical Criteria
VIVARIUM FUNCTIONAL AND TECHNICAL CRITERA

1.0 ARCHITECTURAL

1.1 TYPICAL PLANNING MODULES. The typical planning module, 10'-6" O.C., can be combined or subdivided to accommodate a wide variety of racks and functions in the Animal Facility.

1.2 CEILING HEIGHT. The minimum clear hung ceiling height should be 9'-0" throughout the animal facility, except 10'-0" clear is preferred in the Cage Wash area. A partial interstitial space with a minimum 6'-8" clear height above catwalks is recommended.

1.3 FLOOR LOADING. The recommended live load floor loading should be 125 PSF not including partitions or where large equipment (i.e.: Sterilizer) is located and requires additional capacity. (Local codes should govern the design live load selection for the building.)

1.4 FLOOR CONSTRUCTION AND SLOPE. A two-step structural and topping, not including final epoxy finish, concrete pour is recommended in certain areas to insure slope and drain requirements. Slope floor, pit or trench to drain (all slope dimensions per foot and minimum) as noted below:

a. Animal Hold Rm  Dry: No slope, no floor drain (FD).
               Wet: Slope floor to 12” wide trench drain (TD) 1/8”; slope TD to floor drain (FD) 1/4”.

b. Cage Wash  TD to FD 1/4”.
               Floor: slope to 12” wide TD 1/8”; slope Equipment Pit: slope to FD 1/4”.

c. Detergent Storage  Floor: slope to dry sump or provide containment to match largest single liquid reservoir.

1.5 WALL CONSTRUCTION. Walls should be constructed of cement board (Titan Board) or impact resistant gypsum wallboard on heavy gauge metal studs or fiberglass reinforced panel (FRP) system depending upon location and as indicated under Architectural Finishes. Typically, partitions will extend 6" above the hung ceiling assembly. Designated partitions (suites, cage wash, behavioral suite) may extend to the underside of the structural slab and/or be sound attenuated for fire rating, noise or cross-contamination control.
1.6 **CORRIDORS.** Corridors within the Animal Facility should be 8’ wide (main) and 7’ wide (internal suite). A directional flow single corridor system with suites is proposed for this facility.

1.7 **DOORS.** Animal room doors should be constructed and/or equipped as follows (and meet ADA requirements):

   a. Minimum 48" wide by 86" high.
   b. Hollow metal with epoxy paint with welded edges and filled cavity (sound attenuation material). Top and bottom to be flush, not recessed.
   c. Hollow metal with epoxy paint frame. Gaps shall not to exceed 1/8”. Provide jamb guards, equal to LSP, mounted on Corridor side or wrap wall rail into jamb for protection.
   d. Stainless steel kick plates full width of door and 36" AFF in height. Provide stainless steel channel edge guard on strike side of door.
   e. 12" x 24" view window with red laminated glass (outer layers of 1/8” clear annelaed glass with inner layer of Monsanto Opticolor Film #5557) with magnetic black-out panel – or – provide view ports.
   f. Surface mounted sweep on room side. Gaps shall not exceed 1/8”.
   g. Pull plate on both sides with cylinder lock or card reader where noted. Strike plate to have cup design.
   h. Heavy duty standard stainless steel hinges.
   i. Self-closing with variable delay and hold open surface mounted on Animal Room side.
   j. No sill or transfer grill.

1.8 **NOISE.** Ambient noise levels from the HVAC system should not exceed NC40. Prevent acoustical levels due to intermittent activity originating outside the animal room from exceeding the background sound level by more than 10 dB.

1.9 **ARCHITECTURAL FINISHES.** The following is a list of recommended architectural finishes (epoxy finishes are high solids, >95%, or water-based to minimize or eliminate off-gassing of volatile organic compounds; compare the two or three systems for first and life cycle costs):

   a. **Animal Holding Room**
      
      Floor: Concrete with 3/16" thick trowelled-on, skid-resistant, anti-microbial, chemically-resistant epoxy (Stonblend flooring system); and integral 1/2" radius coved base extending minimum 3-1/2” AFF. Trenches to be finished with same material and covered with stainless steel grating or fiberglass grating equal to Chemgrate.
      
      Walls: Cement board (Titan Board) or impact resistant gypsum wall board on heavy gauge metal studs.
Ceiling: Gypsum wall board (GWB) with epoxy paint

b. Procedure/Laboratory/Surgery/Necropsy

( NOTE: Explosive anesthesia will not be used in this facility.)

Floor: Concrete with 3/16" thick trowelled-on, skid-resistant, anti-microbial, chemically-resistant epoxy (Stonblend flooring system); and integral 1/2" radius coved base extending 3-1/2" AFF. Trenches to be finished with same material and covered with fiberglass grating equal to Chemgrate.

