IOWA STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY

Biorenewables Complex Schematic Design Report

Biorenewables Research Laboratory

Agricultural and Biosystems Engineering Department

West Campus Parking Structure

DECEMBER 10, 2007

PREPARED BY

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SECTION I.

LIST OF PARTICIPANTS

STEERING COMMITTEE PROGRAM APPROVAL AND PLANNING COMMITTEE MEMBERS

This document is a representation of the Biorenewables Complex Planning Committee's efforts to articulate the programmatic, functional, and aesthetic parameters that will be the basis on which contract design professionals will make design studies and prepare schematic design drawings and specifications. The information provided in this document has been reviewed and is approved as defining the project scope and vision.

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SECTION II.A.

PROJECT DESIGN STATEMENT

PROJECT DESIGN NARRATIVE

I. General

A. Site selection is based upon campus planning objectives identified by Iowa State University of providing both a consolidated facility for the Department of Agricultural and Biosystems Engineering, and a state-of-the-art facility for the Biorenewables Research Laboratory. The increased density of facilities that would result from the Biorenewables Complex necessitated the integration of the West Campus Parking Structure to ensure that the parking needs of this part of campus would be served.

B. The Biorenewables Complex is currently planned to be a two phase project.

1. Phase 1 will include the Biorenewables Research Laboratory (BRL), a new pedestrian pathway to the main southeast entrance of the College of Design, the extension of the campus utility tunnel system to the northeast corner of the site, and associated site and landscape improvements.
2. Phase 2 will include the Department of Agricultural and Biosystems Engineering (ABE), a common atrium for the Biorenewables Complex, an above ground pedestrian connection from the Biorenewables Complex to Howe, the West Campus Parking Structure, and associated site and landscape improvements.

II. Program Components

A. Department of Agricultural and Biosystems Engineering

1. The project would consolidate the ABE program into one building. Currently the Department is spread across campus in five separate locations.
2. Provide stare of the art facilities that are better suited to support the current and future research and scholarship needs. Many of the current facilities are inadequate to meet those same needs and do not have the capacity to serve the future requirements of the Department.
3. Provide facilities that would be able to adapt to the needs for future growth in the program. The current facilities do not have the capacity to allow for future growth.

B. Biorenewables Research Laboratory

1. The project would facilitate a multi-disciplinary approach to research by providing a facility for the use of faculty and students from different disciplines.
2. Provide state of the art facilities that would support the current research needs while allowing for the future flexibility as the demands of research change with the growth of the field.
3. Provide a building that would support public outreach by creating a home for the multiple disciplines that participate in the field of Biorenewables research separate from the traditional classification of academic departments.

C. West Campus Parking Structure

1. Increase the amount of parking available to serve the needs of west and central campus. The addition of the Biorenewables Complex would increase the density of the both the structures and the population for this part of the University.
2. Investigate the feasibility of providing a single facility for both the Parking and Police divisions of the Department of Public Safety that would serve their needs. Currently the divisions are separated in spaces that are functional inefficient. Inclusion of either of these programs is dependent upon funding availability after the needs of ABE, BRL, and the West Campus Parking Structure and their associated program elements have been served first.

SECTION II.B.

PROJECT SYSTEMS COORDINATION

PROJECT SYSTEMS COORDINATION

I. ABE / BRL Buildings

A. Although these two buildings will likely be constructed at different times, with BRL constructed first, the design team is designing the complex as a whole to integrate systems where possible. Following are examples:

1) Hydronic equipment

All hydronic equipment for the chilled water and steam systems will be located in the Basement of the BRL building. This requires only one service entrance in lieu of the two required if each building had contained its own hydronic equipment. This also means that equipment can be interconnected to provide some redundancy. Only that equipment needed for BRL will be installed with BRL construction with space left for future ABE equipment.

2) Atrium

An atrium is proposed to be constructed with the ABE building to integrate the two wings of ABE with the BRL building creating an interior space for programs, display and interaction. With the construction of this atrium, the south wall of BRL, initially an exterior wall will become an interior wall. The design team is considering materials for this wall that will be suitable for exterior exposure and also fit into the design concept of the atrium interior.

The roof structure of the atrium may be supported on the north side by the BRL building. If this occurs, the columns, footings and possibly the perimeter roof beam of the BRL building will need to be designed to support this future load.

3) The ABE building has been planned to house lab functions in one wing and office / classroom functions in the other. This allows the HVAC systems to be optimized for each wing.

4) The basement of the ABE building will connect with the BRL basement. Knockout panels will be provided in the BRL basement walls for these connections.

5) Sustainable design opportunities have been and will continue to be evaluated. This evaluation of necessity includes collaboration of the architects, MEP engineers, civil engineer and landscape architect. Final strategies will be decided in the next phase as more definitive analysis can take place.

II. Parking Structure

A. Design is a simple two bay / two span structure to minimize cost and maximize efficiency.

B. Will utilize natural ventilation except in the one below grade level.

C. Elevators are located at the SE corner and stairs at the SE and NW corners so vertical circulation from the parking structure floors integrates with the main E-W pedestrian circulation corridors on the north and south edges of the site.

D. For safety and security, elevators will have a glass cab and stairs will be open stairs, protected by transparent glazing.

SECTION II.C.

ARCHITECTURAL DESIGN NARRATIVE

ARCHITECTURE DESIGN NARRATIVE

I. General

A. The design of the Biorenewables Complex shall be in keeping with the Strategic Plan of Iowa State University. The five priorities of the Strategic Plan are Education, Programs, Economic Impact, Iowa Life, and University Life. The buildings will support and integrate the five priority areas and accompany goals.

B. In keeping with the programs and research that will be accommodated in the Biorenewables Complex, the design will incorporate sustainable design concepts through its construction, material choices, and ongoing operations and maintenance practices. The Complex is intended to serve as a model of sustainability for Iowa State University, the State of Iowa, and the nation.

II. Program Components

A. Department of Agricultural and Biosystems Engineering

1. The building will allow for both increased formal and informal interaction. Spaces are arranged so that both formal and informal gathering spaces for groups of various sizes are located throughout the complex.
2. Teaching and research laboratories and their support spaces are grouped together so that neither component is isolated from the other.
3. Offices and their related support spaces are clustered together in order to encourage collaboration and discussion.
4. Lecture and teaming spaces will be grouped with the laboratories so that the total teaching experience is as direct and connected as possible.
5. The laboratory and support spaces are arrange to allow for flexibility in planning and future growth in the programs.
6. Student support spaces and Departmental administrative offices are prominently located near common public areas and General University spaces in order to increase visibility and aid in recruitment.
7. A large display area along with conference areas are located adjacent to common public areas to increase visibility and maximize their use for both public and private functions.
8. The building will provide an singular identity for the Department that is complementary yet separate from the rest of the Complex through the choice and articulation of materials. The Complex will also complement the existing neighborhood material vocabulary.

B. Biorenewables Research Laboratory

1. The building will provide a singular identity for the Biorenewables Research Laboratory that is complementary yet separate from the rest of the Complex through the choice and articulation of materials. The choice of materials will reinforce the mission of the BRL by integrating sustainable material choices. The Complex will also complement the existing neighborhood material vocabulary.
2. Given that researchers in the building will come from a variety of fields of study from across the campus, the offices – laboratory relationship will be open with the use of glass and open areas for interaction and collaboration.
3. The building is designed to support state of the art research with the flexibility to adapt to future growth and change in the field.
4. Ground floor teaching laboratories are designed to allow for the integration of research and teaching in a showcase environment. The laboratories will support long distance learning.
5. The building will allow for both formal and informal interaction by locating gathering spaces for groups of various sizes throughout. A ground floor conference room adjacent to the display area will allow for video conferencing as well as formal presentations.

C. West Campus Parking Structure

1. The West Campus Parking Structure will provide approximately 600 stalls. The new Complex would displace approximately 139 existing surface stalls so the net increase would be 461 stalls.
2. The housing of Parking and Police Divisions in a single building would enable the two divisions to work more efficiently and provide better service by providing one location for these services.
3. The structure would help define the western edge of the campus and help frame pedestrian pathways into the campus.

SECTION II.D.

PROJECT DEMOLITION NARRATIVE

PROJECT DEMOLITION NARRATIVE

I. Construction of the ABE, BRL and Parking Structure may occur at different times. This fact and the amount of construction staging area the contractor will be allowed to use will affect the amount of demolition on the site.

II. At present the site contains a surface parking lot at the west end and an irrigated grass field used for band practice. Existing trees occur at the east and west ends of the site and within the parking lot.

III. The BRL building will be the first to be constructed and will likely require use of the entire grass field. Some portion of the surface parking lot may also need to be demolished or used for construction access.

IV. Construction of the ABE buildings will require demolition of a substantial portion, if not all, of the surface parking lot.

V. Construction of the Parking Structure will displace all of the surface parking lot.

VI. Where possible, existing trees of significance will be retained.

SECTION II.E.

SITE PLANNING NARRATIVE

SITE PLANNING NARRATIVE

I. Storm Water Plan (See "Storm Water Plan")

A. Existing ABE/BRL site.

1. Roughly 4.43 acres in size.

a) Of that, about a third (0.3 acres) is covered in impervious asphalt.

b) The remainder (4.13 acres) is covered in cool-season turfgrass.

c) Because the runoff rates from these surfaces are relatively high when compared with the presettlement condition of the site, and because no existing detention is provided for storm water runoff on the site, the discharge rates for even small rain events are relatively high.

(1) Table 1 (Peak Runoff Rate) shows that a rainfall event with a frequency of two years over a 24 hour period results in a discharge of 5.19 cubic feet per second.

(2) Also of concern are the discharges from the less frequent 10 year and 100 year events.

(3) Modeling of the existing conditions shows that the combined runoff rate from the site during the 10 year event is 9.48 cubic feet per second, and during the 100 year rain event is 17.15 cubic feet per second (See Table 1).

B. Rain water runoff

1. The ABE/BRL site sits on a ridge that splits rain water runoff into two different watersheds (See Existing Ridge Line on "Storm water Plan").

1. Runoff from the western third of the site, including all of the parking lot area, collects in inlets along Sheldon Extension, and is directed to Clear Creek.

2. The eastern two-thirds of the site drains to the east and south. Runoff in this area is directed into inlets around the perimeter where it is sent directly to College Creek at the south edge of central campus.

C. Proposed Development

1. With the inclusion of detention areas, rain gardens, bioswales, porous paving, and native landscapes, the proposed development will reduce the discharge rates for each of these rain events over the existing condition.

2. Above the 100 year rain event it becomes increasingly harder to detain the volume of runoff.

3. The Storm water Plan will meet the goals established by the Iowa Statewide Urban Design and Specification (SUDAS) for development that include the following:

a) "After development, the release rate of runoff for rainfall events having an expected return period frequency of two years and five years should not exceed the existing, pre-developed peak runoff rate from those same storms."

b) "For rainfall events having an expected return frequency of 10 years to 100 years, inclusive, the rate of runoff from the developed site should not exceed the existing, pre-developed peak runoff from a five-year frequency storm of the same duration."

D. Analysis of the planned building footprints and rain garden (detention) configurations

1. It is possible to meet the release rate goals outlined by SUDAS.

2. A total of 14,260 square feet of detention area is needed to meet the requirements using rain gardens with 1 1/2 feet of ponding and 12 inches of subsurface storage in a washed gravel base.

E. Rain Gardens

1. While rain gardens are essentially detention basins, they offer several benefits that traditional detention basins don't.

2. Because a portion of the detention is provided in a gravel layer beneath the ground, water temperatures tend to be cooler for discharges from rain gardens than from traditional detention basins.

3. Increased water temperatures are a problem because they reduce the availability of oxygen in streams and rivers for aquatic life.

4. The gravel layer in rain gardens also filters out sediment which can cloud streams and rivers and make growing conditions difficult for aquatic plant life.

F. Release Rates

1. As shown in the tables below, the proposed conditions release rates are all less than the existing conditions release rates, which will have a positive impact on the already over-taxed existing storm sewer system.

2. The rain gardens will be designed to have 1.5 feet of surface ponding, 12 inches of amended topsoil and 24 inches of open-graded aggregate.

3. The permeable paving will be designed with12 inches of open-graded aggregate. This paving will not accept run-off from adjacent areas.

Table 1: Peak Runoff Rate

Rainfall Event	Existing Conditions (cfs)	Proposed Conditions (cfs)
2-yr, 24-hr	5.19	3.63
5-yr, 24-hr	7.46	4.26
10-yr, 24-hr	9.48	5.08
25-yr, 24-hr	12.35	5.82
50-yr, 24-hr	14.71	6.10
100-yr, 24-hr	17.15	6.40

Peak Elevation

Rainfall Event	Raingarden 1 (ft)	Raingarden 2 (ft)	Raingarden 3 (ft)	Permeable Pavement (ft)
2-yr, 24-hr	0.47	0.68	0.46	0.03
5-yr, 24-hr	0.62	0.83	0.57	0.04
10-yr, 24-hr	0.72	0.93	0.63	0.06
25-yr, 24-hr	0.86	1.06	0.71	0.08
50-yr, 24-hr	0.99	1.19	0.77	0.11
100-yr, 24-hr	1.14	1.35	0.82	0.13

II. Storm Water Capture and Re-Use

A. Capturing storm water and storing it on site for re-use will also greatly reduce discharge rates for the more frequent rain events. In addition, these systems will reduce the demand for potable water for toilet flushing and other grey-water suitable applications.

B. A water budget was developed for the Biorenewables Laboratory to use rainwater collected from the roof for toilet flushing, green roof irrigation, and certain laboratory faucets. The BRL's wastewater flow calculations show a daily need of 587 gallons per day for these uses. Assumptions about the building's FTE (full time equivalent normal occupancy) were made based on the facility's room chart. The lab faucet use is also an estimate based upon a percentage of faculty/student use.

LEED Wastewater Flow Calculations for BRL

Daily uses per fixture based on LEED Table 2, Credit WE 3.2
Flow rates per fixture based on LEED Table 3, Credit WE 3.2
User editable ranges

FTE: 92 (Derived from BRL Room Schedule dated Aug. 15, 2007 minus conference room capacities)
%Female: 50%

Flush Fixture	Daily Uses	Flowrate (GPU)	Occupants	Sewage Generation	Comments
Standard Water Closet (male)	1	1.6	46	74	
Standard Water Closet (female)	3	1.6	46	221	
Low Flow Water Closet (male)	0	1.1	46	0	
Low Flow Water Closet (female)	0	1.1	46	0	
Composting Toilet (male)		0	46	0	
Composting Toilet (female)		0	46	0	
Standard Urinal (male)	2	1	46	92	
Standard Urinal (female)		1	46	0	
Low Flow Urinal (male)	0	0.5	46	0	
Low Flow Urinal (female)	0	0.5	46	0	
Waterless Urinals (male)		0	46	0	
Waterless Urinals (female)		0	46	0	
			Daily Flow (gallons):	386	
			Monthly Flow (gallons):	11785	

Flow Fixture	Daily Uses	Flowrate (GPU)	Occupants	Sewage Generation	Comments
Conventional Lavatory Faucet (15 sec/use)		0.625	92	0	
Low Flow Lavatory Faucet (15 sec/use)	0.55	0.45	92	23	67 Faculty, Visiting Faculty, Post Docs, and Grad Students using lab faucets with recycled water an average of .75 times per day
Ultra Low Flow Lavatory Faucet (15 sec/use)		0.125	92	0	
Conventional Kitchen Sink (15 sec/use)		0.625	92	0	
Low Flow Kitchen Sink (15 sec/use)		0.45	92	0	
Shower (300 sec/use)		12.5	92	0	
Low Flow Shower (300 sec/use)		9	92	0	
			Daily Flow (gallons):	23	
			Monthly Flow (gallons):	694	

Other	Daily Uses	Flowrate (GPH)	Hours Per Use	Daily Water Need
Truck Washdown	0	850	1	0
	0	0	0	0
			Daily Flow (gallons):	0
			Monthly Flow (gallons):	0

Other	Irrigation per Day (gal/SF)	Area (SF)	Yearly Operation	Daily Water Need	Comments
Irrigation of Green Walls	0	0	0	0	
Irrigation of Green Roof - Outside	0.087	1631	0.33	47	1.0" per week for 4 months Only
Irrigation of Green Roof - Inside	0.087	1510	1	131	1.0" per week for 12 months
			Daily Flow (gallons):	178	
			Monthly Flow (gallons):	5435	
			Total Daily Flow (gallons):	587	
			Total Monthly Flow (gallons):	17915	

C. The 587 gallon figure was plugged into a model that ran this usage and the actual rainfall for a comparable location through a 30 year cycle. This was run 7 times with various sized cisterns to determine how each would perform.

CISTERN VOLUME CALCULATOR - Iowa State Biorenewables Lab

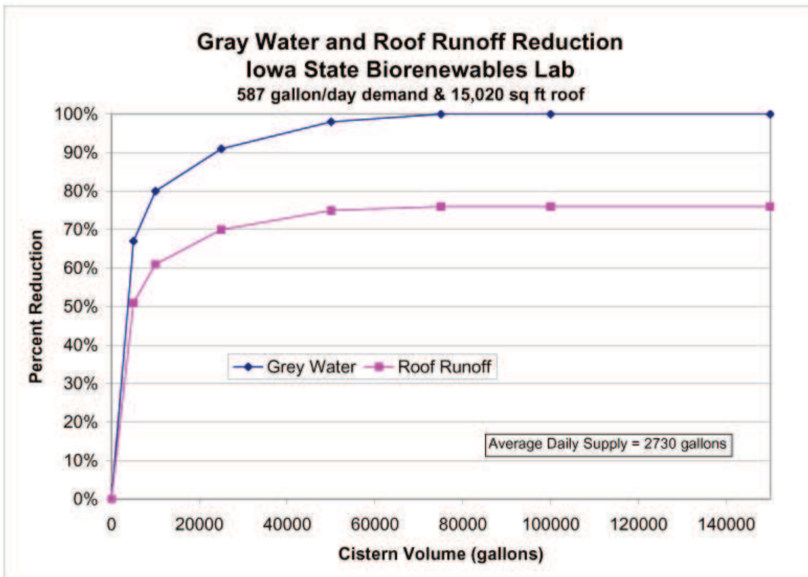
O'Hare Precip, Argonne PET

Input information:			
Daily Demand (gallons)	587		
Evaporation Area (sq ft)	0		
Cistern volume (gallons)	100000 (>0)		
Contributing Area (Sq ft)		Runoff Coefficient	Initial Abstraction
Roof Area 1	15021	0.95	0.05
Area 2	1510	0.2	0.2
Area 3	0	0	

Results:		
#of shortages	0	
# of shortages/year	0.00	
Avg annual shortage:	0	gallons
Avg annual shortage:	0.00%	of demand
Avg annual spill:	66791.42	gallons
Avg annual spill:	23.81%	of supply
# of spills/year	9.19	

year	month	day	Prcp	Snow	Supply	Daily Demand	Evap Loss Demand	Stored Volume
1977	1	1	0	0	0	587	0	99413
1977	1	2	0.04	0.5	0	587	0	98826
1977	1	3	0	0.3	0	587	0	98239
1977	1	4	0	0.7	0	587	0	97652
1977	1	5	0	4	0	587	0	97065
1977	1	6	0	0.9	0	587	0	96478
1977	1	7	0	2.1	0	587	0	95891
1977	1	8	0.02	0	0	587	0	95304
1977	1	9	0.09	0	355.7974	587	0	95073
1977	1	10	0.14	3	800.5442	587	0	95286
1977	1	11	0	0	0	587	0	94699
1977	1	12	0	0	0	587	0	94112
1977	1	13	0.05	1	0	587	0	93525
1977	1	14	0	0	0	587	0	92938
1977	1	15	0	0	0	587	0	92351
1977	1	16	0	0.3	0	587	0	91764
1977	1	17	0	0	0	587	0	91177
1977	1	18	0.02	0.2	0	587	0	90590
1977	1	19	0.02	0	0	587	0	90003
1977	1	20	0.01	1	0	587	0	89416
1977	1	21	0	0	0	587	0	88829
1977	1	22	0	0	0	587	0	88242
1977	1	23	0	1	0	587	0	87655
1977	1	24	0	1.5	0	587	0	87068
1977	1	25	0.01	0	0	587	0	86481
1977	1	26	0.05	0	0	587	0	85894
1977	1	27	0.07	0.5	177.8987	587	0	85485
1977	1	28	0.02	0	0	587	0	84898
1977	1	29	0	0	0	587	0	84311
1977	1	30	0.01	0	0	587	0	83724
1977	1	31	0	0	0	587	0	83137
1977	2	1	0	0	0	587	0	82550
1977	2	2	0.08	0	266.8481	587	0	82230
1977	2	3	0	0	0	587	0	81643
1977	2	4	0.22	0	1515.904	587	0	82572
1977	2	5	0	0	0	587	0	81985
1977	2	6	0	0	0	587	0	81398
1977	2	7	0	0	0	587	0	80811
1977	2	8	0	0	0	587	0	80224

D. The following chart summarizes the results of this analysis and shows that a 25,000 gallon cistern could reduce yearly potable water needs for these uses by 90%. A 25,000 gallon cistern would also reduce storm water discharges by 70% (total yearly volume). There is a diminishing return to the benefits for cisterns larger than 25,000 gallons.



III. Site Design Phasing

A. Phase 1 – Biorenewables Research Laboratory (See Drawings "Phase 1 – Biorenewables Laboratory)

1. The first phase of development will include the construction of the BRL facility and the site infrastructure closely associated with it.

2. A public walkway will be constructed between the sidewalk on Bissel Road and the entrance to the College of Design.

a) Portions of the existing concrete retaining wall in front of the College of Design will be removed to accommodate this path.

b) A raised seatwall formed by the intersection of the new sidewalk to the College of design and the existing sidewalk on the north edge of the site will display hardy ornamental perennials and offer a shared space for students to gather.

c) These patterns will be built upon in future phases of development.

3. Temporary truck access to the high bay laboratory will be provided from the existing parking lot which will remain until the second phase of construction. New sidewalks will be constructed to connect the parking lot to the Biorenewables Laboratory as well as to the College of Design and Howe Hall.

4. Plaza spaces will be provided between the main entrance to the BRL and the sidewalk at Bissel Road and at the high bay laboratory.

   a) The porous paving used for the surface of these plazas will allow the spaces to double as locations of storm water detention and treatment (See "Pavement – Porous Unit Pavers").

   b) Additional detention will be provided at a rain garden on the north edge of the Biorenewables Laboratory (See "Storm water Treatment – Rain Gardens).

   c) This area is sized to accommodate all of the detention needs for the Laboratory, plus a portion of the future detention needs for the atrium space that will be built to connect BRL to the future ABE buildings.

   d) The rain gardens will be planted in a native grass matrix that may include some of the species being investigated for biorenewable fuel sources (See "Planting Styles – Native Grass Matrix").

5. A 25,000 gallon, fiberglass, in-ground cistern will collect rain water from the Laboratory's roof and store it for re-use in toilet flushing, laboratory faucet, and landscape irrigation uses (See "Cisterns – Fiberglass").

   a) A second 400 gallon, stainless steel cistern will be mounted on the roof of the Laboratory building to collect condensate water from the HVAC system and re-use it in a drip irrigation system for the green roofs (See "Cisterns – Above Ground Tank" and "Water Reuse – Recycled Condensate Irrigation").

   b) This type of system will rely solely on the head pressure of the elevated tank to distribute water to the green roofs, so no additional pumps are needed.

   c) It is also a very efficient use of water because the green roofs will need the irrigation most during the summer months when the HVAC unit will be producing the most condensate from dehumidifying the building's air.

6. A green roof will be added to the Biorenewables Research Laboratory.

   a) A semi-intensive system capable of supporting a wide variety of herbaceous grasses and crop plants will be installed over the High Bay Laboratory.

   b) The planting will be divided into distinct plots so that the plants that are being experimented with can be prominently displayed (See "Green Roof – Extensive and Semi-intensive Systems").

7. The turf lawn surrounding the Laboratory will be temporarily replaced with low, ornamental grasses that outline the future location of the ABE buildings.

   a) Taller ornamental grasses will mark the locations of internal and external walls, while a lower fescue mix will represent the "floor" (See "Planting Styles – Native grass Matrix" and "Planting Styles – Low Fescue Lawn").

   b) The planting can be maintained through yearly mowing and broad-leaf pesticide applications.

c) It will help to reduce maintenance for these large lawn spaces and may also provide the University with a test plot to demonstrate the application of native-grass plantings for other campus areas.

B. Phase 2 – ABE and Parking Garage (See Drawings "Phase 2 – ABE)

1. The second phase of development will include the ABE buildings, an Atrium space, and a parking garage on the west edge of the site. The design of the exterior spaces in this phase of development builds upon the arrangement of pathways and plaza spaces from the first phase of development.

2. Additional porous paving plazas are added to the main entrance opposite the new Atrium and the space west of the High Bay Laboratory.

    a) These spaces can be used for VEISHEA displays, and displays of large equipment.

    b) As in the previous development, they also double as storm water detention and treatment areas.

    c) Additional detention is provided by the rain gardens located in several locations around the site.

    d) These areas will be planted in a native grass matrix that can be maintained with yearly mowing and broad-leaf herbicide applications.

3. The existing sidewalk along the north edge of the site will be replaced with a wider, heavy-duty surface that is able to accommodate intermittent traffic to the High Bay Laboratory.

4. An additional in-ground fiberglass cistern will be installed immediately adjacent to the cistern from the first phase of development.

    a) The two cisterns will be linked so that they combine their storage and distribution capabilities.

    b) The new cistern will be sized to accommodate the rain water discharged from the roofs of the ABE and the Atrium.

5. A limited amount of Green Screens will be constructed on wall surfaces in this phase of development.

    a) Some of the faces of the parking garage will be softened with the installation of elevated planters at each deck level (See "Green Screen – Elevated Planters).

    b) The planters will be designed to accept and treat the runoff from the parking decks.

    c) The vegetation will also screen cars in the garage from the hot afternoon sun during the summer months.

    d) A wall designed to block views into the service and maintenance area will be covered with an inexpensive planting of ivy (See "Green Screen – Clinging Vines").

C. Phase 3 – Campus Spaces (See Drawings “Biorenewables Laboratory – Campus Master Plan)

1. The final phase of development for this site will provide shared space for the Biorenewables Laboratory, the ABE, Howell Hall, the College of Design, and Town Engineering.

   a) New sidewalks will link each of these facilities to a central plaza space with stepped seating that will be suitable for outdoor classroom and presentation purposes.

   b) The seating will make efficient use of the existing raised “plinth” at the College of Design so that a minimum amount of wall and grade will need removal.

2. The common plaza will open onto a central lawn that can serve as spill-over space and can be where passive recreation occurs.

   a) Storm water runoff from this large turf space will be collected and treated in a new rain garden detention area to the south of the lawn.

   b) It will then be put to use in decorative display fountains at the plaza’s southwest edge.

   c) Attractive, vertical wind turbines will serve as a focal point for the main lawn and will power the pumps that activate the plaza’s fountain.

IV. Site Treatments

A. Green Screen

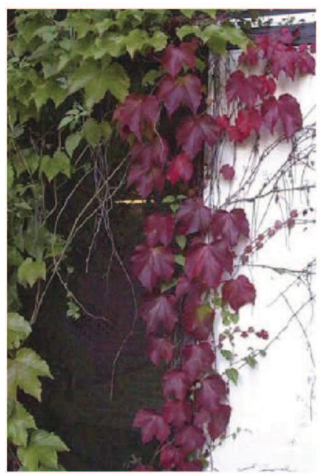
1. Clinging Vines

a) Ivy growth on a building façade can effectively reduce the radiation gain of a building in summer. A study by H.F. Di and D.N. Wang of Ingenta Labs (Taylor and Francis Ltd. 1999) showed that the effect is most pronounced on west facing walls. They determined that "the green wall reduced the peak-cooling load transferred through the west-facing wall by 28% on a clear summer day." While this is mainly due to the shading capability of the leaves, additional cooling comes from the evapo-transpiration process that occurs during photosynthesis when large amounts of water vapor is released.

b) The simplest way to establish a "green screen" is by planting vines at the base of a wall. There are several species that will climb and cling to the façade under their own devices. This approach requires patience, however, as the plants may take many years to reach their mature height (30-60 feet). Some clinging vines can also damage a building's façade. Those with aerial rootlets (Hedera helix, or English Ivy) should be avoided. Vines that utilize suction cups for attachment (Parthenocissus ticuspidata, Pathenocissus quinquefolia) do less damage, though continual maintenance at door and window openings will be required.

c) Recommended Budget = $0.13 per face foot (for 45 foot tall wall)

d) This treatment is recommended for lower-profile wall faces with few window openings.

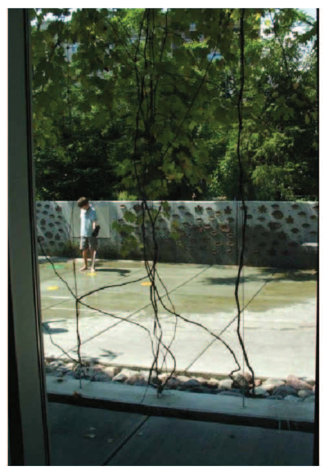

2. Twinging Vines on Support Grid

   a) With the use of a wire support grid, or trellis, a wider variety of vines can be utilized. Twining vines such as Clematis temiflora (Sweetautumn clematis), Vitis riparia (Riverbank Grape), Celastrus scan dens (American Bittersweet), and Aristolochia durior (Dutchman's pipe) attach themselves by wrapping around the support structure. In this manner they do far less damage to the building and can be grown across window openings to boost their shading potential.

   b) Wire support structures are the most cost-effective for large walls and are available as thick gauge wire cage structures (contact www.greenscreen.com) and as cable tension systems (contact www.decorcable.com).

   c) Recommended Budget = $5-10 per face foot

   d) This treatment is recommended for highly visible wall faces with window openings.



3. Proprietary Seeded Panel

   a) For a dramatic display of vegetation, Patrick Blanc's Vertical Garden is a showstopper. The French-born horticulturalist devised a lightweight panel system that clips to a steel support structure. The panels are seeded with epiphytic vegetation and custom grown for each project. Because the system does not rely on any soil medium it is very lightweight and significant heights can be attained.

   b) The diverse array of tropical vegetation available for this type of system means that it is best suited to an indoor application. Constant irrigation and fertilization of the system are required.

   c) Recommended Budget = $20-30 per face foot (Including Irrigation System)

   d) This treatment is not recommended for the Biorenewables Complex project because the projected costs are prohibitive.

Photo Credit: Patrick Blanc, Vertical Gardens

Photo Credit: Patrick Blanc, Vertical Gardens

Photo Credit: Patrick Blanc, Vertical Gardens

Photo Credit: Patrick Blanc, Vertical Gardens

4. Living Wall

a) At the Peggy Notebaert Nature Museum in Chicago, Illinois, CDF recreated a limestone bluff wall with pockets of native vegetation. The stone wall allows water from the museum's roof to trickle down the facade and irrigate the bluff vegetation, reminiscent of historical water patterns.

b) Recommended Budget = $35-40 per face foot (Including Irrigation System)

c) This treatment is not recommended for the Biorenewables Complex project because the context is not appropriate and the projected costs are prohibitive.





5. Elevated Planters

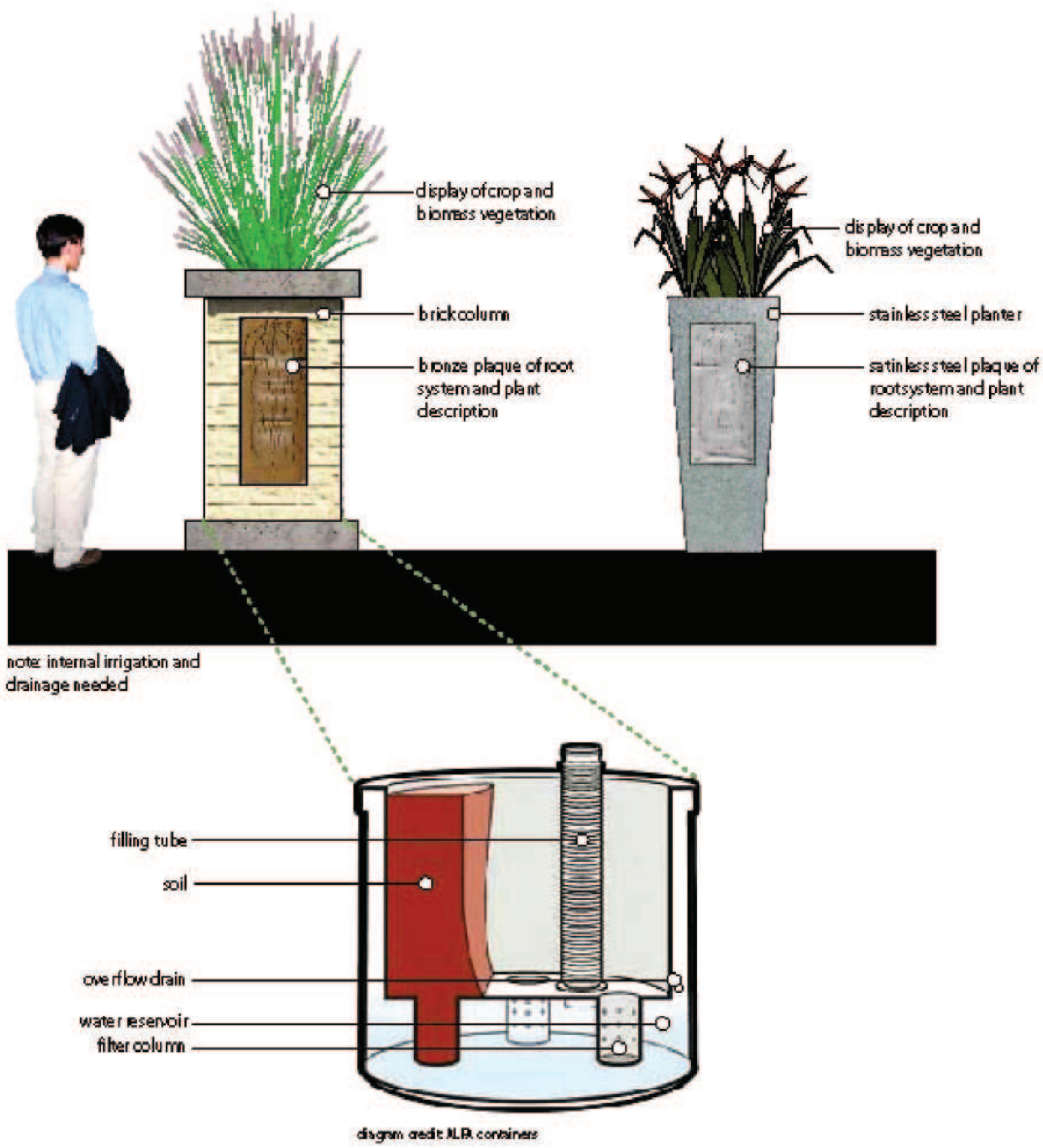
a) When greening is needed for wall heights over 40 feet, elevated planters may be necessary. These hi-tech planters are insulated and have their own internal drainage systems. They can be planted with a combination of trailing and climbing vegetation. They can also be designed to intercept, clean, and detain storm water runoff from roof and deck structures (assuming salts are not used as deicing agents).

b) Recommended Budget = $3-5 per face foot

c) This treatment is recommended for the parking garage where it can be used to shade vehicles, cleanse the runoff from the garage and serve as a green relief for motorists approaching the site.

B. PLANTERS

1. Botanical Display Columns



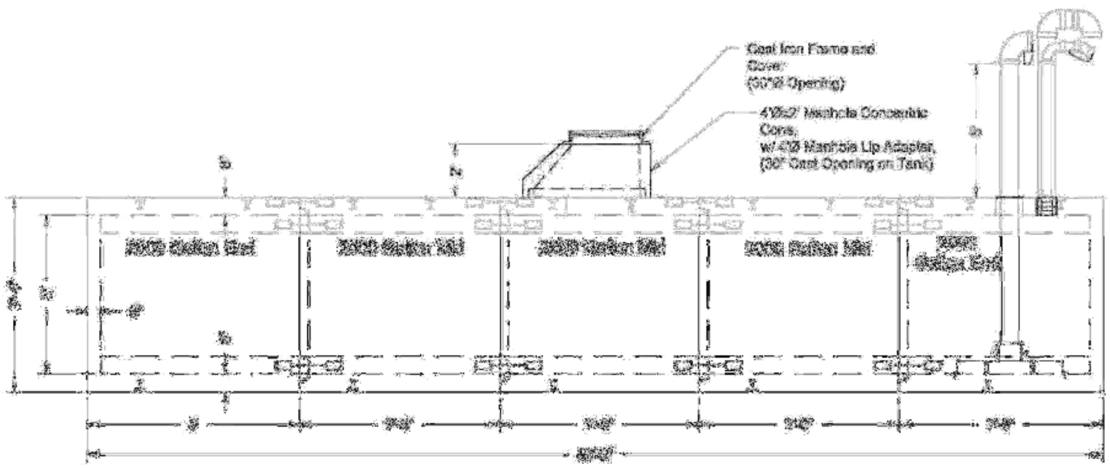
C. CISTERNS

1. Pre-cast Concrete

a) Concrete vaults are a good choice for large cisterns in poorly drained or unstable soil conditions. They are usually delivered in separate pre-cast modules that are pieced together on-site. Because of this, very large cistern sizes are attainable. Concrete vaults can be damaged by the acidic properties of chemically treated water and may require lining where these systems are in use.

b) Recommended Budget = $1.50 - 2.00 per gallon

c) This treatment is not recommended for the Biorenewables Complex project because the cistern volumes and anticipated soil conditions do not warrant it.



Elevation View

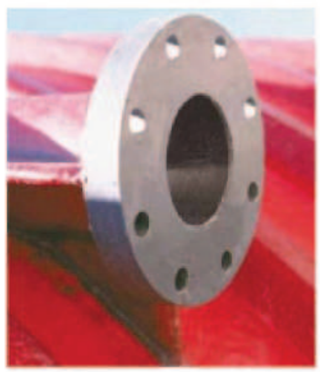
2. Fiberglass

   a) Fiberglass cisterns are relatively resistant to chemical corrosion and are much lighter weight than pre-cast concrete cisterns. They usually arrive at the project site in one piece and so are limited in size.

   b) Several national manufacturers are available. Contact www.xerxescorp.com

   c) Recommended Budget = $1.00 - 1.50 per gallon

   d) This treatment is recommended for the Biorenewables Complex project for cistern volumes up to 30,000 gallons.



3. Open Pond

a) Open ponds are economical alternatives for very large storage volumes (over 100,000 gallons). They do require significant amounts of space, however. If a shallow bank and vegetated shoreline are desired, the pond will need a much larger storage volume than what will be drawn from it. Smaller open ponds will be subject to extreme fluctuations in water levels and water stored in them will tend to pick up more contaminants that water contained within a cistern.

b) Recommended Budget = $0.50 - 1.00 per gallon

c) This treatment is not recommended for the Biorenewables Complex project because of the limited space available on this site.

4. Hope Pipes

a) High Density Polyethylene pipes are frequently used for subsurface storage of storm water. It is possible to adapt them for use as cisterns for recycled rain water. Their primary limitation is the space they need to store significant volumes because of a maximum pipe diameter that is achievable with this type of material. For this reason, they are most often used beneath parking lots. They are not as convenient to maintain as fiberglass, or concrete cisterns and are not as easily adapted with devices such as flow control valves.

b) Recommended Budget = $0.50 - 1.00 per gallon

c) This treatment is not recommended for the Biorenewables Complex project because of the limited space available on the site.

5. Above Ground Tank

   a) Above ground tanks are ideal for low flow irrigation applications because when properly placed they don't require additional pumps to distribute the water. Tanks can be insulated and heated for use over the winter, but they are generally drained down. Tanks can be constructed of Stainless Steel, Fiberglass, and Concrete.

   b) Recommended Budget = $5,000 - 10,000 (for 400 gallon tank and controls)

   c) This treatment is recommended for the captured condensate irrigation system for the green roofs on the Biorenewables Laboratory.

D. WATER REUSE

1. Water Walls

a) For the Prisma development in Nuremberg, Germany, the design firm of Atelier DreiseiU created a visually stunning atrium that relied on six water falls to condition the air within the space. Recycled rain water cascades behind a glass wall where it pulls in outside air and dehumidifies it. The action of the cascade pulls the air with it, so no fans are needed. The water filters the air by removing airborne particulates such as pollen. In the winter the water also warms the air before it is brought into the atrium.

b) For more information go to http://www.dreiseiU.defindex.php?id=526&lang=en&choice=4.

c) This treatment needs to be investigated further before it can be recommended for the atrium space in the second phase of development.


Photo Credit: Waterscapes, Atelier Dreiseitl


Photo Credit: Waterscapes, Atelier Dreiseitl

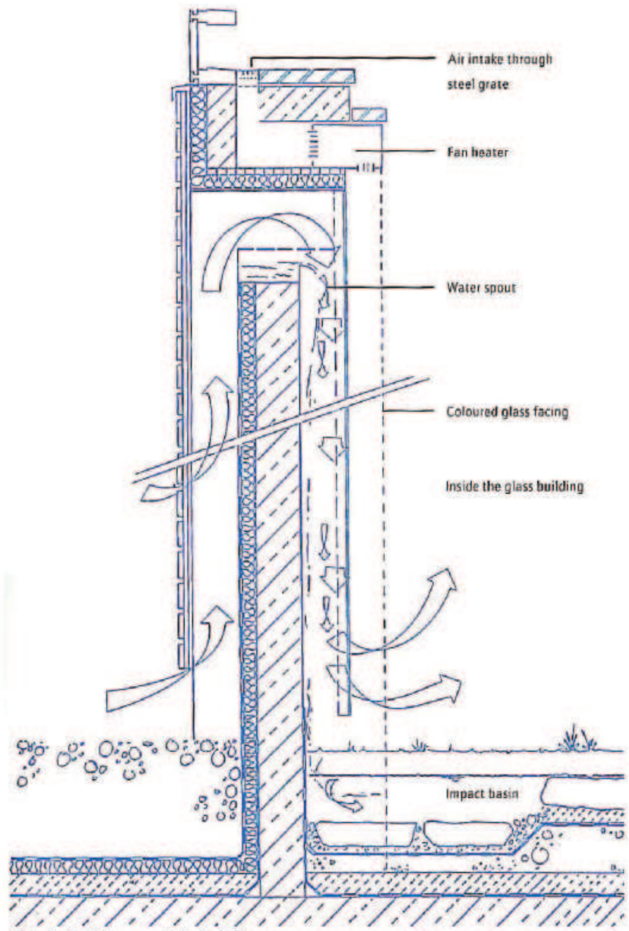


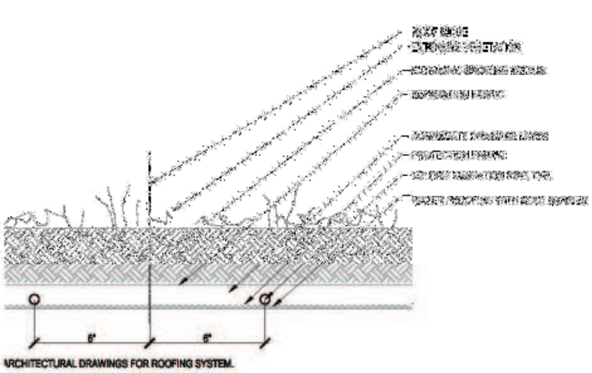
Photo Credit: Waterscapes, Atelier Dreiseitl

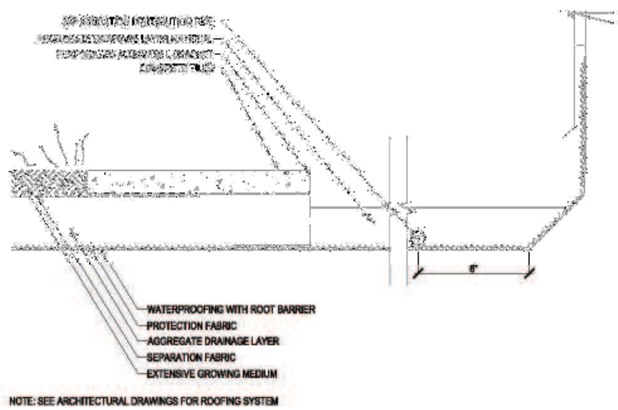
2. Recycled Condensate Irrigation

   a) The dehumidification action of a typical HVAC system offers a low cost source of water for irrigation and other non-potable applications. For the Jardine Water Filtration plant in Chicago, Illinois, Conservation Design Forum created a drip-irrigation system for the green roof that was fed from a condensate tank on the roof.

   b) Recommended Budget = $15,000 - $25,000 (for tank and irrigation system)

   c) This treatment is recommended for both green roof areas on the Biorenewables Laboratory.





E. STORMWATER TREATMENT

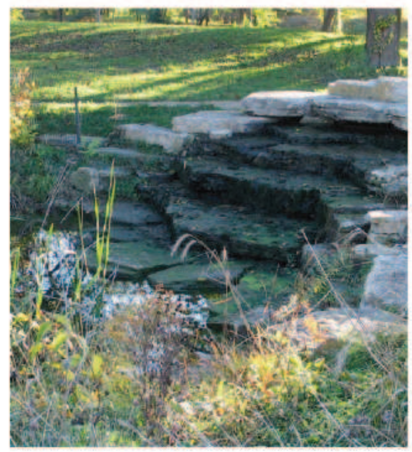
1. Rain Gardens

a) While rain gardens are essentially detention basins, they offer several benefits that traditional detention basins don't. Because a portion of the detention is provided in a gravel layer beneath the ground, water temperatures tend to be cooler for discharges from rain gardens than from traditional detention basins. Increased water temperatures are a problem because they reduce the availability of oxygen in streams and rivers for aquatic life. The gravel layer in rain gardens also filters out sediment which can cloud streams and rivers and make growing conditions difficult for aquatic plant life.

b) Recommended Budget = $6 per square foot

c) This treatment is recommended for handling all of the storm water runoff on the Biorenewables Laboratory Site. Statewide goals for storm water handling and treatment (SUDAS) as well as LEED standards will be met with the inclusion of these systems.





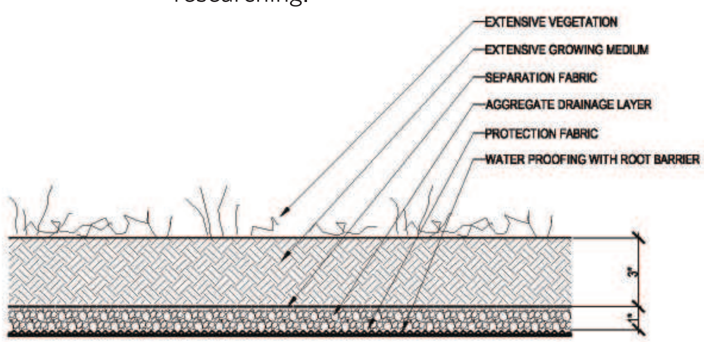
F. GREEN ROOF

1. Extensive and Semi-Intensive Systems

a) Green roofs are appropriate for new and retrofit buildings at many scales from small garages to large warehouses and residential complexes. The load bearing capacity of the roof may dictate the type of green roof used. Green roof systems can significantly reduce runoff volumes and rates (50 - 90%reduction in annual runoff) as well as thermal loading of runoff. The protection that the planting medium affords has been shown to extend the life of roof membranes by two to three times (20 years or more). Additional benefits include the roofs ability to offset detention requirements, a reduction in the urban heat island effect, a reduction in a building's heating and cooling energy requirements and the addition of plant and animal habitat to an otherwise sterile environment.

b) Recommended Budget: $15-20 per square foot (extensive system)
$20-25 per square foot (semi-intensive system)

c) Both green roof types are recommended for the BRL. A semi-intensive system over the high-bay laboratory will exhibit a wide variety of plants that the facility is actively researching.



NOTE: SEE ARCHITECTURAL DRAWINGS FOR ROOFING SYSTEM.

Peggy Notebaert Nature Museum - Semi-Intensive System

Peggy Notebaert Nature Museum - Semi-Intensive System

Chicago City Hall Green Roof- Semi-Intensive System

Jardine Water Purification Plant - Extensive System

G. PLANTING STYLES

1. Native Prairie

a) Native landscapes, such as tall-grass prairie, offer a variety of environmental and cost savings benefits. Environmental benefits include the reduction of surface water runoff and downstream flooding, reduced soil erosion and the re-development of organic topsoil, increased groundwater recharge, enhanced regional air and water quality, restored wildlife habitat, and increased biological diversity of both plants and animals. Long-term maintenance cost savings can also be significant. Once established, a process that generally takes 5-10 years, native landscapes do not require mowing, nor the use of fertilizers, pesticides, herbicides, or supplemental watering. Controlled burning every 1 to 2 years is the primary maintenance required for this system. Not only good for the environment, native landscape systems can result in annual maintenance cost reductions in comparison to traditional turf grass maintenance costs.

b) Recommended Budget = $5,000 per acre (additional establishment period maintenance costs are required)

c) This treatment is not currently recommended for the Biorenewables Laboratory site.

2. Native Grass Matrix (Little Bluestem, Switchgrass, Prairie Dropseed)

    a) An alternative to the diverse Prairie landscape is a planting of only native grasses that can be ornamentally arranged and maintained by yearly mowing and broad-leaf herbicide applications. The benefits of rain water absorption and soil accretion are still achieved, but the system will not create as diverse an ecosystem, nor will it be entirely self-sustaining. Plant selections will draw from the pallette of species being researched for biomass fuel applications.

    b) Recommended Budget = $9 per square foot

    c) This treatment is recommended for the rain garden areas on the BRL site.






3. Low Fescue Lawn

    a) Fine fescues grow slowly and if left uncut reach a mature height of only 8 to 12 inches. They don't like a lot of fertilizer, and thrive in dry, infertile soil. They tolerate moderate foot traffic, partial shade and drought.

    b) Recommended Budget = $0.80 per square foot

    c) This treatment is recommended as an edge treatment to areas with native taller grasses like the rain gardens.

H. PAVEMENT

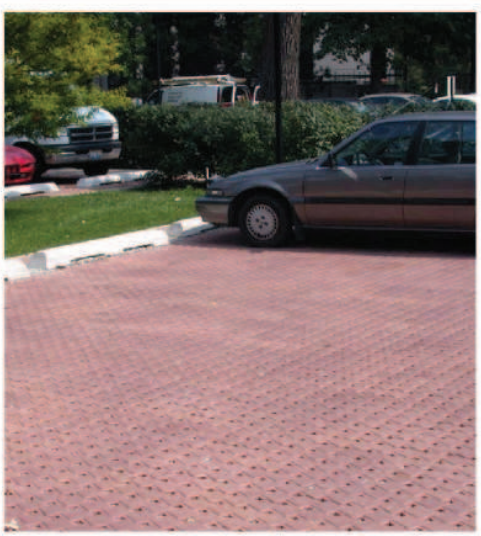
1. Porous Unit Pavers

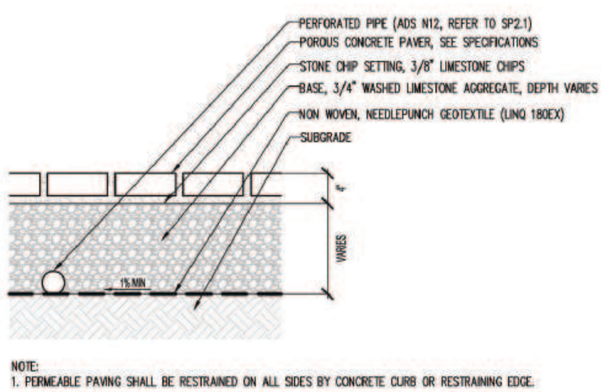
a) Porous unit pavers have spaces between pavers that allow for the transmission of water to an aggregate base, reducing runoff volumes and improving water quality. Runoff is temporarily stored in the base and slowly evaporated and released to storm sewers. Unit pavers also come in a wide variety of shapes and colors and can be an attractive surface treatment.

b) Benefits include the reduction of storm water runoff volumes by 20% or more depending on depth of the aggregate base and a reduction in storm water runoff rates by up to 95%. These systems also filter sediments, hydrocarbons, nutrients, and other urban pollutants from runoff and reduce runoff temperatures.

c) Recommended Budget = $8-10 per square foot

d) This treatment is recommended for the large plaza areas at the BRL.



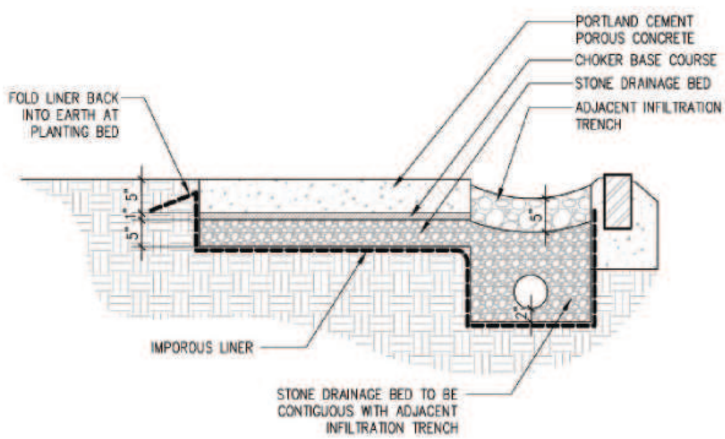


2. Porous Concrete

   a) Similar to conventional concrete but with a stickier mix and the aggregate fines removed to allow water to pass through the surface. Permeable concrete is appropriate for virtually any application where conventional concrete is used except where hazardous materials are expected (e.g., gas stations.)

   b) Recommended Budget = $7-8 per square foot

   c) This treatment is not currently recommended for the Biorenewables Complex project.



SECTION II.F.

FOUNDATIONS AND STRUCTURE

FOUNDATIONS AND STRUCTURE

I. General

A. Codes

1. The buildings will be constructed to *2006 International Building Code* requirements. The building will classified under Occupancy Category III,

2. The building is expected to meet requirements for a Type I-B Fire Resistive Structure

3. The buildings will be designed to resist live loads in excess of those required by the 2006 International Building Code.

4. Snow loads will be based on a 30 pound per square foot ground snow load with roof snow loads and drifting calculated using requirements of ASCE 7-05. The snow load importance factor is 1.1.

5. Wind loads will be based on a 90 mile per hour wind speed with an exposure type B. The wind load importance factor is 1.15. The building is located in seismic site class D. The seismic Importance factor is 1.25.

6. Structural Serviceability Considerations will be based on the requirements of ASCE 7-05

B. Lateral Loads

1. It is expected that wind loads will govern over seismic loads. Wind loads will be resisted by one of two methods depending on the building frame used. If steel construction is used for the building frame wind loads will be resisted by the use of X-braced frames. The braced frames will be located in areas that do not obstruct the appearance or hinder the performance of the building. Examples of possible locations are adjacent to stairwells, elevator rooms, mechanical rooms, etc.

2. If concrete construction is used for the construction of the building frame, a combination of ordinary concrete shear walls and ordinary concrete moment- resisting frames will be used to resist wind loads.

3. Lateral loads will be transferred from walls and other elements to roof and floor diaphragms and from the diaphragms to the shear walls, moment frames, or braced frames. Consideration will be given to proper collection of loads at the load resisting elements and transfer from these elements to foundations that are designed for sliding and overturning resistance. It is expected that wind loads will govern over seismic loads.

C. Foundations

1. A geotechnical investigation has not been completed at this time. Based on information from soils reports for buildings in close proximity to this site it appears possible to support the buildings on conventional shallow spread and strip foundations. Footings bearing at the basement level might be proportioned using an allowable soil bearing capacity approaching or exceeding 5,000 psf. Footings bearing at the first floor levels might be proportioned using allowable soil bearing capacities of 2,000 psf or less. En these locations, footings may need to be lowered or some over-excavation and replacement with engineered fill completed in order to achieve greater bearing capacities. Footings will have a minimum depth of 12 inches and will be constructed of concrete with a minimum compressive strength of 4,000 psi. The bottom of footings will be placed on firm, undisturbed soil or controlled compacted fill with a minimum of 42" of soil cover at the building exterior for

protection against frost damage. The foundation systems will be selected based upon economy and their appropriateness based upon on economy and their appropriateness based upon on the recommendations of the soils consultant after a geotechnical investigation is completed.

2. Foundation and basement walls are expected to be constructed of reinforced cast-in-place concrete. Perimeter drainage will be provided at the base of the foundation walls that enclose below grade space. Free draining backfill will be used at these locations and the walls will be moisture proofed.

D. Slab-on-Grade

1. Floors that are to be constructed on grade are expected to be 4″ concrete slabs on ground reinforced with welded wire fabric. Thicker slabs may be required in areas that support heavy equipment. The slabs will require a granular drainage course and vapor barrier placed over a prepared sub-grade. The vapor barrier will be placed immediately beneath the slab in areas that are to receive floor coverings and beneath a granular leveling course where the concrete slab will be left exposed. It is anticipated that an underground drainage system will be required below the basement level slab-on-grade to prevent hydrostatic uplift forces, based upon groundwater levels on adjacent sites.

II. ABE/BRL Buidings

A. ABE consists of two buildings linked by short bridges. BRL is a single building linked to one of the ABE buildings by short bridges.

1. Vibration

An analysis of the building floor framing systems for vibration will be performed during design. The accelerations, frequencies and amplitudes will be maintained within limits suggested by "Floor Vibrations Due to Human Activities" - AISC's Steel Design Guide Series #11. Excitation of the floor will be based on walking. It is assumed that there will be no equipment in the building that is extremely sensitive to vibration. If such equipment is expected vibration control may be accomplished by adjusting the floor slab mass/thickness and floor beam/girder stiffness.

2. Fire Resistance Statement

The buildings are expected to meet requirements for I-B Type of Construction based on the requirements of the *2006 International Building Code.* It is expected that the structural frame shall meet a 2-hour rating and the roof construction meet a 1-hour rating.

3. Slab-on-Grade

Those areas of the ABE/BRL buildings where heavy equipment and/or vehicle loads occur will have reinforced CIP floor slabs with minimum thickness of 6″. Slabs will be designed for the specific loads in each area. Program areas where these thicker floor slabs will occur are:

	ABE		BRL
A.11.1.6	Rainfall Simulator	B.10.4	High Ceiling Laboratory
A.10.2.1	Field Machinery		
A.10.1.1	Machine Small High Bay		
A.10.3.6	Machine High Bay		
A.10.3.2	Tractor Vehicle Dynamometer		

4. Supported Floors:

   a. The supported floors in the three buildings will be constructed from one of two options: either structural steel or cast-in-place concrete. The structural floor system will be selected based upon economy, appropriateness for the programmed space and impact to the construction schedule.

      1) Structural Steel: This option would consist of using composite structural steel beams and girders supporting a concrete slab on composite metal deck.. The structural steel beams and girders would be supported by structural steel wide flange columns. The steel beams would be fireproofed with spray-applied fireproofing. The floor slab would be the required thickness in order to achieve a 2-hour fire rating; therefore no fireproofing would be required for the deck.

      2) Cast-in-Place Concrete: This option would consist of a mild-reinforced cast-in-place concrete pan joist floor system supported by reinforced cast-in-place beams. The beams would be supported by reinforced cast-in-place concrete columns. The required cover for the reinforcing steel would be provided in the columns, beams and slabs in order to meet a 2-hour fire rating.

   b. Roofs: Mechanical penthouse roofs are expected to be constructed of K series steel joists supporting 1 1/2" deep steel roof deck. The joists will be supported by structural steel beams and light gage metal-load bearing walls. These beams would be supported by structural steel wide flange columns. Typical joist spacing will be on the order of 6 feet. The steel bar joists would not be required to be fireproofed, however the structural steel columns and beams would be required to be fireproofed.

   c. Low roofs on those areas that project beyond the basic building shape are expected to carry an additional contingent dead load of about 70 to 100 pounds per square foot due to support a prairie grass "green roof". These additional dead loads would be supported in a similar fashion as the high roof areas; however a heavier gage steel deck would be required along with smaller spacing between steel bar joists.

B. Atrium

1. An enclosed atrium will be constructed with the ABE building.

2. Floor

   a. Atrium floor, where on grade, will be a cast-in-place concrete slab. The slab thickness in the atrium will be 6" or thicker to support increased loads that may be incurred from time to time when the atrium is used for display and exhibit. This increased thickness may also be required if heating and cooling is provided by a radiant slab system.

   b. Atrium floor where over occupied space may be a structural steel or cast-in-place concrete system as described above for the ABE/BRL supported slabs.

3. Atrium Roof Area:

   a. The atrium space between the three buildings is expected to have a glass paneled roof. These glass panels will be supported by custom long span structural steel roof trusses or long-span steel bar joists. The final systems will be chosen based upon economy and the architectural design of the space.

b. Since the BRL building will be constructed prior to the ABE buildings and the atrium, columns and beams on the south BRL wall that will eventually support the atrium roof will need to be designed for this future load.

4. Vertical Walls

a. The walls between the three ABE/BRL buildings that enclose the atrium are planned as glass walls. Since these walls do not have floor slabs for intermediate support a structure of beams, columns and trusses will be designed to proved lateral support for these walls.

III. Parking Garage

A. The parking garage will be a standard two bay garage with one flat bay and one sloping bay. The anticipated construction of the parking garage is to be a post-tensioned cast-in-place concrete one-way slab system. The one-way slab will span to post-tensioned cast-in-place concrete girders supported by cast-in-place concrete columns. It is anticipated that a cable guardrail system will be used to resist the impact loads from vehicles.

SECTION II.G.

EXTERIOR WALL

EXTERIOR WALL

I. ABE/BRL

A. General

1. Exterior wall will consist of a combination of the following finish materials:

a. ABE/BRL Buildings

1) Brick Veneer supported by structural steel studs.

(a) Rainscreen system will be used with assembly from outside to insides consisting of:

- Brick veneer
- Air Cavity
- 1" to 2" of insulation
- Moisture barrier
- 5/8" Dens Glass Sheathing
- Structural Steel Studs with batt insulation

(b) Flashing: At ledge angles – stainless steel; at windows – use flexible adhesive flashing to form positive seal between window and the wall moisture barrier.

2) Glass and Metal Panel curtain wall/window systems

(a) Glass will be a high performance insulating glass with a high shading coefficient and a high transmittance of day light.

(b) Aluminum extrusions will have 2-coat factory applied Kynar paint and will have a thermal break.

(c) Metal panels will be steel or aluminum panels – factory painted with 2-coat Kynar paint.

(d) Painted metal sunshading devices will be incorporated where appropriate for sun control.

3) Wall within Atrium

(a) BRL walls will be constructed like exterior brick cavity wall since these walls will be exterior walls until atrium is complete. However, since these walls will eventually become interior walls, in lieu of brick veneer, stainless steel siding is proposed.

(b) ABE walls will be constructed as interior walls. Insulation will be reduced and single pane glass will be used since atrium will act as a thermal buffer. Finish wall panels will be combination of glass and aluminum with solid walls of wood panels/slats with acoustical insulation behind.

4) Doors and Frames

(a) Man Doors: Galvanized hollow metal, painted.

(b) Equipment Doors: Insulated overhead or coiling doors, power operated.

II. Atrium

A. The walls between the three buildings will be constructed of butt-glazed glass walls supported by monumental aluminum mullions which in turn will be supported by a secondary steel structure. There are three walls – two short walls facing north and south and a long wall facing east. All will be the height of the ABE/BRL buildings. As the Atrium is intended as a buffer space, the option to use single vs. insulated glass will be analyzed in the next phase.

B. Sunshading will be incorporated at the east wall either as part of the glass wall system or as a "green wall" of landscaping or some combination of both.

III. Parking

A. Walls at the corners and ends of the building enclosing vertical transportation elements will consist of a combination of brick veneer cavity walls and glass and aluminum curtain walls. Single pane glass will be used.

B. Portions of the east and west walls are proposed to be left open so the parking structure can meet requirements of a naturally ventilated parking structure. A cable rail system will be utilized to perform both as a guardrail and vehicular barrier system.

IV. Miscellaneous

A. Entrances

1. Entrances will consist of painted aluminum and glass stile and rail doors with closers. Automatic operators for ADA compliance will be provided at each entry.

2. The need for vestibules on the atrium entrances will be evaluated as design progresses.

3. Vestibules will not be provided at parking structure entrances since the parking structure is naturally ventilated.

B. Window Washing

1. Window washing will be via bosun's chair or hydraulic lifts. Where bosun's chair method is to be used, roofs will be equipped with tie off point and davit supports.

SECTION II.H.

ROOFING

ROOFING

I. ABE/BRL

A. Roofs above Fourth Floor and Penthouse

1. Roof are “flat” roofs but will be sloped at 1/4” / 1’ - 0” to drain by sloping the structure, utilizing sloped roof insulation or a combination thereof.

2. For energy conservation the membrane will be a white Thermoplastic Polyolefin (TPO). The white color is integral throughout the material, overcoming a disadvantage of white coated EPDM. TPO is a proven product that has been on the market since the early 80’s.

B. Low Roofs

1. Low roofs occur in limited areas on portions of the building that project from the basic building foot print. These roofs are visible from the upper stories of ABE/BRL as well as from adjacent buildings.

2. A green roof is proposed for these roofs with the roofs planted to reduce runoff, increase thermal performance and longevity of the roof and provide an aesthetically pleasing roof. The roof membrane and insulation system will be selected from several that are designed specifically for “green roof” applications.

II. Atrium

A. The atrium roof is proposed as a sloped glass panel glazing system supported by long span structural steel trusses. Single or double pane glass units or possibly some metal panel units will be utilized as recommended by an energy analysis.

B. Some quantity of roof panels may be operable to provide natural ventilation at certain times of the year as well as to accommodate smoke ventilation requirements.

III. Parking

A. Roof over the lobbies and vertical transportation elements will be constructed similar to the ABE/BRL roofs.

B. The top floor of the parking structure will not have a roof and thus will be exposed to rain and snow. We recommend against waterproofing this roof as:

1. Would require additional cost of a liquid membrane and topping slab or,

2. Would require a traffic topping which requires on-going maintenance.

3. Our experience is that the top slabs of most parking structures are not waterproofed. However, to minimize seepage through cracks we do recommend that the top slab incorporate the following:

a) Coated rebar

b) Use a concrete additive such as caltite. This additive allows the concrete to react with water to seal hairline cracks.

c) A year after opening (or placing the concrete) reseal all large cracks that develop from shrinkage and creep.

IV. Miscellaneous

A. Parapet coping will be fabricated from factory painted steel or aluminum.

SECTION II.I.

INTERIOR CONSTRUCTION

INTERIOR CONSTRUCTION

I. ABE/BRL

A. Typical Walls

1) All areas containing heavy equipment, vehicles and other industrial applications

a. 8" CMU with ground face finish - floor to structure

2) Ground floor corridors

a. 8" CMU with veneer plaster finish in BRL and office wing of ABE – floor to structure

b. 8" CMU with ground face finish in shop and lab wing of ABE – floor to structure

3) Other Walls: 4" 20 or 25 gauge steel studs at 16" o.c. with single layer of gypsum board, painted finish

a. all walls are planned to extend from floor to structure to provide acoustical privacy

b. At office walls provide batt insulation for acoustical privacy

c. At classroom walls provide additional layers of gypsum board and batt insulation as required by acoustical analysis for sound insulation.