Walls: Cement board (Titan Board) or impact resistant gypsum wall board on heavy gauge metal studs. Ceiling: Gypsum wall board (GWB) with epoxy paint

Casework: Movable solid melamine modular cabinets with a cantilevered stainless steel counter top.

c. Cage Wash

Floor: Concrete with 3/16" thick trowelled-on, skid-resistant, anti-microbial, chemically-resistant epoxy (Stonblend flooring system); and integral 1/2" radius coved base extending 3-1/2" AFF. Trenches to be finished with same material and covered with fiberglass grating equal to Chemgrate.

Walls: Cement board (Titan Board) or impact resistant gypsum wall board on heavy gauge metal studs. Provide aluminum wall protection equal to LSP Sani-Rail.

Ceiling: Gypsum wall board (GWB) with epoxy paint

Provide soffit or canopy hood above washer and sterilizer camber openings.

d. Corridor/Storage

Floor: Concrete with 3/16" thick trowelled-on, skid-resistant, anti-microbial, chemically-resistant epoxy (Stonblend flooring system); and integral 1/2" radius coved base extending 3-1/2" AFF. Trenches to be finished with same material and covered with fiberglass grating equal to Chemgrate.

Walls: Cement board (Titan Board) or impact resistant gypsum wall board on heavy gauge metal studs. Provide aluminum wall protection equal to LSP Sani-Rail.

Ceiling: Gypsum wall board (GWB) with epoxy paint
1.10 **PENETRATIONS/VERMIN CONTROL.** Special consideration should be given to all floor, wall and ceiling penetrations to prevent unsanitary conditions and vermin infestation within the Animal Facility. The following precautions are recommended:

a. Sealing (caulk with pure silicone rubber) of crevices around plumbing fixtures, work surfaces, baseboards, etc., which may provide harborage for insects. All wall penetrations (plumbing and electrical fixtures) to be fully sealed and covered with an escutcheon, if appropriate. All ceiling penetrations (access panels, diffusers, grilles, lights, etc.) to be fully gasketed and recessed mounted.

b. Pre-treatment for vermin control (boric acid or amorphous silica applied at a rate of 5g/m² equal to Bell Environmental) before occupancy in walls and above the ceiling.

c. Specifications should note that there will be zero-tolerance for eating or drinking in animal areas during construction.

d. Exterior lighting near doors or vents should be either high pressure sodium (not mercury vapor) lamps or dichrom yellow (not incandescent flood) lamps.

e. Air curtains at animal facility loading dock elevator with 1,600 ft/min velocity.

f. 18"-24" bare strip of concrete or gravel around perimeter of building.

g. Operable windows and vents should be screened with 18 to 40 mesh depending upon the insects to be excluded and how the air flow will be affected.

h. ULV/electric grids should be located away from openings.

1.11 **FIXTURE MOUNTING.** All wall and ceiling mounted fixtures (electrical, plumbing, fire safety, etc.) should be recessed flush mounted.

1.12 **RACK/CAGE DESCRIPTION.** The following rack and cage descriptions have been furnished by the client (SS: single-sided; DS: double-sided; AW: auto-watering; WB: water bottle; AF: auto-flush; vMI: vented micro-isolator; PE: point exhaust; PS: point supply):

<table>
<thead>
<tr>
<th>Species Description</th>
<th>Rack Size</th>
<th>Cages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WxLxH (in)</td>
<td>/Rack</td>
</tr>
<tr>
<td>a. Mouse</td>
<td>65x25x80</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>SS,WB,vMI,PS,PE</td>
<td></td>
</tr>
<tr>
<td>b. Mouse</td>
<td>71x30x80</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>DS,WB,vMI,PS,PE</td>
<td></td>
</tr>
<tr>
<td>c. Rat/G.Pig</td>
<td>65x28x76</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>SS,WB,vMI,PE</td>
<td></td>
</tr>
</tbody>
</table>
d. Aquatics TBD

1.13 ABSL2 (Animal Biosafety Level) SUITE SPECIAL FUNCTIONAL CRITERIA. The following criteria is specific to this area:

a. General. Regulations do not require passage through two sets of doors for entry into the room/suite from an unrestricted corridor. A sterilizer within building is available.
c. Showers. Guidelines do not require showering out of ABSL2 facilities.
d. Doors and Hardware. Doors should open inward and be provided with automatic closers.
e. View Windows. View windows shall be closed and silicone sealed.
f. Penetrations. Penetrations in walls, floors and ceilings shall be silicone sealed or capable of being sealed to facilitate decontamination.
g. Decontamination. Chemical decontamination shall be employed.
h. Room Construction. Quality room construction with special consideration given to joints, finishes and penetrations.
i. Signage. Provide appropriate signage (universal biohazard symbol) at doors leading into ABSL2 facilities.
j. Sterilizer. Cages, racks and waste are appropriately decontaminated in an autoclave before washing or disposal. If an autoclave is located outside the animal room/suite, materials are transported in a covered leakproof container. Double door (pass-through), high vac uum sterilizer shall be specified with cross-contamination seal and integral effluent decontamination. Enclosed equipment area for sterilizer should be highly ventilated to prevent build-up of heat and moisture.

1.14 ABSL3 (Animal Biosafety Level) SUITE SPECIAL FUNCTIONAL CRITERIA. The following criteria is specific to this area:

a. General. Regulations require passage through two sets of doors for entry into the room/suite from an unrestricted corridor (this may also include a clothes-change room and shower). A sterilizer within the suite is recommended.
b. Personnel/Equipment Access. Provide Ante Room/Air Lock between room/suite and corridor consisting of two sets of doors and provide space for clothes-change area.
c. Showers. Although current guidelines do not require showering out of ABSL3 facilities, a pass-through shower is recommended.
d. Doors and Hardware. Doors should open inward and be provided with automatic closers.
e. View Windows. View windows shall be closed and silicone sealed.
f. Penetrations. Penetrations in walls, floors and ceilings shall be silicone sealed or capable of being sealed to facilitate decontamination.
g. Decontamination. Chemical decontamination shall be employed.
h. Room Construction. Quality room construction with special consideration given to joints, finishes and penetrations.
i. Signage. Provide appropriate signage (universal biohazard symbol) at doors leading into ABLS3 facilities.
j. Sterilizer. Cages, racks and waste are appropriately decontaminated in an autoclave before washing or disposal. If an autoclave is located outside the animal room, materials are transported in a covered leakproof container. Double door (pass-through), high vacuum sterilizer shall be specified with cross-contamination seal and integral effluent decontamination. Enclosed equipment area for sterilizer should be highly ventilated to prevent build-up of heat and moisture.

2.0 HEATING, VENTILATION AND AIR CONDITIONING

2.1 GENERAL. The Guide for the Care and Use of Laboratory Animals (the “Guide”) recommends a separate ventilation system for the animal facility and human occupancy areas as well as system redundancy (reduced capacity during primary system failure is acceptable) and system monitoring.

2.2 HVAC CONCEPT. The following HVAC concept is proposed for this facility:

a. HVAC Concept. The HVAC system shall be pressure independent constant volume or VAV.

b. Energy Conservation/Pressurization Adjustment. The potential to reduce the air changes per hour (ACPH), go to an unoccupied set-back in a particular room (or rooms) or change pressurization should be accommodated. The ACPH reduction, unoccupied set-back or pressurization change should be controlled by the building management system (BMS). The potential to employ a heat recovery system should be evaluated by the Engineer.

c. Controls. All controls should be direct digital control (DDC). Controls to maintain pressure gradients shall be passive in lieu of active in non-ABSL3 areas.

d. Location. Where interstitial space is not available, avoid locating serviceable components (boxes, terminal reheat units, etc.) above animal holding room ceilings.

e. Ventilated Racks/Point Exhausts. The supply and exhaust in designated animal holding room should be designed to accommodate conventional
and/or ventilated racks. Ventilated racks will require snorkel connections in the ceiling for 3” rack supply (SS racks: 45cfm +/-10% @ 0.10sp; DS racks: 60cfm +/-10% @ 0.13sp) and 4” rack exhaust supply (SS racks: 70cfm +/-10% @ 0.12sp; DS racks: 120cfm +/-10% @ 0.16sp). All cfm and sp values shall be confirmed.

f. Probes. Temperature and humidity probes should be polymer type in lieu of capacitative type and located within the ductwork.

g. Dedicated Exhaust. Provide a dedicated exhaust system for the Cage Wash area due to saturated vapor content. Exhaust duct should be stainless steel with industrial couplings [or 316L stainless steel welded], horizontal runs sloped to drain and, if rectangular, duct sections welded at top corner of duct. Enclosed equipment areas for washers and sterilizers should be highly ventilated to prevent build-up of heat and moisture.

h. Humidification. Process steam (with EPA approved boiler additives) or clean steam (generated with potable water and free of all boiler additives) should be used for all humidification applications.

i. Condensate. Condensate from washers shall be returned.

j. Terminal Reheats. Terminal reheats shall fail closed.