II. Doors and Frames

A. Heavy Equipment Labs/Classrooms: Painted hollow metal doors and frames. Stainless steel frames as an alternate.

B. Offices: Natural solid core wood doors and wood frames.

C. BRL Labs: Painted hollow metal frames and solid core natural wood doors.

D. All others: Painted hollow metal doors and frames.

III. Hardware: ISU standard

IV. Miscellaneous

A. Classrooms and Auditorium: Provide acoustical wall paneling as recommended by acoustical analysis.

V. Parking

A. Walls: All walls will be standard CMU. In lobbies CMU will be painted.

B. Floors: Lobby floors will be sealed concrete

C. Ceilings: Painted gypsum board or metal ceilings may be incorporated into the lobbies.

VI. Finishes

A. Refer to attached Finish Schedule

B. Optional finishes for Consideration

FINISH SCHEDULE

I. ABE Office Wing

A. Basement

1. Floors

a. Classroom: Integral Colored, Polished or Sealed Concrete, Rubber or Linoleum

b. Student Club: Polished or Sealed Concrete

c. General Storage: Sealed Concrete

2. Base

a. Classroom: 4" Rubber/Coved

b. Student Club: 4" Rubber/Coved

C. General Storage: 4" Rubber/Coved

3. Walls

a. Classroom: CMU/Painted/Gypsum

b. Student Club: CMU/Painted

C. General Storage: CMU/No Paint

4. Ceilings

a. Classroom: Acoustical Tile/Panels/Open to Structure

b. Student Club: Open to Structure

C. General Storage: Open to Structure

B. Ground Floor

1. Floors

a. Lobby/Display: Integral Color Polished Concrete or Terrazzo

b. Office/Conference/Other Spaces: Carpet

c. Elevator Lobby: Integral Color Polished Concrete or Terrazzo

2. Base

a. Lobby/Display: Stainless Steel or 4" Terrazzo

b. Office/Conference/Other Spaces: 4" Rubber/Straight

c. Elevator Lobby: Stainless Steel or 4" Terrazzo

3. Walls

   a. Lobby/Display: CMU/Painted/Gypsum/Plyboo

   b. Office/Conference/Other Spaces: Gypsum Board Painted

   c. Elevator Lobby: CMU with Veneer Plaster Painted/ Gypsum/Plyboo

4. Ceilings

   a. Lobby/Display: Open to Structure, Gypsum Painted

   b. Office/Conference/Other Spaces: Acoustical Tile/Panels

   c. Elevator Lobby: Gypsum Board/Painted/Open to Structure

C. Second Floor

1. Floors

   a. Office – Office Corridor: Carpet

   b. Classroom: Carpet/Rubber or Linoleum

   c. Elevator Lobby: Integral Color Polished Concrete or Terrazzo

2. Base

   a. Office – Office Corridor: 4" Rubber/Straight

   b. Classroom: 4" Rubber/Straight

   c. Elevator Lobby: Stainless Steel or Terrazzo

3. Walls

   a. Office – Office Corridor: Gypsum Board Painted

   b. Classroom: Gypsum Board Painted, Acoustical Panel/Wall Covering

   c. Elevator Lobby: CMU with Veneer Plaster Painted/Gypsum Board/Plyboo

4. Ceilings

   a. Office – Office Corridor: Acoustical Tile/Panels

   b. Classroom: Acoustical Tile/Panels/Open to Structure

   c. Elevator Lobby: Gypsum Board/Painted/Open to Structure

D. Third and Fourth Floor

1. Floors

   a. Office/Conference/Corridor: Carpet

   b. Elevator Lobby: Integral Color Polished Concrete or Terrazzo

2. Base

   a. Office/Conference/Corridor: 4" Rubber/Straight

   b. Elevator Lobby: Stainless Steel or Terrazzo

3. Walls

   a. Office/Conference/Corridor: Gypsum Board Painted

   b. Elevator Lobby: CMU with Veneer Plaster Painted/Gypsum Board/Plyboo

4. Ceilings

   a. Office/Conference/Corridor: Acoustical Tile/Panels

   b. Elevator Lobby: Gypsum Board/Painted

II. ABE – Laboratory Wing

A. Basement

1. Floors

   a. Laboratories/Classrooms: Polished Concrete with Floor Hardener

   b. Corridor: Polished or Sealed Concrete

2. Base

   a. Laboratories/Classrooms: 4" Rubber/Coved

   b. Corridor: 4" Rubber/Coved/Stainless Steel

3. Walls

   a. Laboratories/Classrooms: CMU/Painted

   b. Corridor: CMU/Painted

4. Ceilings

   a. Laboratories/Classrooms: Open to Structure

   b. Corridor: Open to Structure

B. Ground Floor

1. Floors

   a. Laboratories/Classrooms: Polished Concrete with Floor Hardener

   b. Team Room: Polished or Sealed Concrete

   c. Student Project Area: Polished or Sealed concrete

   d. Corridor: Integral Color Polished concrete or Terrazzo

2. Base

   a. Laboratories/Classrooms: 4″ Rubber/Coved

   b. Team Room: 4″ Rubber/Coved

   c. Student Project Area: 4″ Rubber/Coved

   d. Corridor: 4″ Terrazzo/Stainless Steel

3. Walls

   a. Laboratories/Classrooms: CMU/Painted/Gypsum

   b. Team Room: CMU/Painted

   c. Student Project Area: CMU/Painted

   d. Corridor: CMU/Painted

4. Ceilings

   a. Laboratories/Classrooms: Open to Structure

   b. Team Room: Open to Structure

   c. Student Project Area: Open to Structure

   d. Corridor: Open to Structure

C. Second through Fourth Floors

1. Floors

   a. Laboratories/Classrooms: Polished or Sealed Concrete

   b. Computer Lab: Carpet

   c. Corridors: Polished or Sealed Concrete

2. Base

   a. Laboratories/Classrooms: 4″ Rubber/Coved

   b. Computer Lab: 4″ Rubber/Straight

   c. Corridors: 4″ Rubber/Coved

3. Walls

   a. Laboratories/Classrooms: CMU/Painted

   b. Computer Lab: Gypsum Board/Painted, CMU/Painted

   c. Corridors: Gypsum Board/Painted

4. Ceilings

    a. Laboratories/Classrooms: Open to Structure

    b. Computer Lab: Acoustical Tiles/Panels

    c. Corridors: Open to Structure

III. ABE General

A. Floors

1. Restrooms: Ceramic Tile/Epoxy Grout

2. Telephone/Communication/Electrical: Sealed Concrete

3. Stairs: Rubber Treads and Landings

B. Base

1. Restrooms: Ceramic Tile/Epoxy Grout

2. Telephone/Communication/Electrical: 4″ Rubber/Coved

3. Stairs:

C. Walls

1. Restrooms: CMU/Painted

2. Telephone/Communication/Electrical: Gypsum Board/Painted

3. Stairs: Gypsum Board/Painted

D. Ceilings

1. Restrooms: Acoustical Tile/Panels

2. Telephone/Communication/Electrical: Open to Structure

3. Stairs:

IV. Atrium

A. Basement

1. Floors

    a. Prefunction Area: Integral Color Polished Concrete or Terrazzo

    b. Auditorium: Carpet

    c. Computer Lab: Carpet

    d. Stair: Integral Color Polished Concrete or Terrazzo

2. Base
    a. Prefunction Area: Stainless Steel or 4" Terrazzo
    b. Auditorium: 4" Rubber/Straight
    c. Computer Lab: 4" Rubber/Straight
    d. Stair:
3. Walls
    a. Prefunction Area: Gypsum Board/Painted, CMU with Veneer Plaster Painted
    b. Auditorium: Gypsum Board/Painted, Acoustical Panels/Wall Covering
    c. Computer Lab: Gypsum Board/Painted
4. Ceilings
    a. Prefunction Area: Gypsum Board/Painted, Acoustical Tiles/Panels
    b. Auditorium: Gypsum Board/Painted, Acoustical Tiles/Panels
    c. Computer Lab: Acoustical Tiles/Panels
    d. Stair:

B. Ground Floor
1. Floor: Integral Color Polished Concrete or Terrazzo
2. Ceilings: Glass/Metal Panel – see Roof:

V. BRL

A. Basement
1. Floors
    a. MEP Rooms: Sealed Concrete
    b. Storage: Sealed Concrete
2. Base
    a. MEP Rooms: 4" Rubber/Straight
    b. Storage: 4" Rubber/Straight
3. Walls
    a. MEP Rooms: CMU/No Paint
    b. Storage: CMU/No Paint

4. Ceilings

    a. MEP Rooms: Open to Structure

    b. Storage: Open to Structure

B. Ground Floor

1. Floors

    a. Lobby/Display: Integral Color Polished Concrete or Terrazzo

    b. Offices: Carpet

    c. Teaching Laboratory: Carpet/Rubber or Linoleum

    d. Microbiology Laboratory: Polished or Sealed Concrete/Rubber or Linoleum

    e. High Ceiling Laboratory: Polished Concrete with Floor Hardener/Rubber or Linoleum

    f. Corridors: Integral Color Polished Concrete or Terrazzo

2. Base

    a. Lobby/Display: Stainless Steel or 4" Terrazzo

    b. Offices: 4" Rubber/Straight

    c. Teaching Laboratory: 4" Rubber/Straight

    d. Microbiology Laboratory: 4" Rubber/Coved

    e. High Ceiling Laboratory: None/Rubber if Rubber or Linoleum

    f. Corridors: Stainless Steel or 4" Terrazzo

3. Walls

    a. Lobby/Display: Gypsum Board/Painted

    b. Offices: Gypsum Board/Painted

    c. Teaching Laboratory: Gypsum Board/Painted, Acoustical Panels/Wall Coverings

    d. Microbiology Laboratory: CMU/Painted/Gypsum

    e. High Ceiling Laboratory: CMU/Painted/Gypsum

    f. Corridors: Gypsum Board/Painted, CMU with Veneer Plaster Painted

4. Ceilings

    a. Lobby/Display: Open to Structure, Acoustical Tile/Panels

    b. Offices: Acoustical Tile/Panels

    c. Teaching Laboratory: Acoustical Tile/Panels/Open to Structure

d. Microbiology Laboratory: Open to Structure

e. High Ceiling Laboratory: Open to Structure

f. Corridors: Acoustical Tile/Panels/Open to Structure/GWB

C. Second through Fourth Floors

1. Floors

a. Offices: Carpet

b. Laboratories: Rubber or Linoleum

c. Corridors: Polished or Sealed Concrete, or Rubber or Linoleum

2. Base

a. Offices: 4” Rubber/Straight

b. Laboratories: 4” Rubber/Coved

c. Corridors: 4” Rubber/Coved

3. Walls

a. Offices: Gypsum Board/Painted

b. Laboratories: Gypsum Board/Painted

c. Corridors: Gypsum Board/Painted

4. Ceilings

a. Offices: Acoustical Tile/Panels

b. Laboratories: Open to Structure, Acoustical Tile/Panels

c. Corridors: Open to Structure, Acoustical Tile/Panels

D. General

1. Floors

a. Restrooms: Ceramic Tile/Epoxy Grout

b. Telecommunications/Electrical: Polished or Sealed Concrete

c. Stairs: Rubber Treads and Landings

d. Elevator Lobby: Integral Colored/Polished or Sealed Concrete

2. Base
    a. Restrooms: Ceramic Tile/Epoxy Grout
    b. Telecommunications/Electrical: 4" Rubber/Coved
    c. Stairs:
    d. Elevator Lobby: 4" Rubber/Coved
3. Walls
    a. Restrooms: Gypsum Board/Painted, CMU/Painted
    b. Telecommunications/Electrical: Gypsum Board/Painted
    c. Stairs: Gypsum Board/Painted
    d. Elevator Lobby: CMU/Painted
4. Ceilings
    a. Restrooms: Acoustical Tile/Panels
    b. Telecommunications/Electrical: Open to Structure
    c. Stairs: Open to Structure
    d. Elevator Lobby: Open to Structure, Acoustical Tile/Panels

SECTION II.J.

SPECIAL CONSTRUCTION (LABS)

SPECIAL CONSTRUCTION

I. Laboratory Casework:

A. Flexible, moveable and modular system manufactured by Fisher Hamilton.

B. Minor modifications to the standard system may be required.

II. Laboratory Equipment

A. Fume hoods and built in lab freezers and refrigeration will be part of the construction contract.

B. All other equipment will be provided by the Owner/Users.

III. Overhead Crane

A. A single overhead crane will be provided to service the following ABE program spaces.

A10.1.1 Machine Small High Bay
A10.2.1 Field machinery
A10.3.2 Tractor Vehicle Dynamometer
A10.3.6 Machine High Bay
A11.1.6 Rainfall Simulator

B. An overhead crane will be provided in the BRL A.10.4 High Ceiling Laboratory.

IV. Restrooms

A. Toilet Partitions: High density polyethelene, ceiling hung.

B. Toilet Countertops: Solid surface tops and backsplash.

C. Toilet Accessories: ISU standard.

V. Loading Dock:

A. Provide dock bumpers and dock leveler or lift as appropriate.

VI. Parking Equipment

A. No parking equipment for entrance or egress is required.

B. Parking meters, or an alternate payment system, will be furnished by ISU for installation by the contractor.

SECTION II.K.

CONVEYING EQUIPMENT

CONVEYING EQUIPMENT

I. Elevators

A. ABE

1. One 3500# passenger elevator will be provided in the office wing.

2. One 10000# hydraulic freight elevator will be provided in the laboratory wing.

3. Elevators will be machine room less (MRL) or hydraulic.

B. BRL

1. One 3500# passenger elevator will be provided. This elevator will be used for passenger and freight service.

2. Elevators will be machine room less (MRL) or hydraulic.

C. Parking

1. Two 3500# geared passenger elevators will be provided.

2. Elevators will have a glass face on one wall of the cab and shaft for security.

3. Cab interiors will have stainless steel wall panels for durability.

II. Overhead Cranes

A. See section II.J.: Special Construction

SECTION II.L.

MECHANICAL SYSTEM

MECHANICAL SYSTEMS

I. Base Design Criteria

A. Applicable Codes

1. The Mechanical Systems will be designed in accordance with the following:

a) 2006 International Building Code (IBC)

b) 2005 National Electrical Code (NEC)

c) 2006 International Mechanical Code (IMC)

d) 2003 Uniform Plumbing Code (UPC)

e) 2006 International Fuel Gas Code (IFGC)

f) 2006 International Fire Code (IFC)

g) 2006 International Energy Conservation Code (IECC)

B. Applicable Guidelines and Standards

1. Mechanical systems will be designed in accordance with appropriate portions of the following guidelines and standards, or guidelines and standards published by the named organizations:

a) Laboratory Design Guidelines

(1) In general, the Laboratory Design Guidelines have been developed using appropriate information from the following Standards:

(2) ACGIH Industrial Ventilation - A Manual of Recommended Practice (the latest edition).

(3) ANSI/AIHA Z9.5 2003 - Laboratory Ventilation Standard.

(4) OSHA 29 CFR Part 1910 - Occupational Exposures to Hazardous Chemicals in Laboratories.

(5) ASHRAE Standard 110-2005 - Method of Testing Performance of Laboratory Fume Hoods.

b) National Fire Protection Association (NFPA) guidelines and standards including the following:

(1) NFPA 30 - Flammable and Combustible Liquids Code, 2003 Edition.

(2) NFPA 45 - Fire Protection for Laboratories Using Chemicals, 2004 Edition.

(3) NFPA 54 - National Fuel Gas Code, 2006 Edition.

(4) NFPA 72 - National Fire Alarm Code, 2007 Edition.

(5) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems, 2002 Edition.

(6) NFPA 101 - Life Safety Code, 2006 Edition.

(7) NFPA 110 – Standard for Emergency and Standby Power Systems, 2005 Edition.

c) Occupational Safety and Health Administration (OSHA)

d) ASHRAE Standard 62 Ventilation for Acceptable Indoor Air Quality

e) American Industrial Hygiene Association (AIHA)

f) Iowa State University Facilities Design Manual, with exceptions pending approval.

C. Outdoor Design Conditions

1. Geographic location 42° 01′ N LAT 93° 38′ W LONG at elevation of 950 feet above sea level.

2. Heating degree days: 6791

3. Cooling degree days: 830

4. Temperatures indicated will used to calculate building loads.

5. Summer

Dry-Bulb Temperature	=	93.5°F
Wet-Bulb Temperature	=	76.0°F

(Based on 0.4% dry-bulb and mean coincident wet-bulb temperature for Des Moines, IA, as published by ASHRAE Handbook of Fundamentals - 2005.)

6. Winter

Dry-Bulb Temperature	=	-7.8°F

(Based on 99.6% dry-bulb conditions for Des Moines, IA, as published by ASHRAE Handbook of Fundamentals - 2005.)

D. Indoor Design Conditions (All Buildings Unless Otherwise Noted)

1. Office, Conference and Administrative Support Areas

a) Dry-Bulb Temperature

Summer	=	75°F 4 3°F
Winter	=	70°F 4 3°F

b) Relative Humidity

Summer	=	50% maximum 4 5%
Winter	=	Mechanical humidification not planned

2. Laboratory and Laboratory Support (ABE, BRL only)

a) Dry-Bulb Temperature

Summer	=	75°F 4 2°F
Winter	=	70°F 4 2°F

b) Relative Humidity

Summer	=	50% + 3% (maximum)
Winter	=	Mechanical humidification not planned

3. Cold Rooms (BRL only)

a) Dry-Bulb Temperature = 40°F 4 2°F (year round)

b) Relative Humidity = Non-condensing

4. Telecommunication Rooms

a) Dry-Bulb Temperature = 72°F 4 2°F (year round)

b) Relative Humidity = 50% + 3% (maximum)

5. Mechanical and Electrical Rooms

a) Dry-Bulb Temperature

Summer	=	80°F Maximum
Winter	=	60°F Minimum

b) Relative Humidity = No requirement

6. Elevator Machine Room

a) Dry-Bulb Temperature = 75°F (year round)

b) Relative Humidity = No requirement

7. Storage Spaces

a) Dry-Bulb Temperature = 65 - 80°F

b) Relative Humidity = Mechanical humidification not planned

E. Heating and Cooling Loads (All Buildings Unless Otherwise Noted)

1. Electrical

a) Offices, Conference, and Administrative Support Areas

Lighting	=	1.5 watts per sq ft
Equipment	=	2.0 watts per sq ft

b) Conference Rooms

Lighting	=	1.5 watts per sq ft
Equipment	=	2.0 watts per sq ft

c) Classrooms

Lighting	=	2.0 watts per sq ft
Equipment	=	1.5 watts per sq ft

d) Laboratory

Lighting	=	2.0 watts per sq ft
Equipment	=	8.0 watts per sq ft or actual equipment, whichever is greater

e) Dynamometer Labs

Lighting	=	2.0 watts per sq ft
Equipment	=	To be determined based on engines tested

f) Machine Labs

Lighting	=	2.0 watts per sq ft
Equipment	=	To be determined based on equipment

g) Laboratory Support Spaces (Shared Equipment Spaces)

Lighting	=	2.0 watts per sq ft
Equipment	=	18 watts per sq ft

h) Computer Laboratory

Lighting	=	2.0 watts per sq ft
Equipment	=	16 watts per sq ft

i) Office Workstations

Lighting	=	1.5 watts per sq ft
Equipment	=	2.5 watts per sq ft

j) Staff Lounge

Lighting	=	1.5 watts per sq ft
Equipment	=	3.0 watts per sq ft

k) Locker Rooms

Lighting	=	1.5 watts per sq ft
Equipment	=	0 watts per sq ft

l) Corridor

Lighting	=	0.5 watts per sq ft
Equipment	=	0 watts per sq ft

m) Storage Rooms

Lighting	=	1.0 watts per sq ft
Equipment	=	0 watts per sq ft

n) Mechanical Rooms

Lighting	=	1.0 watts per sq ft
Equipment	=	To be confirmed based on installed equipment

o) Electrical Rooms

Lighting	=	1.5 watts per sq ft
Equipment	=	To be confirmed based on installed equipment

p) Telecom Rooms

Lighting	=	1.5 watts per sq ft
Equipment	=	To be confirmed based on installed equipment

q) Computer Server Rooms

Lighting	=	1.0 watt per sq ft
Equipment	=	45 watts per sq ft

r) Shop Area

Lighting	=	2.0 watts per sq ft
Equipment	=	To be confirmed based on installed equipment

2. Occupancy

a) The occupancy heat rejection will be based on 2005 ASHRAE Handbook of Fundamentals, Chapter 29 for Moderately Active Office Work or:

Sensible	=	250 Btuh/person
Latent	=	200 Btuh/person

b) The number of occupants in each space will be based on the actual occupant density listed in the facility program.

c) Diversity = 90% over all building occupancy

d) Occupancy Schedule

Actual mechanical system operation schedules to be discussed with ISU.

3. Infiltration

a) The building heat loss calculations will include an infiltration load based on 1.5 cfm of infiltration air per linear foot of exterior wall with windows, per floor level, and 1.0 cfm of infiltration air per linear foot of exterior wall without windows, per floor level. ISU and AEI to discuss utilizing crack length criteria.

b) The following infiltration rates will be used for doors:

(1) 200 cfm per door for exterior main doors

(2) 5 cfm per square foot for exterior overhead doors

4. Building Envelope

   a) Walls: To be defined by architect. Values to meet or exceed current energy code standard.

   b) Roof: To be defined by architect. Values to meet or exceed current energy code standard.

   c) Glass: To be defined by architect. Values to meet or exceed current energy code standard.

F. Ventilation Rates

1. The minimum ventilation (outdoor air) rates will be as follows:

   a) Offices, Conference and Administrative Support Area.
      (1) Will meet the requirements of ASHRAE 62 Standard.

   b) Laboratories and Laboratory Support Areas:

      (1) Occupied: 10 air changes per hour, minimum. Possibility of reducing the air change rate indicated to be reviewed / confirmed with ISU EH&S.

      (2) Day and nighttime Unoccupied: 10 air changes per hour, minimum. Possibility of reducing the air change rate indicated to be reviewed / confirmed with ISU EH&S.

   c) Cold Rooms: 0.5 CFM per square foot

      (1) Dehumidifiers provided by cold room supplier.

2. Minimum supply and/or exhaust ventilation rates will be as follows: Actual ventilation rates may exceed these values if calculations so dictate:

   a) General Laboratory (ABE Lab, BRL only)

      (1) Occupied: 10 air changes per hour. Possibility of reducing the air change rate indicated to be reviewed / confirmed with ISU EH&S.

      (2) Day and nighttime Unoccupied: 10 air changes per hour. Possibility of reducing the air change rate indicated to be reviewed / confirmed with ISU EH&S.

F. Fume Hood Exhaust Rate (ABE Lab and BRL only)

1. The exhaust air requirements for fume hoods will be based on maintaining a face velocity of 80 fpm through the sash with the sash 100% open or 100 fpm through the sash with the sash at design working height.

2. Fume hood design working height to be defined in lab programming document. Fume hood face velocities and resultant exhaust air quantities to be confirmed based on hood type defined in lab programming documents.

G. Biosafety Cabinet Density (ABE Lab, BRL only)

1. Current programming indicates Class II, Type A1 BSCs (100% recirculation, 0% exhaust to building exterior) will be used.

H. Pressure Relationships

1. Pressure relationships will be maintained by offsets between supply and exhaust airflow rates. Relative pressures to adjacent spaces will be as follows:

Space Area	Relationship to Adjacent
Breakroom	Negative
Offices	Neutral or Positive
Corridor (ABE Lab, BRL only)	Positive to Laboratory
Laboratory (ABE Lab, BRL only)	Negative
Laboratory Support (ABE Lab, BRL only)	Negative
Toilets, Janitor Closets, Lockers	Negative
Building	Positive to Ambient

I. Laboratory Systems Diversity (ABE Lab, BRL only)

1. In conjunction with variable air volume systems serving laboratory spaces, an HVAC equipment sizing diversity will be applied to design air quantities for sizing laboratory air handling units, laboratory central exhaust systems and associated preheat, reheat, and cooling system equipment.

2. A typical diversity for this type of application is in the range of 90-80%.

3. Diversity to be determined based on building program requirements, occupancy schedule, etc.

4. ISU and AEI to discuss during the Design Development phase of the project.

J. Seismic Criteria

1. Seismic bracing will be provided as required per the State Code for mechanical systems for this facility.

K. Noise Criteria

1. Care will be taken in the layout and design of mechanical systems and distribution systems to meet the intent of ISU's standards for classrooms, AV rooms, and laboratories.

2. Sound attenuation equipment will be provided based on standard design practice as required to meet the criteria.

3. Results are not guaranteed due to many items not under control of the design team and actual building usage.

4. Inside maximum noise levels will be designed to meet the following:

a) Medium and Low Hood Labs and Support Spaces = NC-55 (ABE, BRL only)

b) Seminar and Conference Spaces = NC-35

c) Private Offices = NC-35

d) Executive Spaces = NC-30

e) Open Offices = NC-40

f) Other Occupied Spaces = NC-40

II. Mechanical Site Utility Infrastructure Systems Description

The following systems will be utilized for utilities serving the proposed ABE and BRL buildings along with the Parking Structure / Office building.

A. Site Services

1. The existing 90 psig steam and condensate presently located in an existing steam tunnel located at the corner of Bissel Road and Osborn Drive will be extended south to the building construction site in a new steam tunnel as part of this project. This work is included as part of the utility extension package.

2. The existing direct buried chilled water piping presently located at the corner of Bissel Road and Osborn Drive will be extended south to the building construction site as part of this project. This work is included as part of the utility extension package.

3. Steam and chilled water utilities serving the complex will be sized for 150% of complex heating and cooling design loads.

B. Site Utility Phasing

1. In order to facilitate the construction and minimize campus disruption, a separate site utility package should be issued. This bid package will extend a majority of the site services described in this section.

C. Site Chilled Water Piping System

1. General System Description

a) Chilled water will be used for air handling unit cooling coils and process cooling loads.

b) ISU has indicated that chilled water is available year-round for process cooling needs.

c) Chilled water will be provided to the buildings between 41ºF (summer) and 52ºF (winter).

2. Capacity Requirements

a) ABE Lab building cooling capacity is estimated at 775 tons. ABE Office building cooling capacity is estimated at 220 tons. BRL building cooling capacity is estimated at 635 tons. Parking Office cooling capacity is estimated at 110 tons.

b) Cooling loads indicated do not include any energy saving provisions. AEI to perform specific life cycle cost analyses once complex space programming / envelope construction have been developed to determine appropriate energy saving provisions.

c) Cooling loads indicated do not currently include provisions for future complex program expansion. However, complex chilled water service will be sized for 150% of complex cooling load once complex space programming / envelope construction have been developed.

d) Cooling loads indicated do not include provision for process cooling water generation. Chilled water load associated with process cooling water generation to be added to total chilled water load once complex space programming has been defined.

e) Chilled water flow associated with complex cooling load is estimated at approximately 1,960 gpm based on an average 20.0 ºF water temperature rise.

3. Primary Equipment

a) Existing campus chilled water system will be utilized to serve all new buildings. Building chilled water pumps will not be provided.

b) ISU and AEI to discuss / confirm means of achieving required chilled water temperature differential and impact on space relative humidity.

4. Distribution System

a) Chilled water service is to be extended from the existing chilled water lines that are located at the intersection of Bissel Road and Osborn Drive to the building site. ISU to confirm the existing chilled water distribution system has sufficient capacity to meet the loads of the complex. Taps and valves to existing campus utilities will be provided by ISU. Mechanical contractor to route chilled water lines from complex to taps / valves provided by ISU. ISU to perform final connections to existing campus utilities.

b) Chilled water piping 6" or smaller will be sized for a maximum pressure drop of 4 ft of water /100 of piping. Chilled water piping 8" and larger will be sized for a maximum velocity of 10 fps. AEI to review chilled water pipe sizing criteria in future design phases due to building having only 14 psig differential pressure available from the campus chilled water distribution system.

c) Piping within buildings will be Schedule 40 black steel with welded joints. Piping exterior to buildings will be ductile iron with all joints having set screw locking glands.

d) Shutoff valves will be 150 lb mechanical joint with set screw locking gland type gate valves for pipe sizes up to 12".

e) Flow meter inside building will be an in-line water magnetic flow meter mounted in the chilled water supply line serving each building associated with the Biorenewables Complex.

D. Site Steam and Condensate Systems

1. General System Description

a) Steam will be used for generating building heating hot water, domestic and lab hot water, steam preheat coils, and lab process loads. Steam pressure will be reduced from 90 psig to 80 psig and 90 psig to 6 psig. These pressure reducing stations will be sized to serve ABE buildings, BRL building, and Parking Office.

b) Steam pressure of 80 psig will be used to meet the loads of building glass washers, sterilizers, etc.

c) Steam pressure of 6 psig will be used to meet the loads of building heating hot water convertors, water heaters, and AHU preheat coils.

2. Capacity Requirements

a) ABE Lab building steam connected load is estimated at 6,000 pounds per hour (pph) . ABE Office building steam connected load is estimated at 370 pounds per hour (pph). BRL building steam connected load is estimated at 19,110 pounds per hour (pph)(Note BRL heating hot water, lab hot water and domestic hot water systems serves ABE Lab and ABE Office buildings) . Parking Office steam connected load is estimated at 1,850 pounds per hour (pph).

b) Steam loads indicated do not include energy savings from possible energy saving provisions.

c) Steam loads indicated are not diversified. Steam load diversity for each building will be reviewed in the next project phase.

d) Steam service to the complex will be sized for 150% of the diversified complex steam load.

e) Steam load associated with the atrium to be determined once atrium configuration, extent of atrium glazing, and acceptable space temperatures are defined.

f) Minimum condensate returned from complex is approximately 95% or approximately 50 gpm maximum condensate pump discharge flow.

3. Primary Equipment

a) Steam is produced at the campus central heating plant.

4. Distribution System

a) The existing 90 psig steam and condensate pipes will have to be extended for the proposed buildings. The proposed pipe route will be south along the west side of Bissel Road and will connect to the existing pipe in the utility corridor at the intersection of Bissel Road and Osborn Drive. ISU to confirm the existing steam distribution system has sufficient capacity to meet the loads of the complex. New steam and condensate piping to be routed within a steam tunnel and not direct buried. Link-Seals are not required at the building foundation wall penetration from the utility tunnel.

b) 90 psig steam will be provided from the existing 90 psig steam pipe in the utility tunnel. Condensate will be pumped to the gravity return condensate return pipe.

c) The new 90 psig steam piping inside the utility tunnel will be Schedule 40 black steel pipe with class 150 weld fittings. All condensate piping will be Schedule 80 black steel with malleable iron screwed fittings. Pipe insulation will be preformed fiberglass with all weather jacket. Insulation thickness will conform to ISU Specification Section 33 63 43.

d) Steam and condensate shutoff valves will be 150 lb high performance butterfly valves for piping 2-1/2" and larger, and 150 lb quarter turn ball valves for piping 2" and smaller. Steam traps will be sized for available pressure and required flow, plus a safety factor for system warm-up.

e) Two condensate flow meters in series will be provided by ISU mounted in the pumped condensate return branch serving the buildings. The flow meters will be located inside BRL basement level mechanical equipment room.

f) Steam piping will be sized for a maximum velocity of 8,500 – 10,000 fpm or a maximum pressure drop of 2 psi/100 ft of pipe. Condensate piping will be sized for a maximum pressure drop of 1 psi / 100 ft of piping. Pumped condensate will be sized for a maximum pressure drop of 4 ft of water/100 ft of piping.

III. Building Mechanical Systems Description

A. Steam and Condensate Systems Description

1. General System Description

a) ABE Lab Building:

(1) Steam will be provided to the ABE Lab building from the BRL building.

(2) 80 psig steam will be routed to the penthouse where a pressure reducing station will be provided to reduce the 80 psig steam to 12 psig steam.

(3) Steam pressure reducing station to utilize a single monitor with multiple control valve arrangement.

(4) Two pressure reducing valves will be provided for the 80 psig to 6 psig PRV station. One valve sized for 1/3 of the design load and the other for 2/3 of the design load. Pressure control strategy when using more than one pressure reducing valve to be discussed with ISU.

(5) The steam condensate will be returned back to the existing campus steam condensate return system by duplex electric condensate pumps with cast iron receivers. Steam condensate pump discharge will be routed back to BRL where it will be manifolded and metered by two separate meters piped in series prior to exiting the building.

(6) The reduced steam pressure will be utilized as a heat source in the facility for AHU preheat coils.

b) ABE Office Building:

(1) Steam will be provided to the ABE Office building from the BRL building.

(2) 6 psig steam will be routed to the basement mechanical equipment room where it will be utilized as a heat source for AHU preheat coils.

(3) The steam condensate will be returned back to the existing campus steam condensate return system by a duplex electric condensate pump with cast iron receiver. Steam condensate pump discharge will be routed back to BRL where it will be manifolded and metered by two separate meters piped in series prior to exiting the building.

c) BRL Building:

(1) Steam will be supplied to BRL building at 90 psig from the campus steam distribution system.

(2) Steam to the BRL building will be reduced in two separate pressure reducing stations to service the building's medium (80 psig) and low pressure steam (6 psig) requirements.

(3) The ABE Lab building will be served from the BRL 80 psig pressure reducing station. 80 psig steam will be routed to this building to serve process loads and then extended to the penthouse where a pressure reducing station will be provided to reduce the 80 psig steam to 6 psig steam.

(4) The ABE Office building will be served from the BRL 6 psig pressure reducing station. 6 psig steam will be routed to the ABE Office building basement mechanical equipment room.

(5) The Parking Office will be served from the BRL 80 psig pressure reducing station.

(6) Each steam pressure reducing station to utilize a single monitor with multiple control valve arrangement.

(7) Two pressure reducing valves will be provided for the 90 psig to 80 psig PRV station with each valve sized for 1/2 of the design load. Pressure control strategy when using more than one pressure reducing valve to be discussed with ISU.

(8) Three pressure reducing valves will be provided for the 90 psig to 6 psig PRV station with each valve sized for 1/3 of the design load. Pressure control strategy when using more than one pressure reducing valve to be discussed with ISU.

(9) The steam condensate will be returned back to the existing campus steam condensate return system by duplex electric condensate pumps with cast iron receivers. BRL, ABE Lab, ABE Office, and Parking Office will each have its own steam condensate pump. Steam condensate pump discharge from each building will be routed back to BRL where it will be manifolded and metered by two separate meters piped in series prior to exiting the building.

(10) High pressure condensate will be flashed to low pressure condensate by flash tanks. Flash steam will be recovered and returned to 6 psig steam distribution system.

(11) The reduced steam pressure will be utilized as a heat source in the facility for AHU steam preheat coils, steam to heating hot water converters, domestic hot water heaters, and lab hot water heaters.

d) Parking Office:

(1) Steam will be provided to the Parking Office from the BRL building.

(2) 80 psig steam will be routed to the mechanical equipment room where a pressure reducing station will be provided to reduce the 80 psig steam to 6 psig steam.

(3) Steam pressure reducing station to utilize a single monitor with multiple control valve arrangement.

(4) Two pressure reducing valves will be provided for the 80 psig to 6 psig PRV station. One valve sized for 1/3 of the design load and the other for 2/3 of the design load. Pressure control strategy when using more than one pressure reducing valve to be discussed with ISU.

(5) The steam condensate will be returned back to the existing campus steam condensate return system by a duplex electric condensate pump with cast iron receiver. Steam condensate pump discharge will be routed back to BRL where it will be manifolded and metered by two separate meters piped in series prior to exiting the building.

(6) The reduced steam pressure will be utilized as a heat source in the facility for AHU preheat coils, steam to water converters, and domestic water heaters.

B. Design Criteria

1. General

a) Steam piping for steam pressures greater than 15 psi will be sized for a maximum pressure drop of 3 psi/100 ft of pipe and a maximum velocity of 8500 fpm.

b) Steam piping for steam pressures equal to or less than 15 psi will be sized for a maximum pressure drop of 1/2 psi/100 ft of pipe and a maximum velocity of 8500 fpm.

c) Steam condensate piping will be sized as follows:

- For gravity condensate return piping, sizing criteria on Table 21 of ASHRAE Handbook of Fundamentals - 2005 will be used. The capacity of Table 21 which is based on Schedule 40 steel pipe will be adjusted to Schedule 80 steel pipe.

2. Additional Design Criteria :

a) Steam condensate pumped discharge piping will be sized as follows:

(1) Maximum pressure drop of 4 ft of water/100 ft of piping.

(2) 8 fps maximum velocity.

b) System Warm-up Method

(1) AEI to utilize ISU standard steam drip piping detail to accommodate system warm-up.

c) Reserve Capacity and Redundancy

(1) Redundant steam traps will be provided for AHU steam preheat coils and heating hot water convertors. Trap size not to exceed 2". If required trap capacity would exceed a 2" trap, 3 traps each sized for 50% will be provided.

3. Distribution

a) Plant steam and condensate will be distributed through carbon steel piping with threaded cast or malleable fittings for pipes 2" and smaller and welded fittings for pipes 2-1/2" and larger. Steam piping will be Schedule 40 and condensate piping will be Schedule 80.

b) Steam warm-up valves will not be provided around major isolation valves.

c) Steam and condensate piping and fittings will be insulated with rigid glass fiber insulation.

C. Chilled Water System

1. General System Description

a) Chilled water will be supplied to the complex by primary pumps in the Central Utility Plant (CUP).

b) Chilled water will serve the complex from BRL.

c) Chilled water will be supplied to the air handling unit cooling coils at approximately 41°F. Coils will be selected for 20°F temperature rise to achieve a 61°F return water temperature.

d) ABE Lab Building:

(1) Chilled water will be supplied to the ABE Lab building from the BRL building.

(2) Chilled water usage will be metered via automated BTU meter with flow rate, supply temperature and return temperature input. Data will be input to Building Automation System (BAS) for calculation of building cooling tonnage. ABE Lab building chilled water meter will be located in the BRL basement level mechanical equipment room.

(3) Chilled water will be utilized as a cooling source in the facility for AHU cooling coils, and fan coil units.

e) ABE Office Building:

(1) Chilled water will be supplied to the ABE Office building from the BRL building.

(2) Chilled water usage will be metered via automated BTU meter with flow rate, supply temperature and return temperature input. Data will be input to Building Automation System (BAS) for calculation of building cooling tonnage. ABE Office building chilled water meter will be located in the BRL basement level mechanical equipment room.

(3) Chilled water will be utilized as a cooling source in the facility for AHU cooling coils, and fan coil units.

f) BRL Building:

(1) Chilled water usage will be metered via automated BTU meter with flow rate, supply temperature and return temperature input. Data will be input to Building Automation System (BAS) for calculation of building cooling tonnage. Chilled water meter will be located in the BRL basement level mechanical equipment room.

(2) Chilled water will be utilized as a cooling source in the facility for process cooling water generation, AHU cooling coils, and fan coil units. Note that process cooling water loads may require standby cooling capacity if campus chilled water service is interrupted.

g) Parking Office:

(1) Chilled water will be supplied to the Parking Office from the BRL building.

(2) Chilled water usage will be metered via automated BTU meter with flow rate, supply temperature and return temperature input. Data will be input to Building Automation System (BAS) for calculation of office cooling tonnage. Parking Office chilled water meter will be located in the BRL basement level mechanical equipment room.

(3) Chilled water will be utilized as a cooling source in the facility for AHU cooling coils, and fan coil units.

2. Design Criteria

a) Chilled water piping will be sized as follows:

- Maximum pressure drop of 4 ft of water/100 ft of piping for piping 6" or smaller.
- 10 fps maximum velocity for piping 8" and larger.
- AEI to review chilled water pipe sizing criteria in future design phases due to building having only 14 psig differential pressure available from the campus chilled water distribution systems.

b) All major control valves will be sized by engineering calculations for linear control. Engineering calculations will consider associated pressure drops and Cv values based on specific control valve application.

3. Distribution

a) Chilled water will be distributed through carbon steel piping with threaded fittings for pipes 2" and smaller and welded fittings for pipes 2-1/2" and larger.

b) Proposed chilled water piping insulation is polyisocyurnate type with saran wrap vapor barrier and appropriate insulation jacket.

D. Heating Hot Water System

1. General System Description

a) Heating hot water will be generated at a supply temperature of 180 °F.

b) ABE Lab Building:

(1) Heating hot water will be supplied to the ABE Lab building from the BRL building.

(2) Heating hot water system will serve terminal heating devices such as reheat coils and perimeter devices, such as unit heaters, cabinet unit heaters, fin tube radiation, radiant ceiling panels, radiant floor heat, etc.

(3) Heating hot water system will be variable volume system utilizing a modulating two-way control valve at each terminal heating device.

(4) A differential pressure transmitter between the heating hot water supply and return mains will be utilized to vary the speed of the heating hot water pumps located in the BRL building, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(5) ABE Lab building estimated heating hot water flow rate is 260 gpm.

c) ABE Office Building:

(1) Heating hot water will be supplied to the ABE Office building from the BRL building.

(2) Heating hot water system will serve terminal heating devices such as reheat coils and perimeter devices, such as unit heaters, cabinet unit heaters, fin tube radiation, radiant ceiling panels, etc.

(3) Heating hot water system will be variable volume system utilizing a modulating two-way control valve at each terminal heating device.

(4) A differential pressure transmitter between the heating hot water supply and return mains will be utilized to vary the speed of the heating hot water pumps located in the BRL building, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(5) ABE Office building estimated heating hot water flow rate is 120 gpm.

d) BRL Building:

(1) Heating hot water system will consist of two steam-to-hot-water convertors, two heating hot water distribution pumps, one redundant heating hot water distribution pump, and distribution piping system. ISU and AEI to continue discussions regarding heating hot water distribution pump sizing with respect to the fact these pumps will serve the entire Biorenewables Complex and the fact that only the BRL will be constructed initially.

(2) Heating hot water system will serve terminal heating devices such as reheat coils and perimeter devices, such as unit heaters, cabinet unit heaters, fin tube radiation, radiant ceiling panels, radiant floor heat, etc.

(3) Heating hot water system will be variable volume system utilizing a modulating two-way control valve at each terminal heating device. Distribution pumps will each be provided with a VFD (ISU and AEI to continue discussions regarding the use of VFD's serving these pumps).

(4) A differential pressure transmitter between the heating hot water supply and return mains will be utilized to vary the speed of the heating hot water pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(5) BRL building estimated heating hot water flow rate is 250 gpm.

(6) Each heating hot water distribution pump will be sized for 50% of the heating design load. If one pump fails, the redundant pump will be energized. One of the heating hot water pumps will be allowed to operate on emergency power. ISU and AEI to continue discussions regarding heating hot water distribution pump sizing with respect to the fact these pumps will serve the entire Biorenewables Complex and the fact that only the BRL will be constructed initially.

e) Parking Office:

(1) Heating hot water system will consist of two steam-to-hot-water convertors, one heating hot water distribution pumps, one redundant heating hot water distribution pump, and distribution piping system.

(2) Heating hot water system will serve terminal heating devices such as reheat coils and perimeter devices, such as unit heaters, cabinet unit heaters, fin tube radiation, radiant ceiling panels, etc.

(3) Heating hot water system will be variable volume system utilizing a modulating two-way control valve at each terminal heating device. Distribution pumps will each be provided with a VFD (ISU and AEI to continue discussions regarding the use of VFD's serving these pumps).

(4) A differential pressure transmitter between the heating hot water supply and return mains will be utilized to vary the speed of the heating hot water pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(5) Parking Office heating estimated heating hot water flow rate is 90 gpm.

(6) Each heating hot water distribution pump will be sized for 100% of the heating design load. If one pump fails, the redundant pump will be energized. One of the heating hot water pumps will be allowed to operate on stand-by power.

2. Design Criteria

a) Perimeter heating and reheat hot water piping will be sized as follows:

(1) Maximum pressure drop of 4 ft of water/100 ft of piping for piping 6" and smaller.

(2) 10 fps maximum velocity for piping 8" and larger.

(3) Reheat coils and perimeter heating terminal devices will be sized for water temperature drop of approximately 20°F.

b) Reserve Capacity and Redundancy

(1) Each heating hot water distribution pump will be sized for 50% of the complex design heating load. One of the heating hot water pumps will be allowed to operate on stand-by power. ISU and AEI to continue discussions regarding heating hot water distribution pump sizing with respect to the fact these pumps will serve the entire Biorenewables Complex and the fact that only the BRL will be constructed initially.

(2) Each steam-to-hot-water convertor will be sized for 100% of the complex design heating load.

3. Equipment and Material

a) Convertors shall be shell-and-tube type with low-pressure steam in the shell side and heated water in the tubes. (ISU and AEI to continue discussions regarding leaving water temperature control when more than one convertor is used.)

b) Distribution pumps will be base mounted end suction centrifugal type.

c) The heating hot water system will also include the following components:

(1) Chemical pot feeder

(2) 10% side-stream water filter

(3) Air separator (coalescing style)

(4) Expansion tanks

(5) Make-up water assembly (which includes two water pressure regulating valves in series)

(6) Appropriate valving and piping specialties

4. Distribution

a) Heating hot water will be distributed through Type L copper piping with soldered joints for pipes 2" and smaller, and carbon steel piping with welded joints for pipes 2-1/2" and larger.

b) Unions will not be provided in copper piping serving terminal heating devices and reheat coils.

c) Piping will be insulated with rigid glass fiber insulation with appropriate insulation jacket.

5. Renewable Energy Strategies and Options

a) Provide high pressure steam to heating hot water heat exchanger, similar to Maxi-Therm. The system controls the water temperature by controlling condensate flow in lieu of steam flow. The system discharges the condensate as low pressure condensate to take advantage of the additional energy in the high pressure steam. ISU and AEI to review feasibility of this type of equipment.

E. Geoexchange Water System

1. System viability to be confirmed in Design Development phase. System will be considered for a single ABE Lab space as a system type demonstration.

F. Glycol Water Heat Recovery System

1. General System Description

a) Glycol water heat recovery system pump will circulate glycol water to heat recovery coils located in air handling units and to heat recovery coils located in exhaust systems to recover heat from the exhaust air stream. Glycol heat recovery system will utilize a 35% propylene glycol/water solution.

b) The heat recovery pump will not operate when heat recovery is not effective to reduce lab supply air system energy consumption.

c) ABE Lab Building:

(1) A glycol water heat recovery system will not be provided as air handling units are to have total energy wheels.

d) ABE Office Building:

(1) A glycol water heat recovery system will not be provided as air handling units are return air type.

e) BRL Building:

(1) A glycol water heat recovery system will be provided to serve 100% outside air handling units.

f) Parking Office:

(1) A glycol water heat recovery system will not be provided as air handling units are recirculation type.

2. Design Criteria

a) Glycol heat recovery piping will be sized as follows:

(1) Maximum pressure drop of 4 ft of water/100 ft of piping.

(2) 10 fps maximum velocity.

b) Reserve Capacity and Redundancy

(1) One distribution pump will be sized for 100% of the design system flow rate.

(2) There is no redundant pump. AHU preheat coils will be sized for the total preheat load without taking credit for the heat recovery coils.

3. Equipment and Material

a) Distribution pump will be end suction centrifugal type.

b) The system will consist of the following additional components.

(1) Expansion tank.

(2) Air separator (vortex style)

(3) Chemical pot feeder

(4) 10% side-stream water filter

(5) Glycol water make-up system

(6) Appropriate valving and piping specialties

4. Distribution

a) Glycol water will be distributed through carbon steel piping with threaded fittings for pipes 2″ and smaller and welded fittings for pipes 2-1/2″ and larger.

b) Piping will be insulated with polyisocyurnate type with saran wrap vapor barrier and appropriate insulation jacket.

G. Process Cooling System

1. General System Description

a) Process cooling will be piped to various laboratory equipment and cold room condenser / compressors.

b) Process cooling water will be generated by utilizing chilled water supplied from the Central Utility Plant (CUP) or with non-potable water. Non-potable water is to be used when chilled water from the CUP is not available.

c) Process cooling water will be distributed at 52°F. Process cooling water supply temperature to be confirmed based on lab equipment requirements.

d) ABE Lab Building:

(1) Process cooling water will be supplied to the ABE Lab building from the BRL building.

(2) Process cooling water system will be variable volume system utilizing a modulating two-way control valve at each terminal heating device.

(3) A differential pressure transmitter between the process cooling water supply and return mains will be utilized to vary the speed of the process cooling water pumps located in the BRL building, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(4) ABE Lab building process cooling water capacity requirements to be confirmed based on finalized space programming.

e) ABE Office Building:

(1) Process cooling water will be not supplied to the ABE Office building.

f) BRL Building:

(1) Process cooling water will be generated in the BRL building only and will be sized serve the complex.

(2) Process cooling water system will consist of two plate and frame heat exchangers, one process cooling water distribution pumps, one redundant process cooling water distribution pump, and distribution piping system.

(3) Process cooling water system will be variable volume system utilizing a modulating two-way control valve at each device requiring process cooling water. Distribution pumps will each be provided with a VFD (ISU and AEI to continue discussions regarding the use of VFD's serving these pumps).

(4) A differential pressure transmitter between the process cooling water supply and return mains will be utilized to vary the speed of the process cooling water pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains. System differential pressure transmitter locations to be specifically identified on floor plans.

(5) BRL building process cooling water capacity requirements to be confirmed based on finalized space programming.

g) Parking Office:

(1) Process cooling water will be not supplied to the Parking Office.

2. Design Criteria

a) Process cooling piping will be sized as follows:

(1) Maximum pressure drop of 4 ft of water/100 ft of piping for piping 6" and smaller.

(2) 10 fps maximum velocity for piping 8" and larger.

(3) Devices requiring process cooling water will be sized for water temperature drop of approximately 20°F.

b) Reserve Capacity and Redundancy

(1) Two distribution pumps will each be sized for 50% of the design system flow rate.

(2) Both pumps will be on stand-by power. However, only two will operate while on stand-by power.

(3) Two plate and frame heat exchangers will be provided to decouple the process cooling system from the campus chilled water system. Each heat exchanger will be sized for 100% of the process cooling system load.

(4) A connection to the non-potable water system controlled by a two position automatic valve and a modulating pressure control valve will be provided as a back-up. Water will be drained to waste.

3. Equipment and Material

a) Distribution pumps will be base mounted end suction centrifugal type.

b) System will consist of the following components:

(1) Chemical pot feeder

(2) 10% side-stream water filter

(3) Air separator (coalescing style)

(4) Expansion tank

(5) Make-up water assembly (which includes two water pressure regulating valves in series)

(6) Appropriate valving and pipe specialties

4. Distribution

a) Process cooling water will be distributed through type L copper piping with soldered fittings for pipes 2" and smaller and welded fittings for pipes 2-1/2" and larger.

b) Piping will be insulated with polyisocyurnate type with saran wrap vapor barrier and appropriate insulation jacket.

H. Office Air Handling Systems Description

1. General System Description

a) Systems will be a single duct, variable air volume reheat type providing heating, and cooling of spaces served. The minimum outside air percentage will be determined in accordance with ASHRAE Standard 62; full airside economizer capability will be provided. Minimum outside air to be measured at the outside air duct serving the air handling units along with the supply fan air quantity and the return air quantity.

b) ABE Lab Building:

(1) ABE Lab building will not have an office air handling system.

c) ABE Office Building:

(1) System will include two factory fabricated custom air handling units manifolded together to operate as a single system. Custom air handling units are required due to mechanical equipment room space constraints.

(2) Each air handling unit will be sized for 25,000 cfm.

(3) Air will be supplied to all appropriate spaces; a portion of this air will be returned to the air handling units. Air not returned to the air handling units shall be utilized as make-up air for exhaust systems and for building pressurization.

(4) A ducted return air system shall be used to return air from the spaces back to AHUs.

(5) Air handling system will operate 10 hours per day, 5 days per week. ISU and AEI to discuss system operation schedule.

(6) Air handling system will operate with occupied, unoccupied and morning warm-up control cycles.

(7) Air handling units will be located at the basement level.

(8) Sound attenuating flexible duct, up to 3 ft in total length, will be provided at supply diffusers to control noise. Sound attenuators at the discharge of air terminal devices will not be provided unless required to meet noise criteria.

(9) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork. Ductwork leakage test requirements to be reviewed in future design phase.

(10) Air handling system will not be on stand-by power.

d) BRL Building:

(1) System will include a single packaged air handling unit sized for 16,500 cfm.

(2) Air will be supplied to all appropriate spaces; a portion of this air will be returned to the air handling units. Air not returned to the air handling unit shall be utilized as make-up air for exhaust systems and for building pressurization.

(3) A ducted return air system shall be used to return air from the spaces back to AHUs.

(4) Air handling system will operate 10 hours per day, 5 days per week. ISU and AEI to discuss system operation schedule.

(5) Air handling system will operate with occupied, unoccupied and morning warm-up control cycles.

(6) Air handling unit will be located at the basement level.

(7) Sound attenuating flexible duct, up to 3 ft in total length, will be provided at supply diffusers to control noise. Sound attenuators at the discharge of air terminal devices will not be provided unless required to meet noise criteria.

(8) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork. Ductwork leakage test requirements to be reviewed in future design phase.

(9) Air handling system will not be on stand-by power.

e) Parking Office:

(1) System will include a single packaged air handling unit sized for 23,500 cfm.

(2) Air will be supplied to all appropriate spaces; a portion of this air will be returned to the air handling units. Air not returned to the air handling units shall be utilized as make-up air for exhaust systems and for building pressurization.

(3) A ducted return air system shall be used to return air from the spaces back to the AHU.

(4) Air handling system will operate 10 hours per day, 5 days per week. ISU and AEI to discuss system operation schedule.

(5) Air handling system will operate with occupied, unoccupied and morning warm-up control cycles.

(6) Sound attenuating flexible duct, up to 3 ft in total length, will be provided at supply diffusers to control noise. Sound attenuators at the discharge of air terminal devices will not be provided unless required to meet noise criteria.

(7) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork. Ductwork leakage test requirements to be reviewed in future design phase.

(8) Air handling system will not be on stand-by power.

2. Design Criteria

a) Air Handling Unit Component Sizing

(1) Maximum allowable nominal face velocities or pressure drops are as follows:

Air Intake Louvers:	500 fpm through free area of louver (ISU to review / confirm proposed velocity.)
Steam Preheat Coils:	400 fpm (ISU to define appropriate velocity)
Cooling Coils:	400 fpm
Pre-filters and Final-filters:	350 fpm
Sound Attenuating Devices (in ductwork):	1500 fpm or 0.25" wg

b) Duct System Distribution Criteria

(1) Supply Ductwork Sizing (based on diversified CFM)

From Air Handling Unit to Air terminal (AT) Device

Maximum pressure drop of 0.1"/100 ft when < 10,000 cfm.

Maximum velocity of 1,500 fpm when > 10,000 cfm.

Duct size to AT device = AT inlet size up to 10 ft from AT.

Air Terminal Device to Supply Diffuser

Maximum pressure drop of 0.08"/100 ft when < 8,000 cfm;

Maximum velocity of 1,000 fpm when > 8,000 cfm

(2) Return Ductwork Sizing

Maximum pressure drop of 0.1"/100 ft when < 8,000 cfm;

Maximum velocity of 1,600 fpm when > 8,000 cfm.

c) Reserve Capacity and Redundant Systems

(1) Redundancy will not be provided for.

3. Equipment and Material

a) Air handling units will be of galvanized steel double wall construction. The units will consist of the following components:

(1) Outside air intake damper

(2) Minimum outside air intake damper

(3) 30% (Merv 7) efficient prefilters (as rated on ASHRAE Standard 52.1)

(4) 60% (Merv 11) efficient final filters as rated on ASHRAE Standard 52.1 (ABE Office only)

(5) 95% (Merv 14) efficient final filters as rated on ASHRAE Standard 52.1 (BRL only)

(6) Air mixing device (air blender)

(7) Steam preheat coils with integral face and bypass (ISU & AEI to continue discussions regarding potential issue of over heating and the possibility of utilizing a true face a bypass steam coil arrangement with a second steam coil in series).

(8) Chilled water cooling coils (two banks in series)

(9) Supply fan with VFD

(10) Fan discharge sound attenuating device in ductwork (as required)

(11) Smoke detector at supply air discharge ductwork

(12) Isolation/smoke dampers

(13) Air flow measuring stations

b) Supply fans will be double width double inlet centrifugal type with airfoil blades. Fan speed and air volume will be modulated through variable frequency drives (VFDs) controlled by supply duct static pressure controller.

c) Supply air terminals (ATs) will have internal liner with aluminum foil protection. ATs will be provided with system pressure independent DDC controllers with 24 volt electric actuators.

d) Return fans will be double width double inlet centrifugal type with air foil blades. Fan speed and air volume will be modulated through VFDs controlled by return fan discharge static pressure controller. ISU and AEI to discuss return fan control strategies.

e) Return fans will include the following components:

(1) Isolation/smoke damper at return fan inlet ductwork

(2) Smoke detectors at return fan inlet ductwork

(3) Return fan with VFD

(4) Return fan discharge isolation damper (ABE Office only)

(5) Return air damper

(6) Return airflow measuring station

(7) Relief air damper

(8) Sound Attenuating Device located in inlet ductwork (if required)

4. Distribution

a) High pressure galvanized steel ductwork will distribute supply air from the air handling units to the supply air terminal devices.

b) Low pressure galvanized steel ductwork will be utilized downstream of supply terminal devices to distribute supply air to the spaces.

c) Individual offices will be served by one supply air terminal device.

d) One air terminal device will be provided where individual space temperature control is required.

e) Supply air ductwork will be externally insulated with fiberglass insulation.

I. Laboratory Air Handling Systems

1. General System Description

a) Systems will be 100% outside air, single duct, variable air volume, reheat system providing heating and cooling to spaces.

b) Air supplied to all spaces will be exhausted to outdoors.

c) ABE Lab Building:

(1) System will include four factory fabricated custom air handling units manifolded together to operate as a single system.

(2) Each air handling unit will be sized for 32,500 cfm.

(3) Air handling unit will operate 24 hours per day, 365 days per year. ISU and AEI to discuss system operation schedule.

(4) Air handling units will be located at the penthouse level.

(5) Total energy wheels will be provided for each air handling unit to recover heat from laboratory exhaust systems.

(6) Ductwork will not be lined. Sound attenuating flexible duct up to 3 ft in total length will be provided at the supply diffusers to control noise. Sound attenuators at the discharge of air terminal devices will not be provided unless required to meet noise criteria.

(7) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork. Ductwork leakage test requirements to be reviewed in future design phase.

(8) All four air handling units will be connected to stand-by power, however only two units will be allowed to operate.

d) ABE Office Building:

(1) ABE Office building will not have a laboratory air handling system.

e) BRL Building:

(1) System will include two factory fabricated custom air handling units manifolded together to operate as a single system.

(2) Each air handling unit will be sized for 40,000 cfm.

(3) Air handling units will operate 24 hours per day, 365 days per year. ISU and AEI to discuss system operation schedule.

(4) Air handling units will be located at the basement level.

(5) A glycol water heat recovery system will be provided to recover heat from laboratory exhaust systems.

(6) Ductwork will not be lined. Sound attenuating flexible duct up to 3 ft in total length will be provided at the supply diffusers to control noise. Sound attenuators at the discharge of air terminal devices will not be provided unless required to meet noise criteria.

(7) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork. Ductwork leakage test requirements to be reviewed in future design phase.

(8) Both air handling units will be connected to stand-by power, however only one unit will be allowed to operate.

f) Parking Office:

(1) Parking Office will not have a laboratory air handling system.

2. Design Criteria

a) Air Handling Unit Component Sizing

(1) Maximum allowable nominal face velocities or pressure drops for air handling unit components are as follows:

Air Intake Louvers:	450 fpm through free area of louver (ISU to review/confirm proposed velocity)
Heat Recovery Coils:	400 fpm
Steam Heating Coils:	400 fpm (ISU to define appropriate velocity)
Cooling Coils	400 fpm
Pre-filters and Final-filters:	350 fpm
Sound Attenuating Devices (in ductwork):	1500 fpm or .25"wg

b) Duct System Distribution Criteria

(1) Supply Ductwork Sizing (based on diversified CFM):

From Air Handler to Air Terminal (AT) Device:

Maximum pressure drop of 0.15"/100 ft when, < 10,000 cfm

Maximum velocity of 2,000 fpm when > 10,000 cfm

Duct size to AT device = AT inlet size up to 10 ft from AT

Air Terminal Device to Supply Diffuser:

Maximum pressure drop of 0.1"/100 ft when < 8,000 cfm

Maximum velocity of 1,600 fpm when > 8,000 cfm

c) Reserve Capacity and Redundant Systems

(1) Air handling systems will consist of a minimum of two equally sized air handling units. If one of the supply fans fails, the remaining fan will be capable of providing approximately 70% of the design air flow.

(2) During power outages, supply air will be prioritized through the building controls to be delivered to the laboratory for fume hood exhaust make-up air, and to minimally ventilate the laboratory space.

(3) Building controls will automatically prioritize supply airflow to the laboratory spaces if one of a pair of air handling units is down.

(4) Air handling units will continue to operate upon activation of the building fire alarm system. Local duct mounted smoke detectors will activate duct smoke dampers closed. Air handling unit mounted smoke detectors will deactivate their respective air handling unit upon detection of smoke.

3. Equipment and Material

a) The air handling units will be of galvanized steel double wall construction. The units will consist of the following components:

(1) Outside Air Intake Dampers

(2) 30% (Merv 7) efficient prefilters (as rated on ASHRAE Standard 52.1)

(3) 95% (Merv 14) efficient Final Filters (as rated on ASHRAE Standard 52.1)

(4) Heat Recovery Run Around Loop Coil (BRL only)

(5) Total Energy Wheel (ABE Lab)

(6) Steam Preheat Coil with integral face and bypass (ISU & AEI to continue discussions regarding potential issue of over heating and the possibility of utilizing a true face and bypass steam coil arrangement with a second steam coil in series)

(7) Chilled Water Cooling Coils (two banks in series)

(8) Glycol Reheat Coils (BRL only)

(9) Supply Fan

(10) Fan Discharge Side Sound Attenuators (if required) or in ductwork

(11) Smoke detector at supply air discharge ductwork

(12) Smoke/Isolation Dampers

b) Supply fans will be double width double inlet centrifugal type with airfoil blades. Fan speed and air volume will be modulated through variable frequency drives (VFDs) controlled by supply duct static pressure controllers.

c) Non-laboratory space supply air terminals (ATs) will have have internal liner with aluminum foil protection. ATs will be provided with system pressure independent DDC controllers with electric actuators.

d) Laboratory space supply air terminals will be low pressure Venturi type. Air terminals (ATs) will be provided with pressure independent spring, DDC controller and pneumatic actuator. ISU and AEI to discuss if actuators should be pneumatic or electric type.

4. Distribution

a) High pressure galvanized steel ductwork will distribute supply air from the air handling units to the supply air terminal devices.

b) Low pressure galvanized steel ductwork will be utilized downstream of air terminal devices to distribute supply air to the spaces.

c) One air terminal device will be provided where individual space temperature control is required. Individual room control will be utilized in most rooms.

d) Supply air ductwork will be externally insulated with fiberglass insulation.

J. Mechanical & Electrical Equipment Room / Electrical Closet / Telecom Closet Fan Coil Systems

1. General System Description

a) Fan coil unit will serve each mechanical equipment room, electrical equipment room, electrical closet and telecom closet.

b) ABE Lab Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be a single duct constant air volume, providing heating and cooling to the spaces.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

(5) Supply air ductwork will not be lined.

(6) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 2% for low pressure ductwork. ISU to define if these systems need to be leakage tested.

c) ABE Office Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be a single duct constant air volume, providing heating and cooling to the spaces.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

(5) Supply air ductwork will not be lined.

(6) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 2% for low pressure ductwork. ISU to define if these systems need to be leakage tested.

d) BRL Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be a single duct constant air volume, providing heating and cooling to the spaces.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

(5) Supply air ductwork will not be lined.

(6) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 2% for low pressure ductwork. ISU to define if these systems need to be leakage tested.

e) Parking Office:

(1) System will consist of factory packaged fan coil unit.

(2) System will be a single duct constant air volume, providing heating and cooling to the spaces.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

(5) Supply air ductwork will not be lined.

(6) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 2% for low pressure ductwork. ISU to define if these systems are to be leakage tested.

2. Design Criteria

a) Fan Coil Unit Component Sizing

(1) Maximum allowable nominal face velocities or pressure drop are as follows:

Hot Water Heating Coils:	500 fpm (AEI to review resultant coil velocity when sizing equipment)
Cooling Coils:	500 fpm (AEI to review resultant coil velocity when sizing equipment)
Filters:	500 fpm (AEI to review resultant filter velocity when sizing equipment)

b) Duct System Distribution Criteria

(1) Supply Ductwork Sizing

From Fan Coil Unit

Maximum pressure drop of 0.1"/100 ft of ductwork.

Return Ductwork Sizing

Maximum pressure drop of 0.1"/100 ft of ductwork.

c) Reserve Capacity and Redundant Systems

(1) There will be no redundancy.

3. Equipment and Material

a) The fan coil units will be of galvanized steel wall construction. The units will consist of the following components:

(1) 20% (Merv 5) Efficient Prefilters (as rated on ASHRAE Standard 52.1)

(2) Hot Water Heating Coils.

(3) Chilled Water Cooling Coils

(4) Supply Fan

Supply fans will be centrifugal type.

4. Distribution

a) Low pressure galvanized steel ductwork will be utilized downstream of supply fan to distribute supply air to the spaces.

K. Elevator Equipment Room Fan Coil Systems

1. General System Description

a) One fan coil unit will serve each elevator equipment room.

b) ABE Lab Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be free standing in the room to provide heating and cooling to the space.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

c) ABE Office Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be free standing in the room to provide heating and cooling to the space.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

d) BRL Building:

(1) System will consist of factory packaged fan coil unit.

(2) System will be free standing in the room to provide heating and cooling to the space.

(3) Air supplied to the rooms will be returned to unit.

(4) Fan coil system will operate 24 hours per day, 365 days per year.

e) Parking Office:

(1) Parking Office will not have an elevator equipment room fan coil system.

2. Design Criteria

a) Fan Coil Unit Component Sizing

(1) Maximum allowable nominal face velocities or pressure drop are as follows:

Hot Water Heating Coils:	500 fpm (AEI to review resultant coil velocity when sizing equipment)
Cooling Coils:	500 fpm (AEI to review resultant coil velocity when sizing equipment)
Filters:	500 fpm (AEI to review resultant filter velocity when sizing equipment)

b) Duct System Distribution Criteria

(1) Supply Ductwork Sizing

From Fan Coil Unit

Maximum pressure drop of 0.1"/100 ft of ductwork.

(2) Return Ductwork Sizing

Maximum pressure drop of 0.1"/100 ft of ductwork.

c) Reserve Capacity and Redundant Systems

(1) There will be no redundancy.

(2) Fan coil units to be served by stand-by power.

3. Equipment and Material

a) The fan coil units will be of galvanized steel wall construction. The units will consist of the following components:

(1) 20% (Merv 5) Efficient Prefilters (as rated on ASHRAE Standard 52.1)

(2) Hot Water Preheating Coils.

(3) Chilled Water Cooling Coils

(4) Supply Fan

b) Supply fans will be centrifugal type.

L. Toilet and General Exhaust Systems

1. General System Description

a) The system will service toilet rooms, janitor's closets, locker rooms, etc.

b) ABE Lab Building:

(1) System will consist of centrifugal exhaust fan(s). Number of exhaust fans required per building to be confirmed based on final building program.

(2) Systems will be controlled via occupied/unoccupied control.

(3) The exhaust system will be constant volume.

c) ABE Office Building:

(1) System will consist of centrifugal exhaust fan(s). Number of exhaust fans required per building to be confirmed based on final building program.

(2) Systems will be controlled via occupied/unoccupied control.

(3) The exhaust system will be constant volume.

d) BRL Building:

(1) System will consist of centrifugal exhaust fan(s). Number of exhaust fans required per building to be confirmed based on final building program and location of associated rooms.

(2) Systems will be controlled via occupied/unoccupied control.

(3) The exhaust system will be constant volume.

e) Parking Office:

(1) System will consist of centrifugal exhaust fan(s). Number of exhaust fans required per building to be confirmed based on final building program.

(2) Systems will be controlled via occupied/unoccupied control.

(3) The exhaust system will be constant volume.

2. Design Criteria

a) Duct Distribution Criteria

(1) Exhaust ductwork sizing:

Maximum pressure drop of 0.1"/100 ft of ductwork.

Maximum velocity of 1500 fpm.

b) Reserve Capacity and Redundant Systems

(1) There will be no redundancy.

(2) During power outages the exhaust fan(s) will be off.

3. Equipment and Materials

a) The exhaust system will consist of the following components:

(1) Roof mounted exhaust fans.

(2) Backdraft damper.

(3) Exhaust ductwork serving toilet rooms, janitor's closets, etc. will be galvanized steel.

(4) Exhaust ductwork serving locker rooms will be aluminum.

L. Combined Laboratory Exhaust System

1. General System Description

a) ABE Lab Building:

(1) Building will be served by a central laboratory exhaust air system. The system will combine exhaust from laboratory fume hoods, snorkels, canopy hoods, and general exhaust.

(2) System will consist of 4 exhaust fans connected to a common exhaust fan inlet plenum located on the roof. The fans are intended to operate in parallel and will each be sized for 25% of the design load respectively. Each exhaust fan will be sized for 32,500 cfm. Strobic exhaust fans will be sized such that if 1 of the 4 exhaust fans fail, the remaining three exhaust fans have sufficient capacity to meet the building design exhaust requirements.

(3) Laboratory exhaust system will be variable air volume. While the system is variable air volume, the exhaust fans operate at constant volume to maintain a constant stack discharge velocity. A static pressure sensor in the exhaust fan inlet plenum will modulate an outside air bypass damper, introducing the required outside air into the plenum to maintain a constant flow rate through the fans.

(4) Exhaust system will have packless type sound attenuating devices on the exhaust mains.

(5) Heat recovery will consist of air-to-air total energy wheels with purge mode. Heat wheel will transfer both sensible and latent heat energy from the lab exhaust air stream to the make-up outside air stream using desiccant molecular sieve technology. ISU and AEI to continue discussions regarding utilizing total energy wheels for central laboratory exhaust air.

(6) Heat wheels overall efficiency is over 70% (as high as 86%) compared to only 40% for glycol run around systems. There is some gain in the sensible heat portion of heat transfer, but a large component of the increased efficiency is the latent heat (moisture) transfer.

(7) Wheels use 3A molecular sieve technology. Molecular sieves are designed for selective absorption. Molecular sieves are structurally stable, chemically inert, and have a strong affinity to water vapor. 3A molecular sieve is smaller than most chemical molecules and much smaller than any bacteria or other bio-organism used in laboratories.

(8) 30% efficient (Merv 7) pleated filters will be provided at only the outside air inlet of the wheel.

(9) General exhaust and fume hood exhaust will be variable volume; snorkel and canopy hood exhaust will be constant volume.

(10) Pressure independent, variable volume, low pressure venture style, exhaust air terminal devices will be provided to serve general exhaust grilles in lab and non-lab areas. Pressure independent, constant volume or variable volume, low pressure venture style, exhaust air terminal devices will be provided for the fume hoods, snorkels, and canopy hoods.

(11) High pressure exhaust ductwork will be utilized between the exhaust air terminal devices and the central exhaust plenums.

(12) Low pressure exhaust ductwork will be utilized between the exhaust devices (general exhaust grille, fume hoods, snorkels, or canopy hoods), and the exhaust air terminal devices. Sound attenuating devices at the air terminals will not be provided unless required to meet noise criteria. Three feet of sound attenuating flexible ductwork will be provided at general exhaust grilles (but not at fume hoods, snorkels, or canopy hoods) to control noise.

b) ABE Office Building:

(1) ABE Office building will not have a combined laboratory exhaust system.

c) BRL Building:

(1) Building will be served by a central laboratory exhaust air system. The system will combine exhaust from laboratory fume hoods, snorkels, canopy hoods, and general exhaust.