2.3 SPACE TEMPERATURE AND HUMIDITY CRITERIA. The capability to adjust individual room dry bulb temperatures in 2°F increments between 68-84°F and maintain a relative humidity of 30-70%RH throughout the year is required. A thermostat for each animal holding room is recommended. Humidification and dehumidification may be required. Any deviation from set-point should occur gradually, typically over several hours. The following inside design temperatures and humidity conditions are typical for the following species and/or rooms:

<table>
<thead>
<tr>
<th>Species/Space</th>
<th>Dry-Bulb Temp (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mouse, Rat, Guinea Pig</td>
<td>66 - 72</td>
</tr>
<tr>
<td>b. Aquatics</td>
<td>64 - 72</td>
</tr>
<tr>
<td>c. Nonhuman Primate</td>
<td>64 - 84</td>
</tr>
<tr>
<td>e. Feed Storage</td>
<td>66 - 72</td>
</tr>
<tr>
<td>f. Cage Wash</td>
<td>66 - 72</td>
</tr>
</tbody>
</table>

2.4 VENTILATION CRITERIA. One hundred percent of the air supplied to the animal facility will be outside air and will be exhausted. There should be no recirculation of this air. Supply air quantities shall be based upon heat loads, minimum dilution/ventilation requirements, and/or required make-up air for exhaust systems, whichever is greatest.
2.5 **AIR CHANGE CRITERIA.** Ventilation of animal holding rooms shall be a design base of 15 fresh air changes per hour (ACPH) with the maximum ACPH based on calculations performed by the Engineer. Determination of primary and secondary enclosures may affect the minimum ACPH recommendation. Engineer shall confirm that the minimum ACPH requirement is sufficient to offset heat rejection from fully occupied cages/racks, one human occupant, lighting and miscellaneous electrical loads (i.e.: animal transfer stations). The heat generated from animals shall be calculated using the average-total-heat-gain formula published by ASHRAE. Static pressure reduction caused by filter loading should be taken into account when establishing air change criteria.

2.6 **AIR MOVEMENT (PRESSURIZATION) CRITERIA.** The design of the HVAC system should accommodate the potential to adjust the initial air movement (or relative pressure) of any space in the future. Areas which require positive and continuous control are noted with "out" or "in" to indicate the required direction of air movement in relation to the space named (this designation was previously described as "positive" or "negative" pressure). Rate of air movement may be varied as needed within the limits required for positive control. Where indication of air movement is enclosed in parentheses, continuous directional control is required only when the room or equipment within the room is in use. Air movement for spaces noted as neutral may vary as necessary to satisfy the requirements. Additional adjustments may be needed when space is unused or unoccupied and air systems are shut down or reduced. The initial air movement relationship to adjacent areas should be as follows (IC: isolation cubicle):

<table>
<thead>
<tr>
<th>Space</th>
<th>Air Movement Relationship to Adjacent Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Animal Holding Suite</td>
<td>In</td>
</tr>
<tr>
<td>1. Internal Corridor</td>
<td>In</td>
</tr>
<tr>
<td>2. Animal Hold Rm</td>
<td>In [In/Out: adjustable]</td>
</tr>
<tr>
<td>3. Procedure Rm</td>
<td>In [In/Out: adjustable]</td>
</tr>
<tr>
<td>b. Cage Wash</td>
<td>In</td>
</tr>
<tr>
<td>1. Soiled Work</td>
<td>In</td>
</tr>
<tr>
<td>2. Equipment Enclosure</td>
<td>In</td>
</tr>
<tr>
<td>3. Clean Work</td>
<td>Out</td>
</tr>
<tr>
<td>4. Clean/Sterile Hold</td>
<td>Out</td>
</tr>
<tr>
<td>c. Feed/Bedding Storage</td>
<td>Out</td>
</tr>
<tr>
<td>d. Quarantine</td>
<td>In</td>
</tr>
<tr>
<td>e. Detergent Storage</td>
<td>In</td>
</tr>
<tr>
<td>f. Break</td>
<td>In</td>
</tr>
<tr>
<td>g. Lockers</td>
<td>In</td>
</tr>
<tr>
<td>h. Air Lock</td>
<td>Out (except ABSL3)</td>
</tr>
<tr>
<td>i. Main Corridor</td>
<td>Neutral</td>
</tr>
</tbody>
</table>
2.7 **FILTRATION CRITERIA.** All supply air should be filtered fresh air through 30% DOP prefilters and 95% DOP final filters. Point supplies (PS) for ventilated racks shall be Class 100.

2.8 **BUILDING OPERATING SCHEDULE.** All animal facility mechanical, electrical and plumbing systems are expected to operate 24 hours, 7 days a week with varying degrees of occupancy in a 24 hour period.

2.9 **FLEXIBILITY CRITERIA.** Air distribution systems should be designed to afford flexibility for future redesign, primarily by providing accessibility to the duct systems throughout the facilities and, where feasible, by applying a modular layout of air distribution devices and by providing symmetry and uniformity to the branch duct layout.