(2) System will consist of 4 exhaust fans connected to a common exhaust fan inlet plenum located on the roof. The fans are intended to operate in parallel and will each be sized for 25% of the design load respectively. Each exhaust fan will be sized for 20,000 cfm. Strobic exhaust fans will be sized such that if 1 of the 4 exhaust fans fail, the remaining 3 exhaust fans have sufficient capacity to meet the building design exhaust requirements.

(3) Laboratory exhaust system will be variable air volume. While the system is variable air volume, the exhaust fans operate at constant volume to maintain a constant stack discharge velocity. A static pressure sensor in the exhaust fan inlet plenum will modulate an outside air bypass damper, introducing the required outside air into the plenum to maintain a constant flow rate through the fans.

(4) Exhaust system will have packless type sound attenuating devices on the exhaust mains.

(5) Heat recovery coils will be provided at the fan inlet plenum. 30% efficient (Merv 7) pleated filters will be provided at the coil inlets with face damper and by-pass dampers/ductwork around the filters and coils to allow servicing of the filters and coils while the exhaust fans are operating. Heat recovery coils and filters will be located on roof within a completely enclosed mechanical penthouse.

(6) General exhaust and fume hood exhaust will be variable volume; snorkel and canopy hood exhaust will be constant volume.

(7) Pressure independent, variable volume, low pressure venture style, exhaust air terminal devices will be provided to serve general exhaust grilles in lab and non-lab areas. Pressure independent, constant volume or variable volume, low pressure venture style, exhaust air terminal devices will be provided for the fume hoods, snorkels, and canopy hoods.

(8) High pressure exhaust ductwork will be utilized between the exhaust air terminal devices and the central exhaust plenums.

(9) Low pressure exhaust ductwork will be utilized between the exhaust devices (general exhaust grille, fume hood, snorkels, or canopy hoods) and the exhaust air terminal devices. Sound attenuating devices at the air terminals will not be provided unless required to meet noise criteria. Three feet of sound attenuating flexible ductwork will be provided at general exhaust grilles (but not at fume hoods, snorkels, or canopy hoods) to control noise.

d) Parking Office:

(1) Parking Office will not have a combined laboratory exhaust system.

2. Design Criteria

a) Exhaust System Component Sizing

(1) Maximum allowable nominal face velocities for exhaust system components are as follows:

Pre-filters:	350 fpm
Heat recovery coils:	400 fpm
Total energy wheels:	800 fpm

b) Duct Distribution Criteria

(1) Exhaust ductwork sizing (based on diversified CFM):

From hood, grille, etc. to air terminal device:

Maximum pressure drop of 0.1"/100 ft when < 8,000 cfm (duct size to AT = AT inlet size).

From air terminal device to fan inlet:

Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

Maximum velocity of 2000 fpm when > 10,000 cfm

(2) Exhaust Fan Stack Discharge Velocity will be based on the Strobic discharge performance but should not be less than 3500 fpm.

3. Equipment and Materials

a) Exhaust fans and heat recovery coils will have baked heresite chemical resistant coating on surfaces in contact with exhaust air stream.

b) The central exhaust system will consist of the following components:

(1) Common exhaust fan intake plenum with inlet sound attenuating devices (in ductwork)

(2) 30% (Merv 7) efficient prefilters (as rated on ASHRAE Standard 52.1)

(3) Heat recovery coils with coil by-pass duct and dampers (BRL only)

(4) Total energy wheels (ABE Lab only)

(5) Industrial quality isolation dampers at each fan inlet

(6) Strobic mixed induced dilution style fans

(7) Outside air bypass ductwork, control damper, and appropriate balancing devices.

4. Distribution

a) Exhaust ductwork and plenum construction is currently proposed as galvanized steel and runouts to fume hoods and snorkels will be 316L stainless steel sheet metal. ISU and AEI to review in future design phase. Air terminal devices will be utilized for fume hoods, biosafety cabinets, snorkel exhausts, and general exhaust. Air terminal devices for fume hoods and snorkels will be 316L stainless steel and galvanized steel for general exhaust.

M Below Grade Parking Garage Ventilation System (Parking Structure only)

1. General System Description

a) Air intake will be accomplished by drawing air in through the louver above grade in the parking structure. Air will disperse throughout the parking structure and be exhausted in each of the corners of each level below grade.

b) An exhaust fan in each corner of each level will draw uniform air movement across each parking level.

c) ABE Lab Building:

(1) ABE Lab building will not have a below grade parking garage ventilation system.

d) ABE Office Building:

(1) ABE Office building will not have a below grade parking garage ventilation system.

e) BRL Building:

(1) BRL building will not have a below grade parking garage ventilation system.

f) Parking Office:

(1) Parking Office will have a below grade parking garage ventilation system.

2. Design Criteria

a) Design will be per IMC Section 404.

3. Equipment and Material

a) Exhaust fans will be propeller type. Each fan will be furnished with backdraft damper.

4. Distribution

a) A vertical chase in each corner will exhaust the air to the exterior with grating at top of chase.

N. Agricultural Dust Collection Systems

1. This basis of design is not applicable if system is provided by Owner.

2. General System Description

a) ABE Lab Building:

(1) Each required space will be served by a dust collection system. The system will combine centrifugal separator, point exhaust, filters, etc.

(2) System will consist of 1 exhaust fan and will be located outside.

(3) Dust collection system will be constant air volume. Fans will have packless type sound attenuating devices on the exhaust main, and the outside air by-pass duct.

(4) High pressure/high velocity exhaust ductwork will be utilized between the exhaust inlets and the central exhaust plenum. Sound attenuating devices at the air terminals will not be provided unless required to meet noise criteria.

(5) The air will be discharged back into the same room the exhaust air is from. Type of filtration required will be defined once space programming defines process generating agricultural dust.

b) ABE Office Building:

(1) ABE Office building will not have an agricultural dust collection system.

c) BRL Building:

(1) BRL building will not have an agricultural dust collection system. Proposed grinding room will have a portable small scale dust collection device specified by the lab programmer.

d) Parking Office:

(1) Parking Office will not have an agricultural dust collection system.

3. Design Criteria

a) Duct Distribution Criteria

(1) Exhaust ductwork sizing (based on diversified CFM):

From fan discharge to room:

Maximum pressure drop of 0.1"/100 ft when < 8,000 cfm (duct size to AT = AT inlet size).

From point inlet to fan inlet:

Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

Maximum velocity of 2000 fpm when > 10,000 cfm

4. Equipment and Materials

a) Exhaust fans will be of AMCA Class "C" spark-proof construction with bearings and motors out of the air stream.

b) The central exhaust system will consist of the following components:

(1) Industrial quality isolation damper at each fan inlet.

(2) Constant volume centrifugal exhaust fans with backward inclined blades.

(3) Industrial quality backdraft damper

5. Distribution

a) Exhaust ductwork will be galvanized steel.

O. Wood Dust Collection Systems

1. This basis of design is not applicable if system is provided by Owner.

2. General System Description

a) ABE Lab Building:

(1) Each required space will be served by a dust collection system. The system will combine centrifugal separator, point exhaust, filters, etc.

(2) System will consist of 1 exhaust fan and will be located outside.

(3) Dust collection system will be constant air volume. Fans will have packless type sound attenuating devices on the exhaust main, and the outside air by-pass duct.

(4) High pressure/high velocity exhaust ductwork will be utilized between the exhaust inlets and the central exhaust plenum. Sound attenuating devices at the air terminals will not be provided unless required to meet noise criteria.

(5) The air will be discharged back into the same room the exhaust air is from. Type of filtration required will be defined once space programming defines process generating wood dust.

b) ABE Office Building:

(1) ABE office building will not have a wood dust collection system.

c) BRL Building:

(1) BRL building will not have a wood dust collection system.

d) Parking Office:

(1) Parking Office will not have a wood dust collection system.

3. Design Criteria

a) Duct Distribution Criteria

(1) Exhaust ductwork sizing (based on diversified CFM):

From fan discharge to room:

Maximum pressure drop of 0.1"/100 ft when < 8,000 cfm (duct size to AT = AT inlet size).

From point inlet to fan inlet:

Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

Maximum velocity of 2000 fpm when > 10,000 cfm

4. Equipment and Materials

a) Exhaust fans will be of AMCA Class "C" spark-proof construction with bearings and motors out of the air stream.

b) The central exhaust system will consist of the following components:

(1) Industrial quality isolation damper at each fan inlet.

(2) Constant volume centrifugal exhaust fans with backward inclined blades.

(3) Industrial quality backdraft damper

5. Distribution

a) Exhaust ductwork will be galvanized steel.

Q. Steel Welding Exhaust Systems

1. This basis of design not applicable if system is provided by Owner.

2. ISU and AEI to discuss current welding exhaust management practices utilized on campus to determine best application suited for this building.

3. General System Description

a) ABE Lab Building:

(1) Each required room will be served by a central welding exhaust air system. The system will combine point exhaust and canopy hoods.

(2) System will consist of 1 exhaust fan and will be located on the roof.

(3) Welding exhaust system will be constant air volume.

(4) High pressure/high velocity exhaust ductwork will be utilized between the exhaust air inlets and the exhaust fan.

b) ABE Office Building:

(1) ABE office building will not have a steel welding exhaust system.

c) BRL Building:

(1) BRL building will not have a steel welding exhaust system.

d) Parking Office:

(1) Parking Office will not have a steel welding exhaust system.

4. Design Criteria

a) Duct Distribution Criteria

(1) Exhaust ductwork sizing (based on diversified CFM):

From exhaust inlet to fan inlet:

Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

Maximum velocity of 2000 fpm when > 10,000 cfm

5. Equipment and Materials

a) Exhaust fans will be of AMCA Class "C" spark-proof construction with bearings and motors out of the air stream.

b) The welding exhaust system will consist of the following components:

(1) Industrial quality isolation damper at each fan inlet.

(2) Constant volume centrifugal exhaust fans with backward inclined blades. Each exhaust fan to have its own exhaust stack.

(3) Industrial quality backdraft damper

6. Distribution

a) Exhaust ductwork and plenum will be galvanized steel.

b) Exhaust fan discharge stacks will be 316 stainless steel, all welded construction. ISU and AEI to discuss exhaust fan stack construction.

R. Aluminum Welding Exhaust Systems

1. This basis of design not applicable if system is provided by Owner.

2. ISU and AEI to discuss current welding exhaust management practices utilized on campus to determine best application suited for this building.

3. General System Description

   a) ABE Lab Building:

      (1) Each required room will be served by a central welding exhaust air system. The system will combine point exhaust and canopy hoods.

      (2) System will consist of 1 exhaust fan and will be located on the roof.

      (3) Welding exhaust system will be constant air volume.

      (4) High pressure/high velocity exhaust ductwork will be utilized between the exhaust air inlets and the exhaust fan.

   b) ABE Office Building:

      (1) ABE office building will not have an aluminum welding exhaust system.

   c) BRL Building:

      (1) BRL building will not have an aluminum welding exhaust system.

   d) Parking Office:

      (1) Parking Office will not have an aluminum welding exhaust system.

4. Design Criteria

   a) Duct Distribution Criteria

      (1) Exhaust ductwork sizing (based on diversified CFM):

      From exhaust inlet to fan inlet:

      Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

      Maximum velocity of 2000 fpm when > 10,000 cfm

5. Equipment and Materials

   a) Exhaust fans will be of AMCA Class "C" spark-proof construction with bearings and motors out of the air stream.

   b) The welding exhaust system will consist of the following components:

      (1) Industrial quality isolation damper at each fan inlet.

      (2) Constant volume centrifugal exhaust fans with backward inclined blades.

      (3) Industrial quality backdraft damper

6. Distribution

a) Exhaust ductwork and plenum will be aluminum.

b) Exhaust fan discharge stacks will be aluminum, all welded construction. ISU and AEI to discuss exhaust fan stack construction.

S. Plastic Extrusion Exhaust System

1. This basis of design not applicable if system is provided by Owner.

2. General System Description

a) ABE Lab Building:

(1) Each required room will be served by a plastic extrusion exhaust air system. The system will combine point exhaust and canopy hoods.

(2) System will consist of 1 exhaust fan and will be located on the roof.

(3) Plastic extrusion exhaust system will be constant air volume.

(4) High pressure/high velocity exhaust ductwork will be utilized between the exhaust air inlets and the exhaust fan.

b) ABE Office Building:

(1) ABE office building will not have a plastic extrusion exhaust system.

c) BRL Building:

(1) BRL building will not have a plastic extrusion exhaust system.

d) Parking Office:

(1) Parking Office will not have a plastic extrusion exhaust system.

3. Design Criteria

a) Duct Distribution Criteria

(1) Exhaust ductwork sizing (based on diversified CFM):

From exhaust inlet to fan inlet:

Maximum pressure drop of 0.15"/100 ft when < 10,000 cfm

Maximum velocity of 2000 fpm when > 10,000 cfm

b) Exhaust Fan Stack Discharge Velocity.

(1) 3500 - 4000 fpm

4. Equipment and Materials

   a) Exhaust fans will be of AMCA Class "C" spark-proof construction with bearings and motors out of the air stream. Fans and heat recovery coils will have baked heresite chemical resistant coating on surfaces in contact with air stream.

   b) The central exhaust system will consist of the following components:

      (1) Industrial quality isolation damper at each fan inlet.

      (2) Constant volume centrifugal exhaust fans with backward inclined blades.

      (3) Exhaust stack for each fan discharge.

      (4) Industrial quality backdraft damper

5. Distribution

   a) Exhaust ductwork and plenum will be galvanized steel.

   b) Exhaust fan discharge stacks will be 316 stainless steel, all welded construction. ISU and AEI to discuss exhaust fan stack construction.

T. Atrium Smoke Control System

1. System Description

   a) Atrium smoke control system will be designed to meet the Code requirements.

   b) System will include exhaust air extracted at the top of the atrium and untempered make-up air introduced near the lowest floor level of the atrium. Untempered make-up air will only be used if systems serving the atrium are designed to take into account the untempered make-up air temperature range.

2. Design Criteria

   a) System will be sized per IBC 909.

   b) Design fire = 5000 BTU/second.

   c) Discharge velocities will be less than 200 FPM in the fire zone.

3. Equipment and Material

   a) Exhaust fans may be roof mounted, vertical axial type. Specific style of exhaust fan to be determined based on atrium configuration along with exhaust fan accessibility / maintainability. Atrium exhaust fans shall be UL Listed for use in smoke control systems.

   b) Make-up air is to be introduced at the lowest level of the atrium.

c) Exhaust fan motors will be powered by emergency power. Additional emergency power will be required to cover the automated window or damper actuators and make-up air fans, if necessary.

4. Distribution

a) Exhaust ductwork will be galvanized steel.

U. Retractable Engine Tailpipe Exhaust Capture System

1. General System Description

a) ABE Lab Building:

(1) Engine tailpipe exhaust capture system will serve the Tractor Vehicle Dynamometer space.

(2) System will include overhead high temperature flexible tubing, boom mounted tubing storage wheel, and associated exhaust ductwork / fan.

b) ABE Office Building:

(1) ABE office building will not have a retractable engine tailpipe exhaust capture system.

c) BRL Building:

(1) BRL building will not have a retractable engine tailpipe exhaust capture system.

d) Parking Office:

(1) Parking Office will not have a retractable engine tailpipe exhaust capture system.

2. Design Criteria

a) The retractable engine tailpipe exhaust capture system will be provided by a single manufacturer as a complete engineered system.

3. Equipment and Material

a) Exhaust fan style will be a base mounted single width, single inlet centrifugal. Exhaust fan to have phenolic resin coating.

b) Flexible tubing will be rated for 850°F.

4. Distribution

a) Exhaust pipe will be insulated with both alumina/silica material and mineral wool preformed insulation. Insulation jacket will be stucco embossed aluminum.

V. Fixed Position Engine Tailpipe Exhaust System

1. General System Description

a) ABE Lab Building:

(1) Engine tailpipe exhaust system will serve the Engine Dyno Lab space.

(2) System will include exhaust silencer, thermal expansion devices (as required) and associated exhaust piping.

b) ABE Office Building:

(1) ABE office building will not have a fixed position engine tailpipe exhaust system.

c) BRL Building:

(1) BRL building will not have a fixed position engine tailpipe exhaust system.

d) Parking Office:

(1) Parking Office will not have a fixed position engine tailpipe exhaust system.

2. Design Criteria

a) Engine size / type to be tested to be defined to allow the engine tailpipe exhaust system to be designed / engineered.

b) The engine tailpipe exhaust system can be provided by a single manufacturer as a complete engineered system.

3. Equipment and Material

a) Exhaust pipe will be Schedule 40 carbon steel.

b) Exhaust silencer will be critical grade silencer.

c) Thermal expansion device type to be confirmed based on exhaust pipe routing, thermal expansion requirements, etc.

4. Distribution

a. Exhaust pipe will be insulated with both alumina/silica material and mineral wool preformed insulation. Insulation jacket will be stucco embossed aluminum.

W. Fume Hood and Laboratory Air Flow Control System

1. General System Description

a) ABE Lab Building:

(1) Each lab space will have a stand-alone fume hood and laboratory controller which will control the space temperature, fume hoods, and pressurization. ISU and AEI to discuss fume hood and lab space air flow control strategies.

(2) Pressurization will be controlled by supply air/exhaust air tracking.

(3) Each fume hood will have a low flow alarm to indicate if fume hood face velocity falls below a specified level.

(4) Fume hood and laboratory air flow control system to communicate with Johnson Controls systems without the use of BacNet.

b) ABE Office Building:

(1) ABE office building will not have a fume hood and laboratory air flow control system.

c) BRL Building:

(1) Each lab space will have a stand-alone fume hood and laboratory controller which will control the space temperature, fume hoods, and pressurization. ISU and AEI to discuss fume hood and lab space air flow control strategies.

(2) Pressurization will be controlled by supply air/exhaust air tracking.

(3) Each fume hood will have a low flow alarm to indicate if fume hood face velocity falls below a specified level.

(4) Fume hood and laboratory air flow control system to communicate with Johnson Controls systems without the use of BacNet.

d) Parking Office:

(1) Parking Office will not have a fume hood and laboratory air flow control system.

2. Design Criteria

a) Fume hood and laboratory air flow control system will be interfaced with Building Automation System (BAS). ISU and AEI to discuss interface with BAS. Fume hood alarms shall be local and not communicate to the building BAS.

b) Control system will be on emergency power.

3. Equipment and Material:

a) Systems will be by Johnson Controls or Rosemex.

4. Distribution:

a) Laboratory controls will be distributed architecture.

X. Building Automation System (BRL, ABE Lab, ABE Office & Parking Office)

1. General System Description

a) Mechanical systems will be controlled and monitored through a DDC based Building Automation System (BAS) with distributed processing at the local level. The overall building controls will be Johnson Controls Metasys.

(1) Additional monitoring and control includes environmental controls, lighting controls, fire alarm reporting, equipment monitoring, and energy utilization.

b) The BAS will be designed with DDC controls and actuators on all minor mechanical equipment while major mechanical valves and dampers will have pneumatic actuators with pilot positioners. ISU and AEI to discuss if actuators should be pneumatic or electric type.

2. Design Criteria

a) Building Automation System (BAS) will integrate with the existing Building Systems Automation Center (BSAC).

(1) The BAS shall consist of building level control modules and DDC room/floor control modules with the building level control modules communicating to the existing BAS file server via the ISU Ethernet system.

(2) Ethernet communication data ports for building level controllers will be provided by the telecommunications contractor.

(3) Dedicated control communication wiring between the building level controllers and the DDC room/floor level controllers shall be provided by the BAS contractor and run in a serial configuration.

b) DDC room/floor level controllers will utilize distributed architecture and will not rely on "front-end" or building level controllers to perform required control sequences.

c) Each DDC controller will have a minimum of 10% spare points of each type (DI, DO, AI and AO) at each panel. For universal points, the spares will be divided evenly between the analog and digital types of points.

d) All control panels, DDC controllers, and control air compressors will operate on emergency power.

e) All DDC system primary LAN (building level) controllers, PC's and communications equipment that monitors life safety and critical points (fire alarm, elevator emergency, etc.), will be supported by emergency generators and will have UPS backup for minimum of 4 hrs.

f) System will monitor temperature, humidity, supply and exhaust air quantities for air handling units and exhaust systems.

(1) System will also control and monitor operation of all heat recovery/reclamation equipment associated with the air handling units.

g) Airflow tracking control using DDC will be utilized instead of space pressure control, to maintain the space pressure (positive, neutral or negative) as required by the programming.

h) All building level and DDC room/floor controllers will be installed in panels. DDC room controllers will be installed in panels above the ceiling.

3. Equipment and Material (ISU and AEI to discuss compressed air requirements for controls system.

a) A duplex temperature control air will be provided by a separate temperature control air compressor with refrigerated air dryer.

b) Desiccant air drier to reduce the control air dew point to -40°F will be used for any control air line that passes through outside air spaces.

c) Temperature control air tubing will be hard-drawn, seamless copper tubing with extruded or wrought copper fittings joined with 95-5 solder.

d) Polyethylene tubing will be allowed if installed in rigid conduit or metallic raceways run parallel with the building structure.

e) All control wiring and pneumatic tubing will be installed in dedicated conduit or cable tray.

f) Occupancy sensors will be provided by the electrical contractor and will provide lighting operation, BAS operation, or both lighting and BAS operation. Wiring to occupancy sensors auxiliary contacts will be provided by the BAS contractor.

4. Roles and Responsibilities

a) ISU's generic building automation package templates will be collaboratively customized by the Design team and ISU's representative to design the BAS system.

b) At the completion of the BAS installation, the Design Professional and Professional Consultants will evaluate the results of the Test and Balance Report with the design and discuss with ISU's representative any corrective action deemed necessary

III. Sustainability options still under consideration:

A. ASHRAE 90.1 Baseline

1. Development of the initial building models will be conducted using the current applicable ASHRAE standard for energy performance and modeling, ASHRAE Standard 90.1-2004 including appendixes.

2. Energy conservation opportunities will be compared directly to the requirements of this standard as it applies to construction types and system descriptions.

3. Recent addenda to the standard have provided for more favorable design conditions for special use building such as laboratory settings.

4. The ASHRAE 90.1 Standard is also the standard by which energy comparisons will be made for the purposes of LEED Certification.

5. Per the requirements of LEED 2.2 the ABE/BRL buildings will be required to achieve at least 14.5% energy savings over ASHRAE 90.1-2004.

B. AEI Base Case

1. AEI's typical practice for the design of laboratory facilities and highly functional spaces will often go beyond the specific requirements of the ASHRAE 90.1 Standard.

2. In many instances this AEI best practice approach will lead to increased energy efficiency.

3. In some cases this approach will actually increase energy use as it appropriately balances health and safety concerns associated with laboratory buildings and will include specific responses to programmatic requirements such as appropriate air change rates.

C. Geothermal System (Hybrid)

1. The project may benefit significantly from the use of a vertical column geothermal borefield. AEI would propose analyzing a hybrid geothermal system, meaning a system with the capacity to meet a base load condition but then also couple to more conventional central equipment for heating and cooling.

2. This will provide for a balance between the expense of geothermal systems and the energy efficiency they can provide.

3. The geothermal system sizing will consider issues such as heating and cooling for ventilation air, possible radiant heating/cooling systems, as well as domestic hot water use.

D. Decentralized Cooling

1. Specific areas of the ABE/BRL complex may benefit from decentralized cooling strategies such as fan coil units or active chilled beam components.

2. In high sensible heat gain spaces, specifically, this strategy may offer significant energy savings.

3. Program requirements for watts / sq.ft. of plug load will be key parameters in the appropriate analysis of these technologies.

E. Unconditioned Space

1. Specific areas of the ABE/BRL complex may be candidates for unconditioned space.

2. There is significant program area dedicated to high bay space and shop areas.

3. The energy conservation benefits of unconditioned space are readily apparent and should be quantified in the next phase of project work so that a balance can be made between conditioning these spaces and the overall goals of energy efficiency.

F. Spot Conditioning

1. Similar to the "decentralized cooling" strategy discussed above spot conditioning may offer an alternative to totally unconditioned space.

2. In this strategy the analysis will seek to determine the energy efficiency gains provided by condition specific areas of a program space such as locations where humans will be present.

3. Example concepts for this strategy include radiant panels, air curtains, in-floor radiant heat, and passive chilled beams.

G. Natural Ventilation/Operable Windows

1. Several program areas of the ABE/BRL project may be candidates for natural ventilation or operable windows.

2. This strategy would be limited to spaces without specific ventilation safety issues (laboratory spaces) and where pressure differential between adjacent spaces is not of acute concern.

3. AEI anticipates analyzing this strategy for use in such spaces as Atriums, connectors, and office space.

H. Heat Wheels

1. Also known as "Total Energy Recovery Ventilators", heat wheels provide energy recovery for both sensible and latent heat transfer.

2. These mechanical components have increased in use in laboratory environments for all exhaust air streams and have been shown to be up to 85% effective at heat transfer.

3. The current ASHRAE standard requires energy recovery with an effectiveness of at least 50% for buildings such as ABE/BRL and thus heat wheels should be analyzed for all spaces.

4. A by pass strategy will be considered for any heat recovery during non-recovery periods to lower static pressure in the fan system during these periods.

I. Run Around Energy Recovery

1. Run around energy recovery is significantly less efficient than either heat pipes or heat wheels but maybe applicable for this project due to space constraints related to the building layout, potential contaminants in some exhaust streams (fume exhaust), and its relatively small first cost implications.

J. Heat Pipes

1. Heat pipe technology offers a middle ground for energy recovery effectiveness as it can be as high as 60% effective at sensible heat recovery.

2. Heat pipes are also an indirect heat transfer technology so they eliminate the issues of cross contamination between supply and exhaust air streams.

K. Low Pressure Drop Distribution Systems

1. Energy use for the ventilation of laboratory facilities typically accounts for between 20 and 40% of the total energy use of the building.

2. Reducing static pressure in the ventilation system directly corresponds to energy savings in this large energy use category.

3. Static pressure reduction strategies include decreased velocity across heat transfer coils, lower velocity air distribution, lower supply temperature distribution systems as well as many other components.

L. Solar Thermal Domestic Hot Water

1. Solar thermal systems can offer reasonable pay back periods while addressing the relatively constant energy demand inherent in domestic hot water for constant use facilities.

2. AEI recommends an analysis to determine the energy savings associated with a solar thermal domestic hot water system sized for the entire building DHW load.

3. A system of this nature will require significant surface area on the building enclosure as well as square footage for interior storage capacity.

M. Ventilation Driven by Air Sampling (Lab spaces only)

1. The Aircuity Optinet system offers an opportunity to actively control air flow quantities to laboratory spaces based on the presence (or absence) of contaminants in the occupied zone.

2. Recent benchmark studies have shown laboratory spaces to be below contaminant thresholds for 99.7% of the time at only four air changes per hour.

3. A reduction in average annual air change rates from six to four would offer significant energy savings.

N. Infusers (low temperature distribution)

1. This concept involves the use of low temperature, low humidity air distribution through supply air terminals, called infusers, which induce mixing at the space through the use of induction nozzles.

2. The concept results in the virtual elimination of reheat energy at the space as air mixing occurs through the induction process.

O. Daylighting

1. The use of natural light to provide illumination to much of the program area should be aggressively pursued and implemented.

2. Floor to floor height constraints and the size of the floor plate will directly impact the effectiveness of daylighting, yet this strategy should be optimized and assessed for all perimeter zones at a minimum.

P. Displacement Ventilation

1. Displacement ventilation could be used in office areas as well as high bay spaces to limit fan power energy and the amount of building volume that is actively conditioned by mechanical means.

2. Advancements in displacement ventilation allow for the implementation of this concept without the need for a raised floor.

Q. Return Air

1. In some of the shop areas of ABE supplementing an all outside air system with a return air system would provide significant energy savings.

2. A return air system could be implemented with the use of an air quality monitoring system (demand control ventilation) to ensure proper air quality by varying the amount of outside are introduced to the return air system.

R. Grey Water System

1. As potable water has become an increasingly valuable resource grey water systems have garnered more attention in building projects.

2. The numerous points of potable water use in the ABE/BRL complex will provide opportunities for recycled or grey water, systems.

3. Though limited in economic payback potential the importance of potable water as a natural resource and impact of water conservation on large scale energy efficiency can not be ignored.

4. As such, a grey water system will be developed and analyzed for cost effectiveness for this project.

5. The system may include strategies for storm water collection, condensate recovery, and RO reject water recovery.

IV. Sustainability options that have been discussed and determined that further analysis is not required:

A. Thermal Storage (Ice/Water)

1. Thermal storage has been ruled out as a potential strategy at this time due in large part to the fact that Iowa State already has existing facilities for the production of thermal utilities and thermal storage would directly compete with these utilities in a cost scenario.

2. In the event that the project does pursue some level of hybrid geothermal system a thermal storage solution may make economic sense to limit the size of the vertical borefield.

B. High Efficiency Modular Boilers

1. High efficiency modular boilers have been ruled out as a potential strategy at this time due in large part to the fact that Iowa State already has existing facilities for the production of thermal utilities.

C. Solar Thermal Reheat Hot Water

1. Although solar thermal systems could be implemented to address the reheat load of the ABE/BRL building the reheat demand will be of a scale that makes solar thermal infeasible.

2. The existing thermal utilities provided by the central plan boilers offer a much more cost effective strategy for addressing this building load.

D. Solar Photovoltaics

1. Solar photovoltaics continue to have efficiency issues which prohibit pay back ranges of less than 25 years without drastic incentives.

2. Solar photovoltaics could be implemented at a demonstration scale in the ABE/BRL buildings as glazing frit or other double-use components, but they do not currently offer a viable means of significant energy generation for any facility of more than several thousand square feet.

SECTION II.M.

PIPING SYSTEM

PIPING SYSTEMS

I. Base Design Criteria

A. Applicable Codes

1. The Piping Systems will be designed in accordance with the following Codes:
Uniform Plumbing Code, 2000 Edition.

II. System Descriptions

A. Storm and Clearwater Drainage

1. System Description

a) ABE Lab Building:

(1) A storm drainage system will be provided to convey rainwater from the roof of the building through BRL to a site retention device designed by Civil for storm reuse water. Overflow drainage will be accomplished an overflow drainage system. Clearwater waste from air handling units will be conveyed by gravity through a separate piping system and will connect to the storm sewer at the building drain.

(2) Fire Protection drain lines will be routed to the site retention device by a separate piping system for the water reuse system.

(3) If required by the Geotechnical Report, a subsoil drainage system will convey underslab groundwater exterior footing to a sump. The effluent will be pumped into the gravity building storm drainage system. Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

b) ABE Office Building:

(1) A storm drainage system will be provided to convey rainwater from the roof of the building through BRL to a site retention device designed by Civil for storm reuse water. Overflow drainage will be accomplished an overflow drainage system. Clearwater waste from air handling units will be conveyed by gravity through a separate piping system and will connect to the storm sewer at the building drain.

(2) Fire Protection drain lines will be routed to the site retention device by a separate piping system for the water reuse system.

(3) If required by the Geotechnical Report, a subsoil drainage system will convey underslab groundwater exterior footing to a sump. The effluent will be pumped into the gravity building storm drainage system. Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

c) BRL Building:

(1) A storm drainage system will be provided to convey rainwater from the roof of the building to a site retention device designed by Civil for storm reuse water. Overflow drainage will be accomplished an overflow drainage system. Clearwater waste from air handling units will be conveyed by gravity through a separate piping system and will connect to the storm sewer at the building drain.

(2) Fire Protection drain lines will be routed to the site retention device by a separate piping system for the water reuse system.

(3) If required by the Geotechnical Report, a subsoil drainage system will convey underslab groundwater exterior footing to a sump. The effluent will be pumped into the gravity building storm drainage system. Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

d) Parking Office:

(1) A storm drainage system will be provided to convey rainwater from the roof of the building to a site retention device designed by Civil for storm reuse water. Overflow drainage will be accomplished an overflow drainage system. Clearwater waste from air handling units will be conveyed by gravity through a separate piping system and will connect to the storm sewer at the building drain.

(2) Fire Protection drain lines will be routed to the site retention device by a separate piping system for the water reuse system.

(3) If required by the Geotechnical Report, a subsoil drainage system will convey underslab groundwater exterior footing to a sump. The effluent will be pumped into the gravity building storm drainage system. Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

2. Design Criteria

a) The storm drainage system will be sized based on a maximum rainfall rate of 3.5 in/hr, which corresponds to a 100 year return, 60 minute rainfall. All design and installation will be in accordance with the Uniform Plumbing Code.

3. Equipment and Material

a) Storm and subsoil drainage systems which cannot discharge to the storm sewer by gravity will be drained by gravity to duplex sump pumps and will be discharged into the building storm drainage system. Each sump pump will be sized for 100% of the estimated design flow.

b) Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

c) Storm reuse water used for irrigation will require distribution pumps.

d) Storm reuse water used for sewage conveyance in the building will require distribution pumps, filters, and sanitation treatment like chlorination or ozone.

4. Distribution

a) Below ground storm piping will be service weight hub-and-spigot cast iron pipe with neoprene push-on compression gaskets.

b) Above ground storm piping will be hubless cast iron pipe with heavy duty stainless steel couplings.

c) Roof drain bodies and above ground horizontal storm and clearwater waste piping will be insulated.

d) Duplex effluent pumps in fiberglass sumps will be used to pump clear water waste from the air handling units in the basement that cannot drain by gravity to the site storm sewer.

e) Subsoil drainage piping, if provided, will be polypropylene perforated piping with mechanical couplings.

f) Storm reuse water piping, if provided, will be copper type K tube underground and copper type L tube above ground with solder joints.

B. Storm Water Reuse System

1. System Description

a) ABE Lab Building:

(1) A storm water reuse system will be provided to supply storm and clear water waste from a site collection basin to the storm water reuse system in the ABE lab building.

(2) The storm water reuse system supplies water for irrigation.

b) ABE Office Building:

(1) A storm water reuse system will be provided to supply storm and clear water waste from a site collection basin to the storm water reuse system in the ABE office building.

(2) The storm water reuse system supplies water for irrigation, HVAC make-up and fixture flushing water.

c) BRL Building:

(1) A storm water reuse system will be provided to supply storm and clear water waste from a site collection basin to the storm water reuse system.

(2) The storm water reuse system supplies water for irrigation, cooling water for smaller reactors and fixture flushing water.

d) Parking Office:

(1) A storm water reuse system will be provided to supply storm and clear water waste from a site collection basin to the storm water reuse system.

(2) The storm water reuse system supplies water for irrigation and fixture flushing water.

2. Design Criteria

   a) The storm water reuse holding and distribution system will be sized for 1/2 day estimated system demand.

3. Equipment and Material

   a) The storm water reuse system will have a holding tank located inside the building. The water level in the tank will be controlled by level sensors inside the tank. When the level in the tank reaches the low set point, a valve is open to transfer water from the collection basin to the holding tank inside the building.

   b) Storm reuse water used for irrigation will require distribution pumps.

   c) Storm reuse water used for sewage conveyance in the building will require distribution pumps, filters, and ultra-violet (UV) light sanitation treatment.

   d) The tank will be supplied with a non-potable cold water back-up line for use when the water level in the site basin is too low.

4. Distribution

   a) Storm reuse water piping will be copper type K tube underground and copper type L tube above ground with solder joints.

   b) Each building will have its own distribution holding tank and system.

C. Sanitary Waste and Vent

1. System Description

   a) ABE Lab Building:

      (1) A sanitary waste and vent system will be provided for all fixtures in the building. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to 5 feet outside the building wall.

      (2) All fixtures will be trapped and vented to atmosphere. Vents will be extended through the roof.

      (3) The estimated sewer load is 90 gpm.

   b) ABE Office Building:

      (1) A sanitary waste and vent system will be provided for all fixtures in the building. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to 5 feet outside the building wall.

      (2) All fixtures will be trapped and vented to atmosphere. Vents will be extended through the roof.

      (3) The estimated sewer load is 80 gpm.

c) BRL Building:

(1) A sanitary waste and vent system will be provided for all fixtures in the building. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to 5 feet outside the building wall.

(2) All fixtures will be trapped and vented to atmosphere. Vents will be extended through the roof.

(3) The estimated sewer load is 90 gpm.

d) Parking Office:

(1) A sanitary waste and vent system will be provided for all fixtures in the building. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to 5 feet outside the building wall.

(2) All fixtures will be trapped and vented to atmosphere. Vents will be extended through the roof.

(3) The estimated sewer load is 50 gpm.

2. Design Criteria

a) The sanitary waste system will be designed to maintain a minimum velocity of 2 fps. The sanitary vent system will be designed so that the differential pressure at any point in the building does not exceed 1" water column. All design and installation will be in accordance with the Uniform Plumbing Code.

b) The buildings' sewer size is estimated to be:

BRL	6″ diameter
ABE Lab	6″ diameter
ABE Office	6″ diameter
Parking / Police	4″ diameter

3. Equipment and Material

a) Building drainage systems which cannot discharge to the sewer by gravity will be drained by gravity to duplex sewage ejectors and will be discharged into the sanitary waste drainage system.

b) Floor drains, floor sinks and indirect waste receptors will be provided with automatic trap primers when subject to loss of their trap seals due to evaporation.

c) Sewage ejectors will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

4. Distribution

a) Below ground sanitary waste and vent piping will be service weight hub-and-spigot cast iron pipe with neoprene push-on compression gaskets.

b) Above ground sanitary waste and vent piping will be hubless cast-iron pipe with heavy duty stainless steel couplings. Vent piping to be insulated 5′ from roof penetrations.

D. Water Service

1. System Description

a) ABE Lab Building:

(1) Water will be supplied to the ABE lab building from the RBL building mechanical room.

b) ABE Office Building:

(1) Water will be supplied to the ABE office building from the RBL building mechanical room.

c) BRL Building:

(1) Water will be supplied to the BRL building from the municipal water system.

(2) The water will be distributed to the ABE Lab and ABE Office buildings from the mechanical room.

(3) The BRL plus ABE Lab and ABE Office estimated water demand is 250 gpm.

(4) The estimated size of the water main for the BRL, ABE Lab, and ABE Office buildings is 4".

d) Parking Office:

(1) Water will be supplied to the Parking Office from the municipal water system.

(2) The Parking Office estimated water demand is 70 gpm.

(3) The estimated size of the water main for the Parking Office is 3".

2. Design Criteria

a) The water service will be designed to provide water to the building's fixtures and equipment at a minimum pressure of 15 psig. Maximum pressure will not exceed 80 psig and flow velocity will not exceed 8 fps.

3. Equipment and Material

a) A water meter will be provided on the BRL building entrance. The water meter will be sized for the combined buildings' maximum design flow.

b) The building's water system will be isolated from the municipal water system by a duplex reduced pressure backflow preventer located downstream of the water meter.

c) The water pressure on campus has been able to sustain the required pressures of the current buildings needs. If it is determined, after the results of a flow test, that the water pressure is not high enough to meet the required pressures, a duplex water pressure booster pump system will be provided. The booster pump system will be modular and configured such the system is capable of 100% of the total design flow with the loss of the largest pump. Additional pumps will be installed in BRL to support the flow for the ABE building.

4. Distribution

a) The water service main to the building will be ductile iron with restrained mechanical joints. Inside the building and at the water service entrance, the piping will be Type L copper tube with wrought copper fittings and soldered joints. The solder will be lead-free, 95-5 type solder.

E. Domestic Water

1. System Description

a) ABE Lab Building:

(1) Domestic water will be provided to all toilet room fixtures, electric water coolers, break room sinks, emergency shower/eyewash, and any other devices and fixture that require domestic water supply.

(2) Hot water at 120°F will be supplied from the water heaters in the BRL mechanical room and provided to all fixtures and equipment requiring hot water. The emergency fixtures (showers and eyewashes) will be supplied with tepid water from the potable water system.

(3) The domestic water load is estimated to be 20 gpm.

b) ABE Office Building:

(1) Domestic water will be provided to all toilet room fixtures, electric water coolers, break room sinks, and any other devices and fixture that require domestic water supply.

(2) Hot water at 120°F will be supplied by the water heaters in the BRL mechanical room and provided to all fixtures and equipment requiring hot water.

(3) The domestic water load is estimated to be 100 gpm.

c) BRL Building:

(1) Domestic water will be provided to all toilet room fixtures, electric water coolers, break room sinks, emergency shower/eyewash, and any other devices and fixture that require domestic water supply.

(2) Hot water at 120°F will be provided to all fixtures and equipment requiring hot water. The emergency fixtures (showers and eyewashes) will be supplied with tepid water from the potable water system.

(3) The domestic water load is estimated to be 55 gpm.

d) Parking Office:

(1) Domestic water will be provided to all toilet room fixtures, electric water coolers, break room sinks, and any other devices and fixture that require domestic water supply.

(2) Hot water at 120°F will be supplied from water heaters in the Parking Office mechanical room and provided to all fixtures and equipment requiring hot water.

(3) The domestic water load is estimated to be 70 gpm.

2. Design Criteria

a) The piping will be sized to limit the velocity in any section of the system to a maximum of 8 fps for cold water system and 4 fps for hot water systems. Piping will be designed and installed in accordance with the Uniform Plumbing Code.

b) Each water heater will be sized for 100% of the design hot water load.

3. Equipment and Material

a) Domestic hot water will be produced by a simplex, steam-fired, semi-instantaneous water heater for each building. Tube bundles will be double walled as required by Code. Remote fixtures will be provided hot water by electric instantaneous water heaters. Booster water heaters will be provided on equipment, (dishwashers, laundries, etc.) which has water temperature requirements above the normal distribution temperature.

b) The hot water system temperature will be maintained by recirculating the hot water through a continuous loop with an in-line circulating pump.

c) Duplex alternating water softeners will be installed ahead of the water heaters. They will also supply the lab water heaters. This will aid in the longevity of the water heaters.

d) Water hammer arrestors will be provided at all solenoid valves and at other potential water hammer sources.

e) Tepid water to emergency fixtures will be provided by, a master thermostatic mixing valve with cold water bypass device.

4. Distribution

a) The domestic hot and cold water systems will be Type L copper tube with wrought copper fittings and soldered joints. Solder will be lead-free, 95-5 type solder.

b) The hot water system will be insulated in accordance with Code. The cold water system will be insulated to prevent condensation from forming and damaging adjacent equipment and finishes.

c) Isolation valves will be provided at all riser connections, branch piping run-outs to fixture groups, and at equipment requiring maintenance.

d) Each building will have its own distribution main. The isolation valve will be located in BRL mechanical room.

F. Laboratory Water System

1. System Description

a) ABE Lab Building:

(1) Laboratory water will be provided to all fixtures and equipment located in the laboratory and support areas.

(2) Hot water at 120°F will be provided to all fixtures and equipment requiring hot water from the water heaters in the BRL building mechanical room.

(3) The ABE Lab building's laboratory water main isolation valves will be located in the BRL building mechanical room.

(4) The estimated laboratory water load is 50 gpm.

b) BRL Building:

(1) Laboratory water will be provided to all fixtures and equipment located in the laboratory and support areas.

(2) Hot water at 120°F will be provided to all fixtures and equipment requiring hot water from the water heaters in the BRL building mechanical room.

(3) The estimated laboratory water load is 50 gpm.

2. Design Criteria

a) The piping will be sized to limit the velocity in any section of the system to a maximum of 8 fps for cold water system and 4 fps for hot water systems. Piping will be designed and installed in accordance with the Uniform Plumbing Code.

b) Each water heater will be sized for 75% of the design hot water load.

3. Equipment and Material

a) The laboratory water system will be isolated from the domestic water system by reduced pressure backflow preventers.

b) Laboratory hot water will be produced by duplex steam-fired, instantaneous heat exchanger-type water heaters located in the BRL building mechanical room. Tube bundles will be single walled.

c) The hot water system temperature will be maintained by recirculating the hot water through a continuous loop with an in-line circulating pump.

d) Soft water will be supplied to the water heaters.

e) Water hammer arrestors will be provided at all solenoid valves and at other potential water hammer sources.

4. Distribution

a) The laboratory hot and cold water systems will be Type L copper tube with wrought copper fittings and soldered joints. Solder will be lead-free, 95-5 type solder.

b) The hot water system will be insulated in accordance with Code. The cold water system will be insulated to prevent condensation from forming and damaging adjacent equipment and finishes.

c) Isolation valves will be provided at all riser connections, branch piping run-outs to fixture groups, and at equipment requiring maintenance.

d) Each building will have its own distribution main. The isolation valve will be located in BRL mechanical room.

G. Non-Potable Water Systems

1. System Description

a) BRL Building:

(1) Non-potable water system will provide make-up water to the storm water reuse system.

2. Design Criteria

a) The piping will be sized to limit the velocity in any section of the system to a maximum of 8 fps. A reduced pressure backflow preventer will protect the domestic water supply and will be sized for 60% of the design load.

3. Equipment and Material

a) Water hammer arrestors will be provided at all solenoid valves and at other potential water hammer sources.

4. Distribution

a) The non-potable water system will be Type L copper tube with wrought copper fittings and soldered joints. Solder will be lead-free, 95-5 type solder.

b) The non-potable water system will be insulated to prevent condensation from forming and damaging adjacent equipment and finishes.

c) Isolation valves will be provided at all riser connections, branch piping run-outs to fixture groups, and at equipment requiring maintenance.

H. High Purity Water

1. System Description

a) ABE Lab Building:

(1) A smaller localized system will be provided in the glass wash area to produce and distribute water meeting the quality requirements of deionized water.

(2) This system will not be validated.

(3) Pure water will be continuously circulated in closed loop to the glass wash equipment.

(4) A pure water storage tank will be provided to ensure that water is available for distribution in the event that the production system is shut down.

b) BRL Building:

(1) A smaller localized system will be provided per floor to produce and distribute water meeting the quality requirements of deionized water.

(2) Production equipment will reside inside a laboratory module located on the floor it serves.

(3) This system will not be validated.

(4) Pure water will be continuously circulated in closed loops to users on the floor.

(5) A pure water storage tank will be provided to ensure that water is available for distribution in the event that the production system is shut down.

(6) For use points that require a higher level of quality water, point of use polishing units will be provided.

(7) The capacity of the production system is estimated at 2 gpm.

2. Design Criteria

a) The system design will be based on performing sanitation using peracetic acid solutions.

b) The capacity of the production equipment and the storage tank will be based on the programmed use points and the following consumption estimates:

Sinks:	15 gallons per day each
Glass washers:	10 gallons per wash cycle 2 wash cycles per day per washer 20 gallons per day each
Polishers:	1 gallons per day each

c) The production equipment shall be sized to produce the total estimated consumption in 8 hours of operation

d) The storage tank will be sized to provide storage for 10 hours of estimated usage. The size of the storage tanks are estimated to be 350 Liters.

e) The distribution system will be designed to continuously circulate water at a velocity of 4-6 feet per second under no demand conditions, and a minimum velocity corresponding to a Reynolds number of 20,000 under maximum demand conditions. The maximum demand for the distribution system shall be based on the following demand rates and 50% diversity factor:

Sinks:	1.0 gpm per outlet
Glass washers:	10 gpm per washer

f) The distribution system will be designed to maintain the temperature of the water under 80°F.

g) Reserve Capacity and Redundancy

(1) The storage tank provides reserve capacity of 10 hours in the event of production system failure.

3. Equipment and Material

a) The production equipment is anticipated to consist of a prefilter, multimedia filter, carbon filter, single RO unit, two-bed deionization exchange cylinders, mixed bed deionization exchange cylinders, a one micron post filter, a 185 nm ultraviolet light, and a 0.2 micron final filter.

b) The distribution system equipment will include centrifugal pump(s) to provide circulation and 254 nm UV lights followed by 0.2 micron filters to control bacterial growth.

c) Materials in contact with pure water will be:

Equipment: 316L stainless steel polished to 25 Ra
Storage tank: vinyl ester, steam-cured fiberglass.
Piping: high purity polypropylene.
Elastomers: Viton

4. Distribution

a) The distribution system will be comprised of three loops in BRL and one loop in ABE through which water will be continuously circulated. Each distribution loop will employ a series loop layout. The loops will drop to each use point location and a zero static tee diaphragm valve will be provided.

b) Polypropylene piping will be used for the distribution system. Joints will be made by socket heat fusion. Tri-clamps or sanitary unions will be used where breakable connections are required. Piping will be continuously supported.

c) All tee connections shall be installed to minimize the dead leg. The distance from the sealing point on the branch to the inside of the main line wall shall be less than six (6) branch line diameters.

d) Piping will be installed so that it is completely free draining. A minimum slope of 1/8 inch per foot will be maintained.

e) Sink use points shall be a use point valve over the sink. Pipe loop drops within the room will be enclosed.

f) The quality of the water in the distribution system will be monitored by the PLC that will send a discrete alarm signal to the Building Management System in the event of deviations.

I. Laboratory Compressed Air

1. System Description

a) ABE Lab Building:

(1) Laboratory grade compressed air will be provided to all laboratory areas at a pressure of 90 psig and a dewpoint of -40°F or lower as required. Compressed air will be provided as required by duplex expandable oil-free air compressors.

(2) The laboratory compressed air equipment will be supplied from the equipment located in the BRL building mechanical room.

(3) ABE laboratory compressed air main isolation valve will be located in the BRL Building mechanical room.

b) BRL Building:

(1) Laboratory grade compressed air will be provided to all laboratory areas at a pressure of 90 psig and a dewpoint of -40°F or lower as required. Compressed air will be provided as required by duplex expandable oil-free air compressors.

(2) The laboratory compressed air equipment will be located in the BRL building basement and distribute to the BRL and ABE Lab Buildings.

2. Design Criteria

a) Compressed air piping system will be sized based on 1 scfm per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2
Compressed Air System Diversity Factors

Number of Outlets	Diversity Factor	Minimum Flow (scfm)	Empirical Formula for Flowrate (scfm)
1-5	1.00	0	No. of Outlets*1
6-12	0.80	5	5+(No. of Outlets-5)*5/7
13-33	0.60	10	10+(No. of Outlets-12)*10/21
34-80	0.50	20	20+(No. of Outlets-33)*20/47
81-150	0.40	40	40+(No. of Outlets-80)*20/70
151-315	0.35	60	60+(No. of Outlets-150)*50/165
316-565	0.30	110	110+(No. of Outlets-315)*60/250
566 and up	0.25	170	170+(No. of Outlets-565)*80/435

b) The piping system will be sized to limit pressure drop across the system to maximum of 10% of pressure regulator outlet pressure.

c) The air compressors will be controlled by pressure switches in receiver set to operate between 90 and 105 psig. Each compressor will be sized for 60% of the maximum total demand.

3. Equipment and Material

a) The campus laboratory grade compressed air system will be supplied by a duplex, oil-free, rotary screw air compressor for each building. The system is to be modular. Additional compressors can be installed in BRL when ABE is constructed. The compressor will be base mounted. Air will be treated with coalescing filters, charcoal filters and particulate filters and dried with duplex heatless desiccant air dryers. Compressed air will be stored in an ASME rated vertical receiver with outlet pressure regulator.

b) A pressure regulator will be supplied for floor areas requiring lower pressure laboratory compressed air.

4. Distribution

a) Compressed air piping system will be ASTM B88 Type L, hard temper copper piping with solder joints.

b) Each building will have its own distribution main. The isolation valve will be located in BRL mechanical room.

J. Natural Gas

1. Description

a) ABE Lab Building:

(1) Natural gas is anticipated to be piped to equipment (ex: boilers, water heaters) as required to meet building needs. Gas pressure will be determined based on equipment requirements. Natural gas is anticipated to be a centrally piped and distributed system to serve lab and fume hood gas outlets. Natural gas will be extended to the building from the gas company's natural gas main in the street. It is anticipated that the gas meter will be located at grade at the service entrance to the building.

b) BRL Building:

(1) Natural gas is anticipated to be piped to equipment (ex: boilers, water heaters) as required to meet building needs. Gas pressure will be determined based on equipment requirements. Natural gas is anticipated to be a centrally piped and distributed system to serve lab and fume hood gas outlets. Natural gas will be extended to the building from the gas company's natural gas main in the street. It is anticipated that the gas meter will be located at grade at the service entrance to the building.

2. Design Criteria

a) All design and installation will be in accordance with the Uniform Plumbing Code.

b) Natural gas will be supplied at a pressure of 7" water column. The piping will be sized to limit the pressure drop across the system to 0.5" water column.

c) Natural gas shutoff valves will be located at the main exit of the lab in a recessed wall valve box at 4'-6" above finished floor.

d) Natural gas piping system will be sized based on 5 cfh per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2
Natural Gas System Diversity Factors

Number of Inlets	Diversity Factor	Minimum Flow (cfh)	Empirical Formula for Flowrate (cfh)
1-5	1.00	0	No. of Inlets*5
6-12	0.80	5	(5+(No. of Inlets-5)*5/7)*5
13-33	0.60	50	(10+(No. of Inlets-12)*10/21)*5
34-80	0.50	100	(20+(No. of Inlets-33)*20/47)*5
81-150	0.40	200	(40+(No. of Inlets-80)*20/70)*5
151-315	0.35	300	(60+(No. of Inlets-150)*50/165)*5

3. Equipment and Material

a) Natural gas meter and building pressure regulating valves will be provided by and in accordance with gas utility company requirements.

b) Where shutoff valves are installed in valve boxes, the valve boxes will be steel frames with steel doors, piano hinges and level latches. All pipe penetrations through the box walls will be sealed.

c) Point of use pressure regulators will be self-operated spring-loaded constant pressure valves with internal relief capability.

4. Distribution

a) In exposed spaces, natural gas piping 2" and smaller will be Schedule 40 black steel pipe with malleable iron threaded fittings. Natural gas piping 2-1/2" and larger will be Schedule 40 black steel pipe with butt welded fittings.

b) In concealed spaces, natural gas piping 2" and smaller will be Schedule 40 black steel pipe with socket welded fittings. Natural gas piping 2-1/2" and larger will be Schedule 40 black steel pipe with butt welded fittings.

c) Natural gas valves 2-1/2" and smaller will be two-piece ball valves with bronze bodies and stainless steel balls. Valves 3" and larger will be plug valves with cast iron bodies.

d) Each building will have its own distribution main. The isolation valve will be located in BRL mechanical room.

e) Each room being served will have its own natural gas safety shut-off valve assembly at room exit.

SECTION II.N.

FIRE PROTECTION SYSTEM

FIRE PROTECTION SYSTEMS

I. Base Design Criteria

A. Applicable Codes, Guidelines and Standards:

1. The Fire Protection Systems will be designed in accordance with the following Codes, Guidelines and Standards:

a) NFPA 13, Installation of Sprinkler Systems

b) NFPA 14, Installation of Standpipe, Private Hydrant and Hose Systems

c) NFPA 30, Flammable and Combustible Liquids Code

d) NFPA 45, Fire Protection for Laboratories Using Chemicals

e) NFPA 101, Life Safety Code

f) Iowa State University (ISU) Facilities Planning and Management (FP&M) Design Guidelines and Standards

g) City of Ames Fire Code

h) International Building Code

i) Factory Mutual Global Requirements

II. System Descriptions

A. Fire Service

1. System Description

a) The fire protection will be a combined service brought in the ABE building with the domestic water.

b) The fire protection will be a combined service brought in the BRL building with the domestic water.

c) The fire protection will be a combined service brought in the Campus Police Offices with the domestic water.

B. Fire Pump

1. System Description

a) There will be no fire pump for the ABE building.

b) There will be no fire pump for the BRL building.

c) There will be no fire pump for the Campus Police Offices.

C. Standpipe System

1. System Description

a) The ABE building will be protected by a manual wet, Class I Standpipe System without hoses or hose cabinets.

b) The BRL building will be protected by a manual wet, Class I Standpipe System without hoses or hose cabinets.

c) The Parking structure will be protected by a manual dry, Class I Standpipe System without hoses or hose cabinets.

2. Equipment and Material

a) The standpipe system piping will be black steel piping.

b) Piping will Schedule 40 with shop welded or cut groove couplings.

c) Fire Department Connection (FDC) - The fire department connection will consist of 2-1/2" inlets with drop clappers, snoots, caps and chains.

d) A check valve will prevent flow from the fire protection system to the fire department connection.

e) An automatic ball drip valve will be installed between the check valve and the fire department connection to allow any minor leakage past the check valve to drain out of the system.

f) The fire department connection location will be coordinated with the Local Fire Department and Project Architect.

g) Typically, the design will require a fire hydrant within 100 feet of the FDC.

3. Distribution

a) Standpipe risers within a standpipe system, shall be interconnected.

b) A 2-1/2" fire department valve will be provided on the stair's floor landings.

c) Additional fire department valves will be provided, on the roof and at other locations as required by Code or the Local Authority.

d) All roof fire department valves will be protected from freezing with shutoff valves located inside the thermal envelope of the building.

D. Wet Pipe Sprinkler System

1. System Description

a) The ABE building will be protected throughout with hydraulically calculated sprinkler systems, which except for special protection needs, will be wet pipe systems. All areas of the building will be protected per NFPA 13, including electrical rooms (switchgear, transformers, generators, closets, etc.), loading docks, stair towers, exterior canopies, and mechanical rooms.

b) The BRL building will be protected throughout with hydraulically calculated sprinkler systems, which except for special protection needs, will be wet pipe systems. All areas of the building will be protected per NFPA 13, including electrical rooms (switchgear, transformers, generators, closets, etc.), loading docks, stair towers, exterior canopies, and mechanical rooms.

c) The Campus Police Offices will be protected throughout with hydraulically calculated sprinkler systems, which except for special protection needs, will be wet pipe systems. All areas of the building will be protected per NFPA 13, including electrical rooms (switchgear, transformers, generators, closets, etc.), loading docks, stair towers, exterior canopies, and mechanical rooms.

2. Design Criteria

a) The sprinkler system for the building will be designed and installed in accordance with Factory Mutual Global Property Loss Prevention Data Sheets and NFPA 13.

b) Sprinkler design densities will originate from the FM Global Property Loss Prevention Data Sheets. All systems will be hydraulically calculated with a computer calculation program using the Hazen-Williams method.

c) The pipe sizing for the systems will be as required to satisfy the hydraulic demand,

3. Equipment and Material

a) The piping for the wet pipe sprinkler system will be black steel.

b) Piping 2" and smaller in size will be Schedule 40 with threaded joints.

c) Piping larger than 2" will be Schedule 40 with shop welded, threaded, or cut groove couplings.

d) All sprinklers in Light Hazard areas will be quick response type.

e) The type of sprinkler used in a particular area will be selected by, the Engineer of Record and the Architect. Generally, concealed sprinklers will be installed in areas of high visibility and quality of finishes. Recessed sprinklers will be installed in other areas having suspended ceilings. Pendent or upright sprinklers will be installed in areas without ceilings. Sidewall sprinklers will be used only when other types cannot be used.

f) Areas subject to temperatures below 40°F will be protected by, dry-type sprinklers when possible. If dry-type sprinklers cannot be used, a dry pipe system will be installed. Glycol antifreeze system will not be used.

4. Distribution

a) The sprinkler system will be provided throughout the building in accordance with NFPA 13 and Factory Mutual requirements.

E. Dry Pipe Sprinkler System

1. System Description

a) Areas of the building subject to temperatures below 40°F will be protected by a dry pipe sprinkler system.

b) The parking structure will be protected throughout with hydraulically calculated dry pipe sprinkler system. All areas that are located below grade or classified as enclosed shall be protected.

2. Design Criteria

a) The dry pipe sprinkler system will be designed and installed in accordance with Factory Mutual Global Property Loss Prevention Data Sheets and NFPA 13

b) All systems will be hydraulically calculated with a computer calculation program using the Hazen-Williams method.

c) Sprinkler design densities will originate from the FM Global Property Loss Prevention Data Sheets. All systems will be hydraulically calculated with a computer calculation program using the Hazen-Williams method.

d) The pipe sizing for the systems will be as required to satisfy the hydraulic demand.

3. Equipment and Material

a) Piping for the dry pipe system will be galvanized steel.

b) Piping will be Schedule 40 with shop welded, threaded, or cut groove couplings.

c) All sprinklers in Light Hazard areas will be quick response type. Sprinklers on dry pipe systems will be either upright type or dry pendent type, depending upon the actual installation method.

d) A UL Listed dry pipe valve with trim will be used.

4. Distribution

a) The sprinkler system will be provided throughout the building in accordance with NFPA 13 and Factory Mutual Requirements.

SECTION II.O.

ELECTRICAL SYSTEMS

ELECTRICAL SYSTEMS

I. Base Design Criteria

A. Applicable Codes

1. The Electrical Systems will be designed in accordance with the following Codes:

a) State of Iowa Building Code

b) IEEEInstitute of Electrical and Electronics Engineers

c) IESNA Illuminating Engineering Society of North America

d) NEC 2005 National Electrical Code

e) NECA National Electrical Contractors Association

f) NEMA National Electrical Manufacturers Association

g) UL Underwriters Laboratories

h) NFPA 70, 72, 101, 110, 780

B. Applicable Guidelines and Standards

1. The Electrical Systems will be designed in accordance with appropriate portions of the following Guidelines and Standards.

a) Iowa State University (ISU) Facilities Planning and Management (FP&M) Design Guidelines and Standards

b) ADA, Americans with Disabilities Act Accessibility Guidelines

C. Load Calculation Criteria

1.

Functional Area	Load Density (VA/sq ft)
Office Receptacle	4.0
Lighting	1.5
Lab	12.0
Lab Support	30.0
General Receptacle	2.0
Engine Test Cell	10.0

D. Equipment Sizing Criteria

1. Secondary Design Voltages (BRL/ABE/Parking Structure)

Motors larger than 1/2 HP	480V, 3 phase, 3 wire
General Lighting	277V, 1 phase, 3 wire
Lab Support Equipment	
Specialty Equipment	208Y/120V, 3 phase, 4 wire
Receptacles, Motors less than 1/2 HP, and Specialty Lighting	120V, 1 phase, 3 wire

2. Secondary Design Voltages (Parking/Campus Police Administration)

Motors larger than 1/2 HP	208V, 3 phase, 3 wire
General Lighting	120V, 1 phase, 3 wire
Specialty Equipment	208Y/120V, 3 phase, 4 wire
Receptacles, Motors less than 1/2 HP, and Specialty Lighting	120V, 1 phase, 3 wire

E. Equipment Sizing Criteria

1. Diversity Factor

a) A diversity factor will be used in establishing power service, feeder and equipment capacities.

b) The diversity factor represents the ratio of the sum of the individual non-coincident maximum demands of various subdivisions of the system to the maximum demand of the complete system and will be established using historical data from similar buildings in conjunction with industry standards.

2. Equipment Sizing Criteria

a) 25% spare electrical capacity (amperes) to accommodate functional changes over the life of the building will be included in the design of the power distribution system.

b) Power distribution equipment will be sized to include about 20% spare circuit breakers plus space for 20% future circuit breakers.

c) Unused wall space will be provided in main electrical rooms and other spaces to allow for the installation of equipment in the future. A target of 40% will be used as the basis of design and will be adjusted as the building constants become defined.

3. Feeder Sizes

a) Secondary distribution and branch circuit system design will be based on a maximum of 5% voltage drop from the power service connection point to the utilization equipment.

b) Neutral conductors derived from K4 rated transformers will be capable of carrying 150% of normal phase current from transformer to first distribution board. Neutral conductors from distribution board to panels that serve point of use loads are not anticipated to be increased in size at this time.

4. Power Factor Correction

a) Power factor correction will be considered in the design of the power distribution system to bring the calculated power factor to 85% or better.

b) Preliminary calculations indicate the power factor to be greater than 89% without corrective measures.

c) Power factor correction is not anticipated at this time.

5. Fault Current

a) Short circuit withstand and interrupting ratings shall be provided for electrical distribution equipment, feeder conductors, etc based upon the available fault current at the point of service, which is not available at this time.

b) Equipment shall have ratings not less than the short circuit ratings available from the power sources.

c) Equipment shall be fully rated for the calculated available short circuit. Series ratings will not be allowed.

6. Overcurrent Protective Coordination

a) Overcurrent protective devices shall be selectively coordinated with supply side overcurrent protective devices.

7. Service Capacity (preliminary estimate)

a) Building service and distribution equipment sizes will be based on estimated maximum demand plus known or reasonable anticipated future loads. Estimated maximum demand calculations will utilize appropriate code demand factors, diversity factors and historical data.

b) The anticipated total demand load of the building, including future expansion and spare capacity, is shown in the following building summaries. It is anticipated that these loads will be reduced as the design of the building evolves and the building diversity factor is validated:

(1) Agricultural and Biosystems Engineering (ABE)

The total capacity of the service entrance switchboard will be 1500 kVA. The anticipated total connected load in the building, plus 25% future capacity, is approximately 1232 kVA, based on VA/sq ft projected loads. Transformer size shall be verified with ISU FP&M.

(2) Biorenewables Research Laboratory (BRL):

The total capacity of the service entrance switchboard will be 750 kVA. The anticipated total connected load in the building, plus 25% future capacity, is approximately 569 kVA, based on VA/sq ft projected loads. Transformer size shall be verified with ISU FP&M.

(3) Parking Administration Building

The total capacity of the service entrance switchboard will be 75 kVA. The anticipated total connected load in the building, plus 25% future capacity, is approximately 52 kVA, based on VA/sq ft projected loads. Transformer size shall be verified with ISU FP&M.

(4) Campus Police Administration Building

The total capacity of the service entrance switchboard will be 75 kVA. The anticipated total connected load in the building, plus 25% future capacity, is approximately 52 kVA, based on VA/sq ft projected loads. Transformer size shall be verified with ISU FP&M.

(5) Parking Structure

The total capacity of the service entrance switchboard will be 150 kVA. The anticipated total connected load in the building, plus 25% future capacity, is approximately 105 kVA, based on VA/sq ft projected loads. Transformer size shall be verified with ISU FP&M.

8. Branch Circuit Load Calculations

a) Lighting	Actual Installed VA
b) Receptacles	180 VA per outlet
c) Multiple Outlet Assemblies	180 VA per 2'-0"
d) Special Outlets	Actual installed VA of equipment served
e) Motors	125% of Motor VA

9. Demand Factors

a) Lighting	125% of installed VA
b) Receptacles	100% of first 10 kVA installed plus 50% of balance
c) Motors	125% of VA of largest motor plus 100% of VA of all other motors
d) Fixed Equipment	100% of total VA installed

10. Minimum Bus Sizes

a) 480Y/277V Lighting Panels	100A
b) 480V Equipment Panels	225A
c) 208Y/120V Equipment Panels	225A
d) 208Y/120V General Receptacle Panels	100A
e) 480V Motor Control Center	600A

II. System Descriptions

A. Electric Service

1. System Description

a) Primary electric service for the buildings on site will be derived from the 4,160 volt ISU campus utility grid via two underground feeders from two separate campus substations.

b) The medium voltage feeds will split at underground switchgear and terminate at each individual building's fusible load interrupter switchgear.

c) The switchgear is the primary disconnect for the building transformer, where the voltage will be stepped down to either 480Y/277V or 208Y/120V and routed into the building.

2. Design Criteria

a) The primary system service capacities for each building will be designed to serve the calculated connected load of each facility plus an additional 25% for anticipated future loads.

b) The electrical distribution system shall meet the requirements of the International Building Code and National Electrical Code.

3. Equipment and Material

a) Each campus substation will require an additional S&C medium voltage fusible interrupter switchgear section to be installed adjacent to the existing S&C switchgear.

b) Spare underground medium voltage conduits exist from the EE Substation to the southeast corner of the construction site. Additional underground conduits need to be installed from this point to where the buildings' transformers will be located on the building complex construction site.

c) Additional underground conduits need to be installed from the Pearson Substation to the where buildings' transformers will be located.

d) Underground switchgear located in a vault(s) along each underground conduit pathway, will allow cross ties to other existing underground cables. Each underground switchgear is only allowed to feed a maximum of two (2) buildings. Locations of the vaults will need to be determined with ISU FP&M.

e) Depending on the building and service size, the transformers will either be oil filled, or dry type.

f) Outdoor, biodegradable-oil filled transformers will be furnished by ISU and installed by the contractor.

g) Indoor, dry-type transformers will be furnished and installed by the contractor.

h) Each building main service entrance switchboard will either be a separate enclosure or a unitized package substation, depending on the specific building.

i) The main building transformer installation location options, as preferred by ISU FP&M, are listed in order of preference:

(1) Outdoor, on grade, oil filled, located close to the building it serves.

(2) Indoor, dry-type, in main electrical room.

(3) Outdoor, oil filled, in below grade vault.

4. Distribution

a) One medium voltage service will be routed underground from the EE Substation located south of Coover Hall, and the other medium voltage service will be routed underground from the Pearson Substation located east of Black Engineering.

b) Underground switchgear will distribute each medium voltage feeder into electrical services for each new building. The switches will be looped to other existing or new switches, while the buildings will be radial feed.

c) Each building will have its own transformer, fed from the underground utility switchgear. The transformers will step the voltage down from 4,160V to either 480Y/277V or 208Y/120V, and feed an indoor main switchboard in each building.

B. Normal Power Services and Distribution

1. System Description: Biorenewables Research Laboratory (BRL)

a) Secondary electric service at 480Y/277 volts will be provided from the utility outdoor biodegradable-oil filled transformer and routed underground into the building to a main service switchboard.

b) Building distribution shall be provided at 480Y/277V from the main switchboard to the distribution panelboards and to mechanical equipment via motor control centers. Floor mounted dry-type distribution transformers shall be installed in the main electrical room as required and provide voltage transformation to 208Y/120V distribution panels. The distribution panels will feed local receptacle panels, mechanical equipment panels, and laboratory panels.

c) Laboratories shall have an individual recessed wall or column mounted circuit breaker panelboard located within the labs they serve.

d) Motor control centers serving mechanical equipment shall be located in an area close to the loads they are serving.

e) A central, Uninterruptible Power Supply (UPS) system or power conditioning system are not planned to be designed for installation.