2.10 **REDUNDANCY.** Redundant and parallel systems are required for supply, exhaust, heating and cooling so that minimum environmental conditions can be maintained in the animal holding rooms with one unit out of service.

2.11 **BUILDING MANAGEMENT SYSTEM.** The building management system (BMS) should monitor and control the following in all designated rooms:

   a. Monitor temperature and humidity with an accuracy of +/-1°F and +/-5%RH.
   b. Control temperature and humidity within +/-2°F and +/-10%RH of set point.
   c. Monitor and control air flow (supply/exhaust CFM and room air changes per hour) with an accuracy of +/-10%.
   d. Monitor pressure relationship relative to corridor or adjacent space derived from summing supply/exhaust air flows in non-ABSL3 areas. Monitor and control pressure relationship to corridor or adjacent space in ABSL3 areas.
   e. Card readers.
   f. Control animal level lighting on an adjustable time and duration schedule.
   g. Monitor animal level lighting state (on or off) with a photocell.

2.12 **CENTRAL CONTROL.** Provide a PC type computer to perform the following tasks on a room by room basis (and tied into central facility control system):

   a. Set high/low warning and emergency alarm limits for temperature (+/-2° and +/-4°F from range), humidity (+/-10% and +/-20% RH from range), supply air flow (+/-15% and +/-20% from setpoint), exhaust air flow (+/-15% and +/-20% from setpoint) and pressure relationship deviation (+1 minute and +5 minutes). Record all alarm occurrences. Display should be green for acceptable, yellow for warning and red for emergency. Graphic display (floor plan) of entire animal facility is preferred.
b. Set time and duration of animal level lighting. Record and alarm all lighting states that do not conform to set times.

c. Set security codes and record room access for doors with card reader.

d. Provide written system log reports (continuous chronological list of all alarm conditions system wide), daily environmental reports (temperature, humidity, air flow and pressure average over 24-hour period with high and low value and time of occurrence), daily alarm reports (chronological list of all alarm conditions over 24-hour period by room) and selective historical reports.

e. System will be monitored and controlled locally and remotely.

f. System will be equipped with a pager alarm system. System can be programmed to send selected alarm parameters of specific duration (condition is not corrected in a specified amount of time) to one or more pager numbers. Digital pager read-out will state alarm parameter and room number (i.e.: "High Temperature, Room 104").

g. All system parameters and formats (displays, alarms, reports) to be coordinated with Animal Resource Center staff. The Central Control for the Animal Facility will only control and monitor the Animal Facility, not the entire building.

h. Deactivate sensors when room cleaning is in progress.

2.13 LOCAL CONTROLS. Provide relative pressure monitor (through-the-wall tube with ping pong ball) near each animal room door. Local, battery-powered temperature and humidity monitors shall be owner furnished and installed.

2.14 ANIMAL ROOM EXHAUST FILTERS. Provide a commercially available (standard size), exposed, washable 1" thick filter in the animal holding rooms at each exhaust grille and point exhaust. Filters should be easily removable and replaceable without tools.

2.15 SUPPLY/EXHAUST. Air should be supplied and exhausted in the animal rooms as indicated below (PS: Point Supply; PE: Point Exhaust). Supply and exhaust should be located as far apart as possible to facilitate through-room flow.

<table>
<thead>
<tr>
<th>Space</th>
<th>Supply</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Rm</td>
<td>Ceiling (center) and PS.</td>
<td>Ceiling (in 2-4 corners) and PE.</td>
</tr>
<tr>
<td>Procedure Rm</td>
<td>Ceiling</td>
<td>Ceiling</td>
</tr>
</tbody>
</table>

2.16 ABSL2 SUITE SPECIAL HVAC CRITERIA. The following criteria is specific to this area:

a. Airflow/Pressurization. Current guidelines recommend, but do not require, that the direction of airflow in an ABSL2 facility is inward and that exhaust air is discharged to the outside without being recirculated to other rooms.
b. Physical-Containment Devices. Biological safety cabinets, other physical-containment devices, and/or personnel-protection devices (e.g.: respirators, face shields) are used when procedures with a high potential for creating aerosols are conducted.


d. Chemical Decontamination. No special provisions required.