2. Design Criteria

a) No electrical equipment subject to failure will be installed in any location that would require excavation or building modification in order to replace such equipment.

b) Conduit and Raceways

(1) Conduit will be run concealed, unless in mechanical rooms.

(2) Minimum conduits size will be 3/4".

(3) Conduits will be independently supported.

(4) Conduits under slab and in areas subject to abuse will be rigid galvanized steel with threaded fitting or be rigid PVC conduit encased in 3" of steel reinforced concrete with dye identification.

(5) Conduit installation in concrete slabs shall be prohibited.

(6) Surface conduit run below switch height shall be rigid steel. Surface boxes as switch height or below shall be cast steel type.

(7) Rigid conduit will be used in exterior locations.

(8) EMT fittings used on conduit sizes 2 1/2" and smaller will be compression type.

(9) Branch circuit conduits will not be installed in floor slabs or below floor slabs on grade.

(10) Unbroken conduit runs will not exceed 100 feet. Back-to-back 90 degree bends will not be allowed.

(11) Conduits and boxes will be installed a minimum of 1'-0" and a maximum of 3'-0" above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed accessible from floor using a standard 8 foot ladder and light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling can be serviced and maintained without damage to ceiling tiles and other building elements.

(12) No horizontal conduit runs through wall will be allowed.

(13) For lighting conduit homeruns a junction box shall be located above light fixture in an accessible location to allow for future expansion.

(14) No home run shall terminate in a wall mounted device box. A separate junction box shall be provided above device box above ceiling in an accessible location.

c) Wire and Cable

(1) All wiring will be 98% conductivity copper.

(2) 600 V cable will be THWN-2 or XHHW-2.

(3) Conductors shall be stranded.

(4) Conductor size shall be adjusted to compensate for voltage drop in circuit do to length as follows:

208Y/120 volt circuits over 100 ft in length: Increase wire size one size for each 100 ft of length.

480Y/277 volt circuits over 150 ft in length: Increase wire size one size for each 150 ft of length.

(5) Conductor insulation color code shall be as follows:

208Y/120 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white, ground conductor-green.

480Y/277 volt, 3 phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray, ground conductor-green.

d) Wiring Devices

(1) Receptacles and switches connected to emergency power will be red in color.

(2) Receptacles and switches connected to normal power will be in color selected by the architect.

(3) Receptacle and switch cover plates will be stainless steel No. 430 in non-corrosive locations and No. 302 in corrosive areas including all laboratories.

(4) Receptacles will be Specification Grade.

(5) Receptacles, switches, etc., will have faceplate labeling indicating system panel and circuit identification.

e) Motors and Motor Control

(1) Stand-alone motor disconnects (separate from starter) will be fused and will be installed at each motor.

(2) For the delayed loading of generator, time delay relays will be used in motor starter to sequence the restarting of large motors.

(3) Combination motor starters will use fuses.

(4) Motor control centers will be used if two or more starters are needed in the same room. MCCs shall be designed and specified to contain at least 25% spare size-one spaces.

f) Transformers

(1) Transformers will comply with the energy code minimum efficiencies and be Energy Star listed.

(2) Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case. External vibration isolation pads will also be used.

g) Distribution and Branch Panelboards

(1) Panels, with the exception of laboratory, high bay, and manufacturing areas, will be located in dedicated electrical rooms or closets.

(2) Panelboards will contain 20% spare circuit breakers plus 20% branch circuit breaker bussed spaces for future use.

(3) Main circuit breakers will be provided for those distribution and branch panelboards which are not located in the same room as their feeder disconnect or breaker.

h) Circuit Breakers and Fuses

(1) Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist. Circuit breakers 800 amps and greater will be UL listed for applications at 100% of their continuous ampere rating in their intended enclosure.

(2) Fuses will be RK5.

i) EMF and Harmonics

(1) Generally, electrical vaults and major electrical equipment rooms containing transformers larger than 300 kVA will not be located adjacent to normally occupied workstations.

(2) In areas with large amounts of high-harmonic loads, steps to reduce the effect of harmonic will be considered. Steps will include using separate circuits, restricting the number of receptacles per circuit, over sizing panelboard neutral buses and feeder neutral conductors and installing isolation transformers, K-rated transformers, harmonic filters or other such equipment.

j) Prohibited Materials and Construction Practices

(1) Extra-flexible non-labeled conduit.

(2) Conduit installation in concrete slabs.

(3) Conduit less than 3/4” diameter, unless allowed in certain installations.

(4) Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors. The transition form PVC to steel will be made below the floor.

(5) Aluminum wiring.

(6) Aluminum bus.

(7) Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible.

(8) Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels will be hung from trapeze suspension systems.

(9) Wire ties to support conduit.

(10) Wood strips and wood screws to support lighting fixtures.

(11) Class J fuses.

(12) Direct burial electrical cable.

(13) Ducts within 5' of a buried steam line in any direction.

(14) Armored cable (AC, BX, MC, etc.).

(15) Nonmetallic sheathed cable.

(16) Flat conductor cable type FCC, under carpet, etc.

(17) Switches in which the blades pivot on the top.

(18) Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

(19) IEC listed equipment.

3. Equipment and Material

a) Acceptable equipment manufacturers:

(1) Square D

(2) General Electric

(3) Cutler Hammer

b) The 750 kVA medium voltage utility transformer will be located on the exterior of the building and will feed the building service entrance switchboard inside the building in the main electrical room. The switchboard will be rated at 480Y/277V, 1200A, 3-phase, 4-wire and contain group mounted circuit breakers. The switchboard shall consist of one main breaker with 1200A trip rating and distribution feeder breakers. All breakers will have electronic trip modules (LSI protection) and ground fault protection.

c) The switchboard will contain a digital power meter, capable of recording voltage, amperage, power factor, demand, and historical energy usage. ISU will install a separate KWH meter in a socket located adjacent to the medium voltage switchgear, or the main distribution switchboard. A Transient Voltage Surge Suppression (TVSS) unit will be furnished inside the main switchboard, and will use Metal Oxide Varistor (MOV) technology to provide a level of protection against building voltage transients.

d) Normal power Motor Control Centers (MCC's) will be located in mechanical rooms and areas close to the loads they serve. The MCC's will contain copper bus material and house a combination of full-voltage starters, solid-state reduced-voltage starters, and feeder circuit breakers for VFD's. Internal wiring will be NEMA Class 1B. Operator interface devices will include H-O-A selector switches, red "run" pilot lights, and green "ready" pilot lights.

e) Normal power distribution panels will contain bolt-on feeder circuit breakers. The capacity of the panels will be sufficient for the addition of 25% future connected load. Feeder circuit breaker space will be provided for the addition of 25% future circuit breakers.

f) 480V: 208Y/120V distribution transformers shall have copper windings, 80 degrees C rise type, and have the ability to carry 30% overload without exceeding 150 degrees C rise above ambient. Transformers will be located in the main electrical room as required to transform voltage to 208Y/120V. The transformers may be isolation type with a K-factor rating, anticipating that up to 50% of the connected load will be non-linear. Secondary panelboard neutral busses and neutral feeders would be upsized based on the K-rating.

g) Branch circuit and lighting panelboards will contain bolt-on branch circuit breakers. The panelboards will be rated at a minimum of 100 amperes, 3-phase, with 42 circuit spaces. If the load dictates a larger panel, panel sizes shall be increased to 225 amperes, and the connected load will be limited to provide 25% future connected load via spare 20A branch circuit breakers. Main circuit breakers shall be provided for all panelboard, which are not located in the same room as their feeder disconnect, or breaker.

h) Point-of-use power connection devices will include specification, grade, receptacles (120V, 20A, single-phase), power receptacles, and surface metallic raceway (SMR). The SMR will be divided into two raceway compartments, one for power and one for telecommunications. The density of receptacles in the SMR will vary between 18" OC and 36" OC, depending on the location.

4. Distribution

a) Secondary service will be distributed to the main building service entrance switchboard with (1) 1200 amp rated feeder conduit(s). The raceway will originate at the transformer and route into the main electrical room, where it will feed directly into the top or bottom of the main circuit breaker section.

b) Distribution to the MCC's will consist of conduit and wire. Each MCC will be fed directly from the service entrance switchboard; feed-through MCC's will not be used. This approach allows electrical isolation of each MCC without affecting loads served from other MCC's.

c) The branch electrical rooms will contain 480Y/277V lighting distribution as well as a 208Y/120V distribution panelboard. Branch electrical rooms will not be located on each floor, and the equipment in those rooms will feed multiple floors, in order to reduce the number of transformers and 208Y/120V distribution panelboards required.

d) The main secondary distribution transformer will deliver power to a 208Y/120V Main Distribution Switchboard in the basement electrical room. This switchboard will feed distribution panelboards in upper floors' electrical rooms, and in turn deliver power to the branch circuit panelboards. All laboratory panelboards shall have a main circuit breaker.

5. Circuiting Criteria

a) General Lighting

(1) 277V lighting will be limited to 3200 watts per 20A, 1-pole circuit.

(2) Exit signs and emergency egress lighting will be provided throughout the facility to illuminate egress corridors, stairwells, lobbies, etc. Exit and egress lighting circuits will originate from emergency system branch panels and will be constant "on" with no toggle switch control.

b) Receptacles

(1) Convenience receptacles not installed within the laboratories will have a maximum of 6 duplex outlets on a 20A, 1-pole circuit, 120V.

(2) Laboratory receptacles will have a maximum of 4 duplex outlets on a 20A, 1-pole circuit, 120V. Refer to the Laboratory Program documents for other requirements.

(3) Equipment such as refrigerators and freezers shall be connected to dedicated circuits.

(4) Each fume hood will be provided with a minimum of three (3) 120V, 20A, 1-pole circuits.

(5) Receptacles designated for computer use will have a maximum of three (3) duplex receptacles per 20A, single-pole circuit.

(6) Each enclosed office will be connected to an equivalent of one dedicated circuit. Desk locations in open office areas will be provided with minimum of two duplex receptacles that will be circuited with no more than four duplex receptacles per branch circuit.

6. Renewable Energy Option 1

a) The MicroTurbine is a compact, environmentally friendly generator of electricity and heat. Microturbines combine patented air-bearing technology, advanced combustion technology and sophisticated power electronics to produce efficient and reliable electricity and heat production system that requires little on-going maintenance.

b) One option is to install a bank of MicroTurbines in the BRL to use as a renewable energy "show-case" area, where different groups can visualize this method of high-efficient use of energy.

c) The MicroTurbine air-bearing technology provides a clean, high-pressure field of air to lubricate the one moving component of the microturbine rather than using traditional petroleum products as in conventional bearings.

d) Microturbines can operate by remote control and use a broad range of gaseous and liquid fuels, including previously unusable fuels.

e) Microturbines are easily transportable and designed to allow multiple units to run together to meet an end user's specific electrical and heat requirements.

f) The net efficiency of these units is better than that of traditional utility sources. For instance, typical utility plants have an efficiency of about 38 percent, with roughly 7 percent wasted due to transmission and distribution losses. By comparison, microturbines have an efficiency of about 30 percent. But when used in cogeneration applications that use both the units' power and thermal energy, the combined efficiency can be 70-90 percent.

g) Another important characteristic of these units is low emission rates. Nitrogen oxide (NOx) emission rates can be less than 9 parts per million, or less than 0.5 pounds per megawatt-hour (MWh). By contrast, the emission level from a typical power plant is 10 times higher.

h) The contrast between a microturbine and a diesel engine is even greater. A diesel engine generates more pollutants in one hour than a microturbine produces in nine days.

i) Microturbines require relatively low maintenance, due to their inherent design. The units only have one moving part — namely, a compressor and turbine mounted on a rapidly spinning shaft. For this reason, the availability of these units often exceeds 99.8 percent.

j) Microturbines are compact and create negligible vibration. These characteristics mean that, unlike traditional generation units, they require less space and can be installed and ready for service rather quickly.

7. Renewable Energy Option 2

a) Plan for a future installation of photovoltaic (PV) or wind power equipment and plan to parallel these self-energy generating sources with the normal utility electrical switchboard equipment. This would require dedicating space for future installation of electrical equipment needed for these "green-power" technologies.

8. System Description: Agricultural and Biosystems Engineering (ABE)

a) Secondary electric service at 480Y/277 volts will be provided from the utility outdoor biodegradable-oil filled transformer and routed underground into the building to a main service switchboard.

b) Building distribution shall be provided at 480Y/277V from the main switchboard to the distribution panelboards and to mechanical equipment via motor control centers. Floor mounted dry-type distribution transformers shall be installed in the main electrical room as required and provide voltage transformation to 208Y/120V distribution panels. The distribution panels will feed local receptacle panels, mechanical equipment panels, and laboratory panels.

c) Laboratories shall have individual recessed wall or column mounted circuit breaker panelboards located within the labs they serve.

d) Motor control centers serving mechanical equipment shall be located in an area close to the loads they are serving.

e) A central, Uninterruptible Power Supply (UPS) system or power conditioning system are not planned to be designed for installation.

9. Design Criteria

a) No electrical equipment subject to failure will be installed in any location that would require excavation or building modification in order to replace such equipment.

b) Conduit and Raceways

(1) Conduit will be run concealed, unless in mechanical rooms.

(2) Minimum conduits size will be 3/4".

(3) Conduits will be independently supported.

(4) Conduits under slab and in areas subject to abuse will be rigid galvanized steel with threaded fitting or be rigid PVC conduit encased in 3" of steel reinforced concrete with dye identification.

(5) Conduit installation in concrete slabs shall be prohibited.

(6) Surface conduit run below switch height shall be rigid steel. Surface boxes as switch height or below shall be cast steel type.

(7) Rigid conduit will be used in exterior locations.

(8) EMT fittings used on conduit sizes 2 1/2" and smaller will be compression type.

(9) Branch circuit conduits will not be installed in floor slabs or below floor slabs on grade.

(10) Unbroken conduit runs will not exceed 100 feet. Back-to-back 90 degree bends will not be allowed.

(11) Conduits and boxes will be installed a minimum of 1'-0" and a maximum of 3'-0" above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed accessible from floor using a standard 8 foot ladder and light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling can be serviced and maintained without damage to ceiling tiles and other building elements.

(12) No horizontal conduit runs through wall will be allowed.

(13) For lighting conduit homeruns a junction box shall be located above light fixture in an accessible location to allow for future expansion.

(14) No home run shall terminate in a wall mounted device box. A separate junction box shall be provided above device box above ceiling in an accessible location.

c) Wire and Cable

(1) All wiring will be 98% conductivity copper.

(2) 600 V cable will be THWN-2 or XHHW-2.

(3) Conductors shall be stranded.

(4) Conductor size shall be adjusted to compensate for voltage drop in circuit do to length as follows:

208Y/120 volt circuits over 100 ft in length: Increase wire size one size for each 100 ft of length.

480Y/277 volt circuits over 150 ft in length: Increase wire size one size for each 150 ft of length.

(5) Conductor insulation color code shall be as follows:

208Y/120 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white, ground conductor-green.

480Y/277 volt, 3 phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray, ground conductor-green.

d) Wiring Devices

(1) Receptacles and switches connected to emergency power will be red in color.

(2) Receptacles and switches connected to normal power will be in color selected by the architect.

(3) Receptacle and switch cover plates will be stainless steel No. 430 in non-corrosive locations and No. 302 in corrosive areas including all laboratories.

(4) Receptacles will be Specification Grade.

(5) Receptacles, switches, etc., will have faceplate labeling indicating system panel and circuit identification.

e) Motors and Motor Control

(1) Stand-alone motor disconnects (separate from starter) will be fused and will be installed at each motor.

(2) For the delayed loading of generator, time delay relays will be used in motor starter to sequence the restarting of large motors.

(3) Combination motor starters will use fuses.

(4) Motor control centers will be used if two or more starters are needed in the same room. MCCs shall be designed and specified to contain at least 25% spare size-one spaces.

f) Transformers

(1) Transformers will comply with the energy code minimum efficiencies and be Energy Star listed.

(2) Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case. External vibration isolation pads will also be used.

g) Distribution and Branch Panelboards

(1) Panels, with the exception of laboratory, high bay, and manufacturing areas, will be located in dedicated electrical rooms or closets.

(2) Panelboards will contain 20% spare circuit breakers plus 20% branch circuit breaker bussed spaces for future use.

(3) Main circuit breakers will be provided for those distribution and branch panelboards which are not located in the same room as their feeder disconnect or breaker.

h) Circuit Breakers and Fuses

(1) Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist. Circuit breakers 800 amps and greater will be UL listed for applications at 100% of their continuous ampere rating in their intended enclosure.

(2) Fuses will be RK5.

i) EMF and Harmonics

(1) Generally, electrical vaults and major electrical equipment rooms containing transformers larger than 300 kVA will not be located adjacent to normally occupied workstations.

(2) In areas with large amounts of high-harmonic loads, steps to reduce the effect of harmonic will be considered. Steps will include using separate circuits, restricting the number of receptacles per circuit, over sizing panelboard neutral buses and feeder neutral conductors and installing isolation transformers, K-rated transformers, harmonic filters or other such equipment.

j) Prohibited Materials and Construction Practices

(1) Extra-flexible non-labeled conduit.

(2) Conduit installation in concrete slabs.

(3) Conduit less than 3/4" diameter, unless allowed in certain installations.

(4) Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors. The transition form PVC to steel will be made below the floor.

(5) Aluminum wiring.

(6) Aluminum bus.

(7) Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible.

(8) Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels will be hung from trapeze suspension systems.

(9) Wire ties to support conduit.

(10) Wood strips and wood screws to support lighting fixtures.

(11) Class J fuses.

(12) Direct burial electrical cable.

(13) Ducts within 5’ of a buried steam line in any direction.

(14) Armored cable (AC, BX, MC, etc.).

(15) Nonmetallic sheathed cable.

(16) Flat conductor cable type FCC, under carpet, etc.

(17) Switches in which the blades pivot on the top.

(18) Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

(19) IEC listed equipment.

10. Equipment and Material

a) Acceptable equipment manufacturers:

(1) Square D

(2) General Electric

(3) Cutler Hammer

b) The 1500 kVA medium voltage utility transformer will be located on the exterior of the building and will feed the building service entrance switchboard inside the building in the main electrical room. The switchboard will be rated at 480Y/277V, 2400A, 3-phase, 4-wire and contain group mounted circuit breakers. The switchboard shall consist of one main breaker with 2400A trip rating and distribution feeder breakers. All breakers will have electronic trip modules (LSI protection) and ground fault protection.

c) The switchboard will contain a digital power meter, capable of recording voltage, amperage, power factor, demand, and historical energy usage. ISU will install a separate KWH meter in a socket located adjacent to the medium voltage switchgear, or the main distribution switchboard. A Transient Voltage Surge Suppression (TVSS) unit will be furnished inside the main switchboard, and will use Metal Oxide Varistor (MOV) technology to provide a level of protection against building voltage transients.

d) Normal power Motor Control Centers (MCC's) will be located in mechanical rooms and areas close to the loads they serve. The MCC's will contain copper bus material and house a combination of full-voltage starters, solid-state reduced-voltage starters, and feeder circuit breakers for VFD's. Internal wiring will be NEMA Class 1B. Operator interface devices will include H-O-A selector switches, red "run" pilot lights, and green "ready" pilot lights.

e) Normal power distribution panels will contain bolt-on feeder circuit breakers. The capacity of the panels will be sufficient for the addition of 25% future connected load. Feeder circuit breaker space will be provided for the addition of 25% future circuit breakers.

f) 480V: 208Y/120V distribution transformers shall have copper windings, 80 degrees C rise type, and have the ability to carry 30% overload without exceeding 150 degrees C rise above ambient. Transformers will be located in the main electrical room as required to transform voltage to 208Y/120V. The transformers may be isolation type with a K-factor rating, anticipating that up to 50% of the connected load will be non-linear. Secondary panelboard neutral busses and neutral feeders would be upsized based on the K-rating.

g) Branch circuit and lighting panelboards will contain bolt-on branch circuit breakers. The panelboards will be rated at a minimum of 100 amperes, 3-phase, with 42 circuit spaces. If the load dictates a larger panel, panel sizes shall be increased to 225 amperes, and the connected load will be limited to provide 25% future connected load via spare 20A branch circuit breakers. Main circuit breakers shall be provided for all panelboard, which are not located in the same room as their feeder disconnect, or breaker.

h) Engine test cells and Dynamometer drive equipment shall have service from the unit substation with interconnections and auxiliary equipment as specified by the equipment manufacturer or system integrator. This may include, but not be limited to: isolation transformers, interconnections, reactors, etc. The electrical system will have utility required protection devices to allow for AC dynamometer regeneration.

i) Point-of-use power connection devices will include specification, grade, receptacles (120V, 20A, single-phase), power receptacles, and surface metallic raceway (SMR). The SMR will be divided into two raceway compartments, one for power and one for telecommunications. The density of receptacles in the SMR will vary between 18" OC and 36" OC, depending on the location.

11. Distribution

a) Secondary service will be distributed to the main building service entrance switchboard with (1) 2400 amp rated feeder conduit(s). The raceway will originate at the transformer and route into the main electrical room, where it will feed directly into the bottom of the main circuit breaker section.

b) Distribution to the MCC's will consist of conduit and wire. Each MCC will be fed directly from the service entrance switchboard; feed-through MCC's will not be used. This approach allows electrical isolation of each MCC without affecting loads served from other MCC's.

c) The branch electrical rooms will contain 480Y/277V lighting distribution as well as a 208Y/120V distribution panelboard. Branch electrical rooms will not be located on each floor, and the equipment in those rooms will feed multiple floors, in order to reduce the number of transformers and 208V distribution panelboards required.

d) The main secondary distribution transformer will deliver power to a 208Y/120V Main Distribution Switchboard in the basement electrical room. This switchboard will feed distribution panelboards in upper floors' electrical rooms, and in turn deliver power to the branch circuit panelboards. All laboratory panelboards shall have a main circuit breaker.

12. Circuiting Criteria

    a) General Lighting

        (1) 277V lighting will be limited to 3200 watts per 20A, 1-pole circuit.

        (2) Exit signs and emergency egress lighting will be provided throughout the facility to illuminate egress corridors, stairwells, lobbies, etc. Exit and egress lighting circuits will originate from emergency system branch panels and will be constant "on" with no toggle switch control.

    b) Receptacles

        (1) Convenience receptacles not installed within the laboratories will have a maximum of 6 duplex outlets on a 20A, 1-pole circuit, 120V.

        (2) Laboratory receptacles will have a maximum of 4 duplex outlets on a 20A, 1-pole circuit, 120V. Refer to the Laboratory Program documents for other requirements.

        (3) Equipment such as refrigerators and freezers shall be connected to dedicated circuits.

        (4) Each fume hood will be provided with a minimum of three (3) 120V, 20A, 1-pole circuits.

        (5) Receptacles designated for computer use will have a maximum of three (3) duplex receptacles per 20A, single-pole circuit.

        (6) Each enclosed office will be connected to an equivalent of one dedicated circuit. Desk locations in open office areas will be provided with minimum of two duplex receptacles that will be circuited with no more than four duplex receptacles per branch circuit.

13. Renewable Energy Option 1

    a) The MicroTurbine is a compact, environmentally friendly generator of electricity and heat. Microturbines combine patented air-bearing technology, advanced combustion technology and sophisticated power electronics to produce an efficient and reliable electricity and heat production system that requires little on-going maintenance.

    b) One option is to install a bank of MicroTurbines in the ABE to use as a renewable energy "show-case" area, where different groups can visualize this method of high-efficient use of energy.

    c) The MicroTurbine air-bearing technology provides a clean, high-pressure field of air to lubricate the one moving component of the microturbine rather than using traditional petroleum products as in conventional bearings.

    d) Microturbines can operate by remote control and use a broad range of gaseous and liquid fuels, including previously unusable fuels.

    e) Microturbines are easily transportable and designed to allow multiple units to run together to meet an end user's specific electrical and heat requirements.

    f) The net efficiency of these units is better than that of traditional utility sources. For instance, typical utility plants have an efficiency of about 38 percent, with roughly 7 percent wasted due to transmission and distribution losses. By comparison, microturbines have an efficiency of about 30 percent. But when used in cogeneration applications that use both the units' power and thermal energy, the combined efficiency can be 70-90 percent.

g) Another important characteristic of these units is low emission rates. Nitrogen oxide (NOx) emission rates can be less than 9 parts per million, or less than 0.5 pounds per megawatt-hour (MWh). By contrast, the emission level from a typical power plant is 10 times higher.

h) The contrast between a microturbine and a diesel engine is even greater. A diesel engine generates more pollutants in one hour than a microturbine produces in nine days.

i) Microturbines require relatively low maintenance, due to their inherent design. The units only have one moving part — namely, a compressor and turbine mounted on a rapidly spinning shaft. For this reason, the availability of these units often exceeds 99.8 percent.

j) Microturbines are compact and create negligible vibration. These characteristics mean that, unlike traditional generation units, they require less space and can be installed and ready for service rather quickly.

14. Renewable Energy Option 2

a) Plan for a future installation of photovoltaic (PV) or wind power equipment and plan to parallel these self-energy generating sources with the normal utility electrical switchboard equipment. This would require dedicating space for future installation of electrical equipment needed for these "green-power" technologies.

15. System Description: Parking Administration Building

a) Secondary electric service at 208Y/120 volts will be provided from the utility grid to the indoor dry-type transformer, included in the building unitized package substation.

b) Building distribution shall be provided at 208Y/120V from the main substation to branch distribution panelboards. The distribution panels will include local receptacle panels and mechanical equipment panels.

c) A central, Uninterruptible Power Supply (UPS) system or power conditioning system are not planned to be designed for installation.

16. Design Criteria

a) No electrical equipment subject to failure will be installed in any location that would require excavation or building modification in order to replace such equipment.

b) Conduit and Raceways

(1) Conduit will be run concealed, unless in mechanical rooms.

(2) Minimum conduits size will be 3/4".

(3) Conduits will be independently supported.

(4) Conduits under slab and in areas subject to abuse will be rigid galvanized steel with threaded fitting or be rigid PVC conduit encased in 3" of steel reinforced concrete with dye identification.

(5) Conduit installation in concrete slabs shall be prohibited.

(6) Surface conduit run below switch height shall be rigid steel. Surface boxes as switch height or below shall be cast steel type.

(7) Rigid conduit will be used in exterior locations.

(8) EMT fittings used on conduit sizes 2 1/2" and smaller will be compression type.

(9) Branch circuit conduits will not be installed in floor slabs or below floor slabs on grade.

(10) Unbroken conduit runs will not exceed 100 feet. Back-to-back 90 degree bends will not be allowed.

(11) Conduits and boxes will be installed a minimum of 1'-0" and a maximum of 3'-0" above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed accessible from floor using a standard 8 foot ladder and light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling can be serviced and maintained without damage to ceiling tiles and other building elements.

(12) No horizontal conduit runs through wall will be allowed.

(13) For lighting conduit homeruns a junction box shall be located above light fixture in an accessible location to allow for future expansion.

(14) No home run shall terminate in a wall mounted device box. A separate junction box shall be provided above device box above ceiling in an accessible location.

c) Wire and Cable

(1) All wiring will be 98% conductivity copper.

(2) 600 V cable will be THWN-2 or XHHW-2.

(3) Conductors shall be stranded.

(4) Conductor size shall be adjusted to compensate for voltage drop in circuit do to length as follows:

208Y/120 volt circuits over 100 ft in length: Increase wire size one size for each 100 ft of length.

(5) Conductor insulation color code shall be as follows:

208Y/120 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white, ground conductor-green.

d) Wiring Devices

(1) Receptacles and switches connected to emergency power will be red in color.

(2) Receptacles and switches connected to normal power will be in color selected by the architect.

(3) Receptacles will be Specification Grade.

(4) Receptacles, switches, etc., will have faceplate labeling indicating system panel and circuit identification.

e) Motors and Motor Control

(1) Stand-alone motor disconnects (separate from starter) will be fused and will be installed at each motor.

(2) For the delayed loading of generator, time delay relays will be used in motor starter to sequence the restarting of large motors.

(3) Combination motor starters will use fuses.

f) Transformers

(1) Transformers will comply with the energy code minimum efficiencies and be Energy Star listed.

(2) Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case. External vibration isolation pads will also be used.

g) Distribution and Branch Panelboards

(1) Panels will be located in dedicated electrical rooms or closets.

(2) Panelboards will contain 20% spare circuit breakers plus 20% branch circuit breaker bussed spaces for future use.

(3) Main circuit breakers will be provided for those distribution and branch panelboards which are not located in the same room as their feeder disconnect or breaker.

h) Circuit Breakers and Fuses

(1) Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist.

(2) Fuses will be RK5.

i) EMF and Harmonics

(1) In areas with large amounts of high-harmonic loads, steps to reduce the effect of harmonic will be considered. Steps will include using separate circuits, restricting the number of receptacles per circuit, over sizing panelboard neutral buses and feeder neutral conductors and installing isolation transformers, K-rated transformers, harmonic filters or other such equipment.

j) Prohibited Materials and Construction Practices

(1) Extra-flexible non-labeled conduit.

(2) Conduit installation in concrete slabs.

(3) Conduit less than 3/4" diameter, unless allowed in certain installations.

(4) Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors. The transition form PVC to steel will be made below the floor.

(5) Aluminum wiring.

(6) Aluminum bus.

(7) Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible.

(8) Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels will be hung from trapeze suspension systems.

(9) Wire ties to support conduit.

(10) Wood strips and wood screws to support lighting fixtures.

(11) Class J fuses.

(12) Direct burial electrical cable.

(13) Ducts within 5' of a buried steam line in any direction.

(14) Armored cable (AC, BX, MC, etc.).

(15) Nonmetallic sheathed cable.

(16) Flat conductor cable type FCC, under carpet, etc.

(17) Switches in which the blades pivot on the top.

(18) Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

(19) IEC listed equipment.

17. Equipment and Material

a) Acceptable equipment manufacturers:

(1) Square D

(2) General Electric

(3) Cutler Hammer

b) The 75 kVA medium voltage utility transformer will be located adjacent to the building service entrance switchboard (unitized package substation) inside the building in the main electrical room. The switchboard will be rated at 208Y/120V, 225A, 3-phase, 4-wire and contain group mounted circuit breakers. The switchboard shall consist of one main breaker with 225A trip rating and distribution feeder breakers. All breakers will have electronic trip modules (LSI protection).

c) The switchboard will contain a digital power meter, capable of recording voltage, amperage, power factor, demand, and historical energy usage. ISU will install a separate KWH meter in a socket located adjacent to the medium voltage switchgear, or the main distribution switchboard. A Transient Voltage Surge Suppression (TVSS) unit will be furnished inside the main switchboard, and will use Metal Oxide Varistor (MOV) technology to provide a level of protection against building voltage transients.

d) Normal power distribution panels will contain bolt-on feeder circuit breakers. The capacity of the panels will be sufficient for the addition of 25% future connected load. Feeder circuit breaker space will be provided for the addition of 25% future circuit breakers.

e) Branch circuit and lighting panelboards will contain bolt-on branch circuit breakers. The panelboards will be rated at a minimum of 100 amperes, 3-phase, with 42 circuit spaces. Main circuit breakers shall be provided for all panelboard, which are not located in the same room as their feeder disconnect, or breaker.

f) Point-of-use power connection devices will include specification, grade, receptacles (120V, 20A, single-phase), power receptacles, and surface metallic raceway (SMR). The SMR will be divided into two raceway compartments, one for power and one for telecommunications. The density of receptacles in the SMR will vary between 18" OC and 36" OC, depending on the location.

18. Distribution

a) The main building transformer and switchboard will distribute 208Y/120V feeders to branch electrical panelboards, as required. The main switchboard and branch electrical panelboards will feed all lighting, receptacles, and HVAC equipment within the building.

19. System Description: Campus Police Administration Building

a) Secondary electric service at 208Y/120 volts will be provided from the utility grid to the indoor dry-type transformer, included in the building unitized package substation.

b) Building distribution shall be provided at 208Y/120V from the main substation to branch distribution panelboards. The distribution panels will include local receptacle panels and mechanical equipment panels.

c) A central, Uninterruptible Power Supply (UPS) system or power conditioning system are not planned to be designed for installation.

20. Design Criteria

a) No electrical equipment subject to failure will be installed in any location that would require excavation or building modification in order to replace such equipment.

b) Conduit and Raceways

(1) Conduit will be run concealed, unless in mechanical rooms.

(2) Minimum conduits size will be 3/4".

(3) Conduits will be independently supported.

(4) Conduits under slab and in areas subject to abuse will be rigid galvanized steel with threaded fitting or be rigid PVC conduit encased in 3" of steel reinforced concrete with dye identification.

(5) Conduit installation in concrete slabs shall be prohibited.

(6) Surface conduit run below switch height shall be rigid steel. Surface boxes as switch height or below shall be cast steel type.

(7) Rigid conduit will be used in exterior locations.

(8) EMT fittings used on conduit sizes 2 1/2" and smaller will be compression type.

(9) Branch circuit conduits will not be installed in floor slabs or below floor slabs on grade.

(10) Unbroken conduit runs will not exceed 100 feet. Back-to-back 90 degree bends will not be allowed.

(11) Conduits and boxes will be installed a minimum of 1'-0" and a maximum of 3'-0" above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed accessible from floor using a standard 8 foot ladder and light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling can be serviced and maintained without damage to ceiling tiles and other building elements.

(12) No horizontal conduit runs through wall will be allowed.

(13) For lighting conduit homeruns a junction box shall be located above light fixture in an accessible location to allow for future expansion.

(14) No home run shall terminate in a wall mounted device box. A separate junction box shall be provided above device box above ceiling in an accessible location.

c) Wire and Cable

(1) All wiring will be 98% conductivity copper.

(2) 600 V cable will be THWN-2 or XHHW-2.

(3) Conductors shall be stranded.

(4) Conductor size shall be adjusted to compensate for voltage drop in circuit do to length as follows:

208Y/120 volt circuits over 100 ft in length: Increase wire size one size for each 100 ft of length.

(5) Conductor insulation color code shall be as follows:

208Y/120 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white, ground conductor-green.

d) Wiring Devices

(1) Receptacles and switches connected to emergency power will be red in color.

(2) Receptacles and switches connected to normal power will be in color selected by the architect.

(3) Receptacles will be Specification Grade.

(4) Receptacles, switches, etc., will have faceplate labeling indicating system panel and circuit identification.

e) Motors and Motor Control

(1) Stand-alone motor disconnects (separate from starter) will be fused and will be installed at each motor.

(2) For the delayed loading of generator, time delay relays will be used in motor starter to sequence the restarting of large motors.