2.17 ABSL3 SUITE SPECIAL HVAC CRITERIA. The following criteria is specific to this area:

a. Airflow/Pressurization Criteria. System for ABSL3 facility should create directional airflow that draws air into the laboratory through the entry area. Personnel must verify that the direction of airflow is proper (typically accomplished by placing magnehelic gauge or other visual device next to each door) before opening a door. Controls to maintain pressure gradients should be active in this area. Relative pressure should be maintained as follows:

1. Internal Suite Corridor: Negative to Main Corridor and positive to Animal Holding Room and Procedure Room.
2. Animal Holding Room: Negative to Internal Suite Corridor.
3. Procedure Room: Negative to Internal Suite Corridor.

b. Physical-Containment Devices. Biological safety cabinets, other physical-containment devices, and/or personnel-protection devices (e.g.: respirators, face shields) are used when procedures with a high potential for creating aerosols are conducted.

c. Exhaust/Filtration. Current regulations allow exhaust air from the laboratory room and HEPA filtered air from Class II biological safety cabinets to be discharged through a non-recirculating (100% exhaust) building exhaust system, without filtration prior to discharge to atmosphere; a dedicated exhaust is not required. We recommend a 100% redundant dedicated exhaust system for the ABSL3 Suite designed to accommodate a future 100% redundant HEPA filtration system (including, but not limited to, bag-in/bag-out cabinets and fan sized for additional static load generated by HEPA filter) to accommodate potential regulation changes. Location of the future HEPA filter shall be carefully selected and dedicated to facilitate filter decontamination, replacement and general maintenance.

d. Chemical Decontamination. No special provisions required.

3.0 ELECTRICAL

3.1 EMERGENCY POWER. Emergency power should be provided to maintain the following (in addition to Life Safety requirements):
3.2 LIGHTING. Each animal holding room should be equipped with three independently controlled lighting systems, one for animals and two for staff. The three systems are as follows:

a. Animal. The animal lighting system should provide a programmable, automatic day/night cycle on an adjustable time and duration schedule with photocell confirmation of cycle controlled and monitored by the BMS. The animal lighting system should provide 30-35 FC at 3’ AFF in rodent rooms and 60-70 FC at 3’ AFF in other animal rooms.

b. Staff (Fluorescent). The staff fluorescent lighting system should be manually controlled by an integral light switch/one-hour timer mounted inside the animal holding room near the door. The human lighting system should provide 60-70 FC at 3’ AFF. The staff and animal lighting systems can be accommodated in the same multi-bulb fixture.

c. Staff (Red). The staff red lighting system should be manually controlled by an integral light switch/one-hour timer mounted outside the animal holding room near the door. The red light system should provide 5 FC at 3’ AFF.

3.3 SPECIAL ELECTRICAL FIXTURES. All electrical fixtures (i.e.: electrical receptacles, data/telephone jacks, lighting fixtures, light switches, etc.) should be designed for "wash down" and shall be UL listed for such service. Electrical circuits should be ground-fault interrupted (GFI). All lighting fixtures should be flush mounted.

3.4 ELECTRICAL OUTLETS. All rooms should be equipped with wall mounted 120V/20A duplex electrical outlets mounted 4’-0” AFF, unless otherwise noted.

3.5 DATA/TELEPHONE SYSTEM. All designated rooms should be equipped with wall-mounted telephone/data junction box with capped conduit and water-proof coverplate.

3.6 SECURITY SYSTEM. A card-key [swipe or proximity] based access system should be provided for the Animal Facility at each entry/exit door and designated animal holding rooms/suites. A closed-circuit television (CCTV) system should be provided to monitor each entry/exit door. Security system should be controlled and monitored locally and remotely.

3.7 ABSL2/3 SUITE SPECIAL ELECTRICAL CRITERIA. The following criteria is specific to this area:
a. Interlocked Doors. Electronically interlocked doors with a fail-open feature should be provided in Air Locks.
b. Penetrations. All electrical conduit penetrations should be the seal-off type.

4.0 PLUMBING

4.1 HAND WASH SINK. Provide potable hot and cold water at each sink with wrist-operated controls. Hand wash sink to be stainless steel. Provide liquid soap, glove and paper towel dispensers (type to be determined) near each hand wash sink. Hand wash sink fixtures should have an integral vacuum breaker.

4.2 HOSE-BIB. Provide potable hot and cold water at each hose-bib. Provide mop rack near each hose-bib station. Hose-bibs should have an integral vacuum breaker.

4.3 ANIMAL WATERING SYSTEM. Provide an automatic watering system to all animal research rooms (and convertible Procedure/ARL). Quality of water shall be reverse osmosis (RO) type III with acidification. Automatic watering system wall be equipped with a programmable interval and duration flush system for each rack (one-line rack flush) and be centrally monitored for pressure or leaks. CPVC automatic watering manifold shall be surface mounted 8'-6" AFF with a quick disconnect fitting for each rack (animal transfer station does not need outlet because AW valve is attached to rack, not cage). Recess mount pressure reducing stations in corridor (walls must be at least 8” to recess mount PRS).

4.4 FLOOR DRAINS. Where indicated, provide minimum 4” or 6” throat diameter [self-priming] floor drains with lockable/removable grated and solid drain covers and a removable strainer basket. Drainpipes should be minimum 4” diameter. Where designated, provide flushing trap, in lieu of rim, floor drains (FFD).

4.5 PROCESS AND CLEAN STEAM. Provide high pressure (80 PSI) process steam to washers. Process steam typically contains small amounts of dissolved impurities, traces of pipe scale and debris, and volatile boiler feed water chemicals such as amines and/or hydrazines. Provide high pressure (80 PSI) clean steam to Sterilizers. Clean steam generated with RO water (meeting reagent grade water type III requirements) is recommended for sterilizers because it does not degrade standard temperature polycarbonate rodent cages and does not require stainless steel piping skids.

4.6 HOT WATER. Provide 110°F water to hand wash sinks, hose bibs and washers. 180°F hot water for washers will be generated by internal steam boosters fed by 110°F hot water.
4.7 **HOT WATER DISCHARGE.** Local codes may not allow discharge of >140°F water into sanitary sewer from washing equipment (to be confirmed by Engineer). Provide integral cool-down tank on washers, if required.

4.8 **NEUTRALIZATION.** Local codes may not allow discharge of low or high pH solutions from washing equipment (allowable pH values to be determined by Engineer).

4.9 **SAFETY STATIONS.** Provide the following personnel safety equipment where designated:

a. SS: Combination eye, face wash/safety shower (typically in cage wash and internal suite corridors).

b. EW: Counter mounted eye, face wash (typically in procedure rooms).

4.10 **SPECIALTY GASES/SERVICES.** Provide the following specialty gases/services to all procedure rooms and laboratories through a central distribution system. Oxygen (O2) and Carbon Dioxide (CO2) require all piping components and fixtures to be lubricated, cleaned, capped, protected and delivered certified for "Oxygen Service". Provide local shut-off valves as required by code.

a. Medical Vacuum (V).

b. Oxygen (O2). Number of cylinders and manifold location (preferrably external to Animal Facility) to be determined.

c. Carbon Dioxide (CO2). Number of cylinders and manifold location (preferrably external to Animal Facility) to be determined.

e. Reagent Grade Water (RGW). Type I or II RGW will be provided by owner furnished/owner installed local units.

f. Alkaline Detergent. Manifolded from bulk storage tanks located at dock to washers. Provide 4” polypropylene pipe between tanks and washers for manifold tubing. Typically, pumps and manifolding are supplied by detergent vendor.

4.11 **FIRE PROTECTION/SPRINKLER SYSTEM.** Provide vermin-proof sprinkler heads. Locate high-temperature sprinkler heads close to washing and sterilizing equipment. Provide low frequency (<20,000 Hz) alarms if allowable by code for the comfort of the animals.

4.12 **AQUATIC LIFE SUPPORT SYSTEM.** Provide 70F, chlorine-free and metal-free potable water to each Aquatic Room.

4.13 **ABSL2 SUITE SPECIAL PLUMBING CRITERIA.** The following criteria is specific to this area:
a. Sinks. Current guidelines require a hand washing sink in room that houses infected animals.

b. Hot/Cold Water. Hot and cold potable water should be supplied through a double check valve.

c. Atmospheric Drains. The atmospheric contained drain system typically services sink and floor drains. Regulations require that drain traps are always filled with water or a suitable liquid disinfectant.

d. Pressurized Drains. The pressurized contained drain system typically services the hot condensate from sterilizers and should be constructed of a suitable material to accept drain discharges of 140°F, or less. This system can be deleted if the sterilizer is equipped with an integral effluent sterilization system and a gap connection is employed at the floor drain for hot condensate.

e. Laboratory/Medical Vacuum. Current guidelines do not require HEPA filters and liquid disinfectant traps on vacuum lines in ABSL2 facilities.

f. Effluent Sterilization System. Current regulations do not require effluent sterilization (heat or chemical kill tank) for waste discharged into the sanitary sewer from BSL3 facilities. High vacuum steam sterilizers should be specified with integral effluent sterilization system.

4.14 ABSL3 SUITE SPECIAL PLUMBING CRITERIA. The following criteria is specific to this area:

a. Sinks. Regulations require either foot, elbow or automatic operation of hand wash sinks in room that houses infected animals. Automatic (infrared proximity) controls with thermal mixing valves and manual overrides are recommended.

b. Hot/Cold Water. Hot and cold potable water should be supplied through a double check valve.

c. Atmospheric Drains. The atmospheric contained drain system typically services sink and floor drains. Regulations require that drain traps are always filled with water or a suitable liquid disinfectant. Traps within this system should have extra depth, a total of 2” WG greater than the maximum static pressure generated by the HVAC supply or exhaust, to prevent the trap from being cleared in the event of HVAC/exhaust system malfunction. Drain vents should be HEPA filtered.

d. Pressurized Drains. This system can be deleted if the sterilizer is equipped with an integral effluent sterilization system and a gap connection is employed at the floor drain for hot condensate.

e. Laboratory/Medical Vacuum. Provide dedicated local vacuum system for this area. Regulations require HEPA filters and liquid disinfectant traps on vacuum lines. Provide local HEPA filters and liquid disinfectants trap for all vacuum outlets. Local filters and traps will avoid line contamination. Locate HEPA filters up stream of liquid disinfectant traps to avoid getting filter wet. A disposable HEPA filter should be installed on the vacuum line just prior to the vacuum pump.
f. Effluent Sterilization System. Current regulations do not require effluent sterilization (heat or chemical kill tank) for waste discharged into the sanitary sewer from BSL3 facilities. High vacuum steam sterilizers should be specified with integral effluent sterilization system.

5.0 COMMISSIONING

5.1 GENERAL. All systems necessary for a fully functional Animal Facility shall be designed to comply with the Animal Welfare Act, meet or exceed the requirements indicated in the Guide for the Care and Use of Laboratory Animals (the "Guide") and continued AAALAC accreditation.

5.2 ANIMAL STUDIES. After successful commissioning of all specified building systems, the Owner shall conduct (quantity and duration to be determined) mice and rat in-life studies in compliance with protocols for standard toxicology to access any adverse effects on the study animals in the new facility.

5.3 PEST CONTROL. At least 3 weeks before occupancy, a commercial pest control company should screen the entire facility for evidence of rodents or insects and carry out a vermin-eradication program if required.

5.4 HVAC. Complete the following tests after testing, adjusting and balancing the HVAC system:

a. Smoke Bomb Test. Ignite smoke bomb in center of one animal room to verify a smooth airflow toward the exhausts.

b. Probe Assignment. Confirm all probe points are correctly addressed to the building management system (BMS).

c. Probe Operation. Confirm all probes are operating correctly by comparing temperature, humidity, airflow and pressure differential readouts and printouts from BMS with certified portable testing equipment in each room.

d. Temperature Test. Simulate a 100% increase in the anticipated animal census BTU load in each room (one at a time) and monitor the temperature for 24 hours. Repeat the test using a 50% decrease in the anticipated animal census BTU load in each room. Room temperatures during these tests should stay within set ranges.

5.5 HOOD TESTING. After testing, adjusting and balancing the HVAC system, all chemical fume hoods shall be subjected to the Knutson-Caplan ASHRAE Test #110-1995 for “As Manufactured” and “As Installed” and all biological safety cabinets shall meet the requirements of NSF Standard #49. Down-draft necropsy workstations should be tested to confirm total smoke capture at least 12” [or 16"] above the work surface.
5.6 **EMERGENCY POWER.** Operate emergency generator under full load for 4 hours to confirm proper operation.

5.7 **LIGHTING.** One animal room shall be tested by filling the room with racks and taking light readings at 12 (to be confirmed) locations 30” AFF using a calibrated light meter. The overall mean measurement shall be within 10% (to be confirmed) of the design specifications. The reliability of all lighting timers shall be checked by monitoring 7 days of consecutive cycles of the programmable automatic day/night cycle system.

5.8 **ELECTRICAL SYSTEM.** Test all electrical outlets and GFI circuits for proper operation. Overload one circuit to test circuit breaker.

5.9 **PLUMBING.** Test all floor drains by creating a local flood condition. Under the supervision of the Health and Safety Officer, test all emergency showers and eye-wash stations.

5.10 **CAGE SANITIZATION.** Operate rack washer, tunnel washer and sterilizer for one day. Confirm washers provide 180°F rinse cycle.
Appendix G
BSL:3 Construction Standards

A copy of this material is available in the Office of Institutional Planning at the University of Colorado Health Sciences Center, 13001 E. 17th Place, Aurora, CO 80045-0508.
Appendix H
Transition Schedule
### UCHSC MASTER PLAN TRANSITION SCHEDULE

**COP Timetable - 2003**  
Revised November 1, 2002

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<th>Mid Development Phase</th>
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**Notes:**
- Total program and space requirements above exclude affiliates, parking, and other space-related infrastructure.
- Key: Bars represent time required for design and construction. The lighter portion of the bar represents the design phase, the darker portion, construction.
Appendix I
Fitzsimons Development Map
Appendix J
UCHSC Annual Report Grants and Contracts
Fiscal Year 2002

A copy of this report can is available on:
http://www.uchsc.edu/ogc/pubs.html
or
in the Office of Institutional Planning at the University of Colorado Health Sciences Center, 13001 E. 17th Place, Aurora, CO 80045-0508.