(3) Combination motor starters will use fuses.

f) Transformers

(1) Transformers will comply with the energy code minimum efficiencies and be Energy Star listed.

(2) Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case. External vibration isolation pads will also be used.

g) Distribution and Branch Panelboards

(1) Panels will be located in dedicated electrical rooms or closets.

(2) Panelboards will contain 20% spare circuit breakers plus 20% branch circuit breaker bussed spaces for future use.

(3) Main circuit breakers will be provided for those distribution and branch panelboards which are not located in the same room as their feeder disconnect or breaker.

h) Circuit Breakers and Fuses

(1) Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist.

(2) Fuses will be RK5.

i) EMF and Harmonics

(1) In areas with large amounts of high-harmonic loads, steps to reduce the effect of harmonic will be considered. Steps will include using separate circuits, restricting the number of receptacles per circuit, over sizing panelboard neutral buses and feeder neutral conductors and installing isolation transformers, K-rated transformers, harmonic filters or other such equipment.

j) Prohibited Materials and Construction Practices

(1) Extra-flexible non-labeled conduit.

(2) Conduit installation in concrete slabs.

(3) Conduit less than 3/4" diameter, unless allowed in certain installations.

(4) Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors. The transition form PVC to steel will be made below the floor.

(5) Aluminum wiring.

(6) Aluminum bus.

(7) Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible.

(8) Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels will be hung from trapeze suspension systems.

(9) Wire ties to support conduit.

(10) Wood strips and wood screws to support lighting fixtures.

(11) Class J fuses.

(12) Direct burial electrical cable.

(13) Ducts within 5' of a buried steam line in any direction.

(14) Armored cable (AC, BX, MC, etc.).

(15) Nonmetallic sheathed cable.

(16) Flat conductor cable type FCC, under carpet, etc.

(17) Switches in which the blades pivot on the top.

(18) Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

(19) IEC listed equipment.

21. Equipment and Material

a) Acceptable equipment manufacturers:

(1) Square D

(2) General Electric

(3) Cutler Hammer

b) The 75 kVA medium voltage utility transformer will be located adjacent to the building service entrance switchboard (unitized package substation) inside the building in the main electrical room. The switchboard will be rated at 208Y/120V, 225A, 3-phase, 4-wire and contain group mounted circuit breakers. The switchboard shall consist of one main breaker with 225A trip rating and distribution feeder breakers. All breakers will have electronic trip modules (LSI protection).

c) The switchboard will contain a digital power meter, capable of recording voltage, amperage, power factor, demand, and historical energy usage. ISU will install a separate KWH meter in a socket located adjacent to the medium voltage switchgear, or the main distribution switchboard. A Transient Voltage Surge Suppression (TVSS) unit will be furnished inside the main switchboard, and will use Metal Oxide Varistor (MOV) technology to provide a level of protection against building voltage transients.

d) Normal power distribution panels will contain bolt-on feeder circuit breakers. The capacity of the panels will be sufficient for the addition of 25% future connected load. Feeder circuit breaker space will be provided for the addition of 25% future circuit breakers.

e) Branch circuit and lighting panelboards will contain bolt-on branch circuit breakers. The panelboards will be rated at a minimum of 100 amperes, 3-phase, with 42 circuit spaces. Main circuit breakers shall be provided for all panelboard, which are not located in the same room as their feeder disconnect, or breaker.

f) Point-of-use power connection devices will include specification, grade, receptacles (120V, 20A, single-phase), power receptacles, and surface metallic raceway (SMR). The SMR will be divided into two raceway compartments, one for power and one for telecommunications. The density of receptacles in the SMR will vary between 18" OC and 36" OC, depending on the location.

22. Distribution

a) The main building transformer and switchboard will distribute 208Y/120V feeders to branch electrical panelboards, as required. The main switchboard and branch electrical panelboards will feed all lighting, receptacles, and HVAC equipment within the building.

23. System Description: Parking Structure

a) Secondary electric service at 480Y/277 volts will be provided from the utility grid to the indoor dry-type transformer, included in the building unitized package substation.

b) Building distribution shall be provided at 480Y/277V from the main substation to feed lighting and a distribution panelboard. A floor/suspended mounted dry-type distribution transformer shall be installed in the main electrical room to provide voltage transformation to a 208Y/120V distribution panel. The distribution panel will feed receptacles, mechanical equipment, and various other loads.

c) A central, Uninterruptible Power Supply (UPS) system or power conditioning system are not planned to be designed for installation.

24. Design Criteria

a) No electrical equipment subject to failure will be installed in any location that would require excavation or building modification in order to replace such equipment.

b) Conduit and Raceways

(1) Conduit will be run exposed.

(2) Minimum conduits size will be 3/4".

(3) Conduits will be independently supported.

(4) Conduits under slab and in areas subject to abuse will be rigid galvanized steel with threaded fitting or be rigid PVC conduit encased in 3" of steel reinforced concrete with dye identification.

(5) Conduit installation in concrete slabs shall be prohibited.

(6) Surface conduit run below switch height shall be rigid steel. Surface boxes as switch height or below shall be cast steel type.

(7) Rigid conduit will be used in exterior locations.

(8) EMT fittings used on conduit sizes 2 1/2" and smaller will be compression type.

(9) Branch circuit conduits will not be installed in floor slabs or below floor slabs on grade.

(10) Unbroken conduit runs will not exceed 100 feet. Back-to-back 90 degree bends will not be allowed.

(11) Conduits and boxes will be installed a minimum of 1'-0" and a maximum of 3'-0" above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed accessible from floor using a standard 8 foot ladder and light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling can be serviced and maintained without damage to ceiling tiles and other building elements.

(12) No horizontal conduit runs through wall will be allowed.

(13) For lighting conduit homeruns a junction box shall be located above light fixture in an accessible location to allow for future expansion.

(14) No home run shall terminate in a wall mounted device box. A separate junction box shall be provided above device box above ceiling in an accessible location.

c) Wire and Cable

(1) All wiring will be 98% conductivity copper.

(2) 600 V cable will be THWN-2 or XHHW-2.

(3) Conductors shall be stranded.

(4) Conductor size shall be adjusted to compensate for voltage drop in circuit do to length as follows:

208Y/120 volt circuits over 100 ft in length: Increase wire size one size for each 100 ft of length.

480Y/277 volt circuits over 150 ft in length: Increase wire size one size for each 150 ft of length.

(5) Conductor insulation color code shall be as follows:

208Y/120 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white, ground conductor-green.

480Y/277 volt, 3 phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray, ground conductor-green.

d) Wiring Devices

(1) Receptacles and switches connected to emergency power will be red in color.

(2) Receptacles and switches connected to normal power will be in color selected by the architect.

(3) Receptacles will be Specification Grade.

(4) Receptacles, switches, etc., will have faceplate labeling indicating system panel and circuit identification.

e) Motors and Motor Control

(1) Stand-alone motor disconnects (separate from starter) will be fused and will be installed at each motor.

(2) For the delayed loading of generator, time delay relays will be used in motor starter to sequence the restarting of large motors.

(3) Combination motor starters will use fuses.

f) Transformers

(1) Transformers will comply with the energy code minimum efficiencies and be Energy Star listed.

(2) Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case. External vibration isolation pads will also be used.

g) Distribution and Branch Panelboards

(1) Panels will be located in dedicated electrical rooms or closets.

(2) Panelboards will contain 20% spare circuit breakers plus 20% branch circuit breaker bussed spaces for future use.

(3) Main circuit breakers will be provided for those distribution and branch panelboards which are not located in the same room as their feeder disconnect or breaker.

h) Circuit Breakers and Fuses

(1) Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist.

(2) Fuses will be RK5.

i) EMF and Harmonics

(1) In areas with large amounts of high-harmonic loads, steps to reduce the effect of harmonic will be considered. Steps will include using separate circuits, restricting the number of receptacles per circuit, over sizing panelboard neutral buses and feeder neutral conductors and installing isolation transformers, K-rated transformers, harmonic filters or other such equipment.

j) Prohibited Materials and Construction Practices

(1) Extra-flexible non-labeled conduit.

(2) Conduit installation in concrete slabs.

(3) Conduit less than 3/4" diameter, unless allowed in certain installations.

(4) Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors. The transition form PVC to steel will be made below the floor.

(5) Aluminum wiring.

(6) Aluminum bus.

(7) Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible.

(8) Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels will be hung from trapeze suspension systems.

(9) Wire ties to support conduit.

(10) Wood strips and wood screws to support lighting fixtures.

(11) Class J fuses.

(12) Direct burial electrical cable.

(13) Ducts within 5' of a buried steam line in any direction.

(14) Armored cable (AC, BX, MC, etc.).

(15) Nonmetallic sheathed cable.

(16) Flat conductor cable type FCC, under carpet, etc.

(17) Switches in which the blades pivot on the top.

(18) Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

(19) IEC listed equipment.

25. Equipment and Material

a) Acceptable equipment manufacturers:

(1) Square D

(2) General Electric

(3) Cutler Hammer

b) The 150 kVA medium voltage utility transformer will be located adjacent to the building service entrance switchboard (unitized package substation) inside the building in the main electrical room. The switchboard will be rated at 480Y/277V, 300A, 3-phase, 4-wire and contain group mounted circuit breakers. The switchboard shall consist of one main breaker with 300A trip rating and distribution feeder breakers. All breakers will have electronic trip modules (LSI protection).

c) The switchboard will contain a digital power meter, capable of recording voltage, amperage, power factor, demand, and historical energy usage. ISU will install a separate KWH meter in a socket located adjacent to the medium voltage switchgear, or the main distribution switchboard. A Transient Voltage Surge Suppression (TVSS) unit will be furnished inside the main switchboard, and will use Metal Oxide Varistor (MOV) technology to provide a level of protection against building voltage transients.

d) Normal power distribution panels will contain bolt-on feeder circuit breakers. The capacity of the panels will be sufficient for the addition of 25% future connected load. Feeder circuit breaker space will be provided for the addition of 25% future circuit breakers.

e) A 480V: 208Y/120V distribution transformer shall have copper windings, 80 degrees C rise type, and have the ability to carry 30% overload without exceeding 150 degrees C rise above ambient. The transformer will be located in the main electrical room to transform voltage to 208Y/120V.

f) Branch circuit and lighting panelboards will contain bolt-on branch circuit breakers. The panelboards will be rated at a minimum of 100 amperes, 3-phase, with 42 circuit spaces. Main circuit breakers shall be provided for all panelboard, which are not located in the same room as their feeder disconnect, or breaker.

g) Point-of-use power connection devices will include specification, grade, receptacles (120V, 20A, single-phase) and power receptacles.

26. Distribution

a) The main building transformer and switchboard will distribute 480Y/277V feeders to feed all lighting in the building branch electrical panelboards. The main switchboard will also feed a 480V: 208Y/120V transformer.

b) The secondary distribution transformer will deliver power to a 208Y/120V Distribution Panel. This distribution panelboard will feed receptacles, HVAC equipment, and various other loads within the building.

C. Emergency/Standby Power Service and Distribution

1. System Description: Agricultural and Biosystems Engineering (ABE)

a) The emergency/standby power source will be derived from a single 480Y/277V diesel powered engine-generator set located in a roof mounted, sound attenuated, weatherproof enclosure. .

b) The emergency/standby power will be distributed to three (3) automatic transfer switches. The transfer switches will split the generator power into multiple branches of power including life-safety power, legally required standby power, and optional standby power.

c) The following equipment will be provided with emergency power in the event of a normal power failure:

(1) Emergency Systems Power (Life Safety Systems)

- Egress lighting
- Exit signs
- Fire alarm equipment
- Critical telecommunications Equipment

(2) Legally Required Standby Power

- Mechanical smoke control equipment associated with the atrium exhaust and stair pressurization.
- Emergency Generator enclosure lighting and receptacles
- Ventilation and smoke removal and other systems that when stopped could create hazards or hamper rescue or fire-fighting operations.
- Sewage ejector and sump pumps

(3) Optional Standby System Power (Owner Selected Items)

- 120V/20A duplex and 208V/20A or 30A receptacles in laboratory spaces as identified in the laboratory program documents.
- Telecom, access control, CCTV, etc.
- One laboratory air handling system and exhaust fans to maintain pressure relationships.
- One Elevator (requirement to be confirmed by ISU).

d) The main emergency/standby power switchboard will be located in the emergency/standby power main electrical room and will distribute emergency/standby power to the building loads.

e) Standby MCC's will be located in mechanical areas near the loads that they serve.

f) Standby branch circuit panelboards, emergency egress lighting panels, and emergency branch circuit panelboards will be located on each level of each building as required.

2. Design Criteria: Agricultural and Biosystems Engineering (ABE)

a) The design criteria for the Emergency/Standby System will be similar to that for the normal power system.

b) The standby/emergency generator sub-base fuel tank will be sized to support at least 12 hours of generator operation at full load.

c) The capacity of the generator will be sufficient to serve the facility, with approximately 25% kW future capacity.

3. Equipment and Material: Agricultural and Biosystems Engineering (ABE)

a) The 600 kW/750 kVA, (final size to be determined as the program and design progresses) 480Y/277V, Emergency/Standby generator shall be located in a sound attenuated, weatherproof enclosure, with a sub-base fuel tank sized to operate the generator at full load for at least 12 hours.

b) Emergency/standby generator shall be diesel engine driven and shall consist of engine, generator, controls, exhaust system, critical silencer, radiator, batteries, starting system and generator power circuit breaker with ground fault indication. The generator main circuit breaker shall be sized to allow the generator to operate continuously at 100% of full load.

c) The generator control panel shall be used to automatically start, protect, and monitor engine-generator set using solid state controls. Control panel shall include starting motor magnetic switch, electrically operated fuel control, relay to disconnect battery charger during cranking and protective relays to open power circuit breaker and shut down engine on abnormal conditions.

d) Generator testing shall consist of the use of a load bank. An exterior wall mounted conductor lug box, fed from the generator main switchboard, will include one set of lugs permanently connected to the switchboard, and the other set of lugs will be available to temporarily install conductors from a load bank. The load bank allows the generator to be tested, without disturbing normal building loads.

e) The main Emergency/Standby Power distribution switchboard will be used to separate the generator power into three separate sources: Life Safety, Legally Required Standby Power Equipment, and Optional Standby Equipment. The switchboard will be located in the main emergency/standby electrical room. Metering will be provided to indicate various parameters including voltage, current, power, power factor, power demand, and energy.

f) 480Y/277V, three or four-pole, solid or switched-neutral, Automatic Transfer Switches (ATS) will be used to couple the generator power to the distribution system. The transfer switches will be located in the standby/emergency power main equipment room. All ATS' will be bypass-isolation type.

g) An emergency power distribution panel will be located in the standby/emergency power main equipment room and will consist of group-mounted feeder circuit breakers to serve emergency lighting panelboards or branch lighting circuits.

h) A standby power distribution switchboard will be located in the standby/emergency power main equipment room and will consist of group-mounted feeder circuit breakers to serve standby power distribution panelboards located in branch electrical rooms, as required. Standby power motor control centers will be located in mechanical equipment rooms, close to the loads they serve.

i) One 480V:208Y/102V emergency power distribution transformer will be located in the standby/emergency power main equipment room to transform voltage from 480V to 208Y/120V between the emergency lighting panels and the main emergency branch circuit panelboards.

j) One 480V:208Y/120V, standby power distribution transformers will be located in the standby/emergency power main electrical room to transform voltage from 480V to 208Y/120V between the main standby power switchboard and the 208Y/120V standby power switchboard. The 208Y/120V standby power switchboard will feed standby power distribution panelboards in upper floors' electrical rooms, and in turn deliver power to the standby power branch circuit panelboards.

k) Emergency lighting panelboards, emergency branch circuit panelboards, standby equipment branch circuit panelboards, and standby motor control centers will be similar to those that are part of the normal power system.

l) Transient Voltage Surge Suppressors (TVSS) will be furnished on the emergency distribution panel and the two standby switchboards. The TVSS's will be MOV technology, clamping type, and will be located directly adjacent to the panels they protect. The TVSS's will provide a level of protection against the transients created by the switching of the transfer switches.

4. Distribution: Agricultural and Biosystems Engineering (ABE)

   a) The entire Emergency/Standby power distribution system will consist of conduit and wire. Busway will not be used in any portion of this system.

   b) The generator source will be divided into three distribution systems: emergency, legally required standby power, and optional standby equipment.

   c) As required by Code, the feeders and branch circuit wiring to emergency loads (lighting, fire alarm, telecommunications) will be in dedicated raceway. Individual feeders will originate at the emergency distribution panel and will rise through the building to serve the emergency lighting panels. The emergency branch circuit panelboard will be served from the emergency lighting panel via the distribution transformer.

   d) Individual standby power equipment feeders will originate at the main standby power equipment switchboard and will rise through the buildings to serve the upper floors' standby equipment distribution panelboards. The standby power distribution panelboards will in turn serve the individual standby equipment branch circuit panelboards.

   e) Individual standby motor feeders will originate at the standby power motor switchboard and will rise through the building to serve standby MCC's located in the mechanical equipment rooms, as required.

5. System Description: Biorenewables Research Laboratory (BRL)

   a) The emergency/standby power source will be derived from a single 480Y/277V diesel powered engine-generator set located in a roof mounted, sound attenuated, weatherproof enclosure. .

   b) The emergency/standby power will be distributed to three (3) automatic transfer switches. The transfer switches will split the generator power into multiple branches of power including life-safety power, legally required standby power, and optional standby power.

   c) The following equipment will be provided with emergency power in the event of a normal power failure:

      (1) Emergency Systems Power (Life Safety Systems)

         - Egress lighting
         - Exit signs
         - Fire alarm equipment
         - Critical telecommunications Equipment

      (2) Legally Required Standby Power

         - Emergency Generator enclosure lighting and receptacles.
         - Sewage ejector and sump pumps.

      (3) Optional Standby System Power (Owner Selected Systems)

- 120V/20A duplex and 208V/20A or 30A receptacles in laboratory spaces as identified in the laboratory program documents.
- Telecom, access control, CCTV, etc
- One laboratory air handing system and exhaust fans to maintain pressure relationships.
- Elevator (requirement to be confirmed by ISU)

d) The main emergency/standby power switchboard will be located in the emergency/standby power main electrical room and will distribute emergency/standby power to the building loads.

e) Standby MCC's will be located in mechanical areas near the loads that they serve.

f) Standby branch circuit panelboards, emergency egress lighting panels, and emergency branch circuit panelboards will be located on each level of each building as required.

6. Design Criteria: Biorenewables Research Laboratory (BRL)

a) The design criteria for the Emergency/Standby System will be similar to that for the normal power system.

b) The standby/emergency generator fuel tank will be sized to support at least 12 hours of generator operation at full load.

c) The capacity of the generator will be sufficient to serve the facility, with approximately 25% kW future capacity.

7. Equipment and Material: Biorenewables Research Laboratory (BRL)

a) The 300 kW/375 kVA, (final size to be determined as the program and design progresses) 480Y/277V, Emergency/Standby generator shall be located on the roof in a sound attenuated, weatherproof enclosure, with a sub-base fuel tank sized to operate the generator at full load for at least 12 hours.

b) Emergency/standby generator shall be diesel engine driven and shall consist of engine, generator, controls, exhaust system, critical silencer, radiator, batteries, starting system and generator power circuit breaker with ground fault indication. The generator main circuit breaker shall be sized to allow the generator to operate continuously at 100% of full load.

c) The generator control panel shall be used to automatically start, protect, and monitor engine-generator set using solid state controls. Control panel shall include starting motor magnetic switch, electrically operated fuel control, relay to disconnect battery charger during cranking and protective relays to open power circuit breaker and shut down engine on abnormal conditions.

d) Generator testing shall consist of the use of a load bank. An exterior wall mounted conductor lug box, fed from the generator main switchboard, will include one set of lugs permanently connected to the switchboard, and the other set of lugs will be available to temporarily install conductors from a load bank. The load bank allows the generator to be tested, without disturbing normal building loads.

e) The main Emergency/Standby Power distribution switchboard will be used to separate the generator power into three separate sources: Life Safety, Legally Required Standby Power Equipment, and Optional Standby Equipment. The switchboard will be located in the main emergency/standby electrical room. Metering will be provided to indicate various parameters including voltage, current, power, power factor, power demand, and energy.

f) 480Y/277V, three or four-pole, solid or switched-neutral, Automatic Transfer Switches (ATS) will be used to couple the generator power to the distribution system. The transfer switches will be located in the standby/emergency power main equipment room. All ATS' will be bypass-isolation type.

g) An emergency power distribution panel will be located in the standby/emergency power main equipment room and will consist of group-mounted feeder circuit breakers to serve emergency lighting panelboards or branch lighting circuits.

h) A standby power distribution switchboard will be located in the standby/emergency power main equipment room and will consist of group-mounted feeder circuit breakers to serve standby power distribution panelboards located in branch electrical rooms, as required. Standby power motor control centers will be located in mechanical equipment rooms, close to the loads they serve.

i) One 480V:208Y/102V emergency power distribution transformer will be located in the standby/emergency power main equipment room to transform voltage from 480V to 208Y/120V between the emergency lighting panels and the main emergency branch circuit panelboards.

j) One 480V:208Y/120V, standby power distribution transformers will be located in the standby/emergency power main electrical room to transform voltage from 480V to 208Y/120V between the main standby power switchboard and the 208Y/120V standby power switchboard. The 208Y/120V standby power switchboard will feed standby power distribution panelboards in upper floors' electrical rooms, and in turn deliver power to the standby power branch circuit panelboards.

k) Emergency lighting panelboards, emergency branch circuit panelboards, standby equipment branch circuit panelboards, and standby motor control centers will be similar to those that are part of the normal power system.

l) Transient Voltage Surge Suppressors (TVSS) will be furnished on the emergency distribution panel and the two standby switchboards. The TVSS's will be MOV technology, clamping type, and will be located directly adjacent to the panels they protect. The TVSS's will provide a level of protection against the transients created by the switching of the transfer switches.

8. Distribution: Biorenewables Research Laboratory (BRL)

a) The entire Emergency/Standby power distribution system will consist of conduit and wire. Busway will not be used in any portion of this system.

b) The generator source will be divided into three distribution systems: emergency, legally required standby power, and optional standby equipment.

c) As required by Code, the feeders and branch circuit wiring to emergency loads (lighting, fire alarm, telecommunications) will be in dedicated raceway. Individual feeders will originate at the emergency distribution panel and will rise through the building to serve the emergency lighting panels. The emergency branch circuit panelboard will be served from the emergency lighting panel via the distribution transformer.

d) Individual standby power equipment feeders will originate at the main standby power equipment switchboard and will rise through the buildings to serve the upper floors' standby equipment distribution panelboards. The standby power distribution panelboards will in turn serve the individual standby equipment branch circuit panelboards.

e) Individual standby motor feeders will originate at the standby power motor switchboard and will rise through the building to serve standby MCC's located in the mechanical equipment rooms, as required.

D. Grounding System

1. System Description

a) A complete low-impedance grounding electrode system will be provided for this facility. The grounding electrode system will include the main water service line, structural steel, building footing steel (concrete encased), and ground ring around the perimeter of the BRL and ABE buildings, if required by the lightning protection contractor. The equipment grounding system will extend from the building service entrance equipment to the branch circuit. All grounding system connections will be made using exothermic welds.

b) Bonding jumpers will be provided as required across pipe connections to water meters, dielectric couplings in a metallic cold water system, and across expansion/deflection couplings in conduit and piping systems.

c) All feeders and branch circuits will be provided with an equipment ground conductor. Under no circumstances will the raceway system be used as an equipment grounding conductor.

d) Each generator will feed multiple transfer switches, and per IEEE Standard 446-1995, switching the neutral has certain advantages, including reducing circuit breaker trips due to false ground fault detection. Since the neutral will be switched, the generator will be considered separately derived system and will not be bonded to the electrical service neutral.

2. Design Criteria

a) The grounding electrode system will be designed in accordance with NEC article 250.

b) System resistance to ground will be 5.0 ohms or less.

3. Equipment and Material

a) The reference ground for the equipment grounding system will be established from a structural ground grid as follows:

b) A #3/0 AWG bare copper ground wire will be installed at 30" below grade around the entire perimeter of the ABE and BRL buildings, if required by the lightning protection contractor. 5/8" x 10' driven copper ground rods (test wells) will be installed and connected to this ground loop at not-greater-than 200-foot intervals with a #3/0 AWG bare copper conductor. Steel columns in exterior walls will also be connected to this ground loop with #3/0 AWG bare copper at intervals not to exceed 60 feet. Interior steel columns will be connected to the exterior ground loop on each side of the building at intervals not to exceed 200 feet with a #3/0 AWG bare copper conductor.

c) Additional ground loops shall be provided around the outdoor utility transformer, electrical equipment rooms, and emergency generator rooms. These ground loops with be bonded to the main ground bus bar inside the main electrical equipment room.

d) Wall-mounted copper ground bus will be located in the main electrical room, floor electrical rooms, and voice/data rooms. The main electrical room ground bus will be connected to the exterior ground loop, if available.

4. Distribution

a) A separate, insulated #3/0 AWG ground wire will be provided from the main electrical room ground bus to each floor's electrical room ground buses, underground incoming water service line ahead of meter, and underground gas line at the building entrance.

b) The main service entrance neutral will be bonded to the system ground bar within the switchboard by a removable bus bar link.

c) A code-sized, unbroken bond leader will be connecting the electrical room ground bar to the XO terminal of the local transformers.

d) A #3/0 AWG, bare copper, grounding electrode conductor will be extended to all voice/data rooms, so that those systems can be properly bonded.

e) A separate ground wire will be provided for all circuits.

E. Lightning Protection System

1. System Description

a) Protect all structures and associated appurtenances with a system of conductance designed to safely divert the energy of a lightning strike to the earth while minimizing damage to the facility.

2. Design Criteria

a) Comply with NFPA 780 - Standard for the Installation of Lightning Protection Systems. Installing Contractor will provide a UL Master Label for the completed system.

3. Equipment and Material

a) Materials will be rated Class I for structure heights of 75 ft or less. Class II for structure heights above 75 ft.

b) Air terminals will be solid copper with a tapered point, 10" minimum height, and have a mounting base suitable for the location.

c) Conductors will be bare-stranded copper, except aluminum will be used where installation is in contact with aluminum surfaces.

d) Ground rods will be copper-clad steel, 5/8" diameter by 10 ft long, with a bronze mechanical-type conductor clamp.

4. Distribution

a) The system layout and design will encompass all exterior surfaces of the facilities under a complete zone of protection as defined by NFPA 780. Air terminal spacing will not exceed 20 feet, except spacing up to 50 feet is allowed for non-perimeter areas of flat roofs. Locations will comply with NFPA 780 and will generally follow the building roof ridges and/or perimeters.

b) One (1) down conductor will be provided for every 250 linear feet of building perimeter, with a minimum of two (2) conductors. Conductors will be configured to provide a two-way path to earth. Metal bodies will be bonded to the conductor system in accordance with NFPA 780.

c) A ground rod will be connected to each down conductor. The electric power service grounding system will be bonded to the Lightning Protection System.

F. Lighting Systems

1. System Description

a) A complete lighting system for all indoor and outdoor illumination will be provided. The indoor lighting system will consist primarily of energy-efficient fluorescent lighting fixtures and the use of natural light. High-intensity discharge lighting will be used in selected indoor locations such as parking, loading dock, warehouse, and large mechanical spaces. Incandescent lighting will be used only as requested by the Owner or where aesthetics are of prime importance. The outdoor lighting system will consist of high intensity discharge lighting fixtures.

b) In general, indoor lighting controls will consist of low-voltage switches controlled by low-voltage lighting control system, room occupancy sensors, and line voltage switches (final lighting control schemes to be coordinated with ISU and Architect). Outdoor lighting controls will utilize photocells and control by the Building Automation System.

c) Emergency/night lighting will be provided by unswitched branch circuits. These unswitched branch circuits will be fed from an emergency lighting panel.

2. Natural Daylighting Strategies

a) Electric lighting for the ABE/BRL facility will be specified with the most current energy efficient and environmentally sensitive lamp and ballast technologies. The focus of the electric lighting design will be to supplement rather than replace natural daylighting. The first light source of choice for most building occupancy spaces will be natural daylighting. It is chosen for its excellent color rendering properties, high efficiency and inherent natural variability, which has the great capacity to inform occupants of general weather conditions and also to entrain the human circadian rhythm cycle. The proposed lighting strategies will support all critical visual activities with proper illumination of sufficient quality and quantity suitable for a world class building.

b) The more daylighting that is allowed into any building, the more it will be apparent that the electric lighting within is far weaker in comparison. This is just the function of human perception. The task lighting at the work stations as well as the general ambient electric lighting will appear inadequate to a person who has just glanced down from a south facing curtain wall unless it is heavily shaded. The balance of brightness within the entire field of view must be taken into account and reconciled to insure a comfortable visual environment. This may mean higher connected electric lighting to wash more vertical surfaces with higher light levels if daylighting is present in abundance and hence, greater corresponding internal heat generated only to be removed mechanically. If the amount of daylight is carefully controlled and limited, then lower internal electric lighting levels are required to balance the daylight brightness.

c) Consistent with the LEED-NC Reference Guide and good engineering practices, an overall reduction of connected lighting density of 20 to 30% may be expected as compared to the allowances published in the IESNA.

3. Design Criteria

a) Design Lighting Levels, Average Maintained Footcandles:

Office:	50-70
Laboratory, Support, Technical Area:	
▪ Bench and Table Top:	80-100
▪ Elsewhere:	50
Conference:	60
Corridor:	15-20
Lobby:	25
Toilets:	20
Storage:	10
Mechanical/Electrical:	
▪ Task:	40
▪ General:	10-20
Open Parking:	0.5
Covered Parking:	5
Exterior Lighting:	1-2

4. Equipment and Material

a) Lighting Fixture Types:

Laboratory and Laboratory Support:

- Direct/indirect fluorescent fixtures or 2' x 4', 3- or 4- lamp recessed fluorescent troffer with acrylic lens and 2- or 3-lamp ballasts.

Office:

- 2' x 4', 2- or 3-lamp recessed fluorescent troffer with deep cell parabolic louver or suspended indirect fluorescent fixture; 2-lamp ballasts.

Common Area:

- Premium quality architectural fluorescent or HID lighting.

Circulation:

- 1' x 4', 2-lamp recessed fluorescent troffer with deep cell parabolic louver or wall-mounted compact fluorescent sconces; 2-lamp ballasts.

Building Support:

- 4', 2-lamp, surface- or pendant-mounted, open industrial fluorescent fixture; 2-lamp ballasts.

- Metal halide industrial fixture.

Open Parking:

- High-pressure sodium custom parking lot fixture.

Closed Parking:

- High-pressure sodium surface mounted fixture. The design team will investigate the potential use of LED light fixtures to be installed in the parking ramp.

- The fixtures in cold rooms will be rated for intended applications.

b) The fixtures in wash rooms and wet areas will be UL Listed for a wet location.

c) EXIT signs will be ISU FP&M approved LED type, located in all paths of egress.

d) Lamps and Ballasts:

(1) In general, fluorescent lamps will be 32 watt, T8, 3500K color temperature, with a color rendering index of 75 or greater. Metal halide lamps will be clear with a color rendering index of 60 or greater. High-pressure sodium lamps will be clear.

(2) Fluorescent ballasts will be high-frequency electronic type with less than 10% total harmonic distortion. High-intensity discharge ballasts will be high power factor, constant wattage type.

e) Lighting Control:

(1) Photocells and occupancy sensors will be utilized in select spaces to minimize energy consumption. Occupancy sensors will be passive infrared or a combination infrared/ultrasonic type.

(2) Dimmers will be provided in conference rooms as required.

(3) A programmable, low-voltage control system will be provided in the BRL and ABE. It will consist of low-voltage switching and relays and will control all lighting excluding, mechanical, and janitorial spaces. The system will be software based and will provide flexible control of automatic and manual on/off, recording, and reporting functions.

5. Distribution:

a) In general, fluorescent and high-intensity discharge lighting will be 277V. Incandescent lighting will be 120V, and lighting control wiring will be low voltage.

b) All lighting circuit wiring will be in conduit and routed concealed within walls, partitions, or ceiling spaces. Surface-mounted conduit will be minimized and used only in non-finished spaces.

c) The ampacity of lighting circuits will be sized for 25% future growth plus 125% continuous loading factor per the National Electric Code.

G. Fire Alarm System

1. System Description

a) Each building will have a fire alarm system and will be stand-alone, fully addressable system as manufactured by Notifier, Simplex, Gamewell-FCI, or equal.

b) The fire alarm system will be comprised of smoke detectors, heat detectors, duct detectors, manual pull stations, and audio/visual signaling devices.

2. Design Criteria

a) The fire alarm system will comply with requirements of NFPA 72 for a protected premises signaling system except as modified and supplemented by this document.

b) A main fire alarm control panel(s) will be located at a location as determined by ISU and the Authority Having Jurisdiction.

c) A fire alarm annunciator panel(s) will be mounted at the main building entrance, if required by ISU and fire department

d) Audio/visual devices will be installed in all areas of the building in accordance with the NFPA and the ADA Guidelines.

e) Smoke detectors shall be installed as required by the National Fire Protection Association, the Uniform Building Code, and the Uniform Fire Code. Smoke detectors will be installed in, but not limited to, the following locations: air handling units, elevator lobbies, elevator machine rooms, and electrical equipment rooms.

f) Heat detectors will be installed in areas that are not feasible for smoke detectors.

g) Manual Pull Stations will be installed adjacent to all exit doors and in each elevator lobby.

h) The fire alarm system will be linked with the campus central system via 18-2 shielded cables, to the nearest building automation panel.

3. Equipment and Material

a) The fire alarm system will be an electronically multiplexed voice communication system.

b) Remote transponder panels will be used to provide supervised amplifiers and signal circuits for audio/visual devices and magnetic door holders.

c) The system will utilize individual, addressable photoelectric smoke detectors; heat detectors; addressable manual pull stations; and addressable monitor and control modules. The system will monitor all sprinkler supervisory and water flow switches and will interface with elevators, HVAC smoke control, and smoke fire dampers.

d) All fire alarm equipment will be UL listed.

e) Fire alarm system will have 12 hours of battery capacity and generator backup.

f) Smoke detectors will be analog addressable type and have alarm verification, set at 60 seconds.

g) Minimum size conductor for door holder circuits, horn, and strobe circuits will be 14 AWG. Raceway junction box covers shall be painted red for identification.

4. Distribution

a) All initiating and signaling devices will operate at 24VDC and will be installed in accordance with manufacturer's specifications.

b) All wiring will be installed in conduit. Minimum conduit size will be 3/4".

c) Wire nut connections in control panels shall be prohibited.

d) Water flow detection devices shall have one device per address.

e) Signaling line circuits will not be loaded greater than 75% of capacity. The panel will have one spare signaling line circuit or capacity for 50 additional initiating devices.

f) Notification appliance circuits will be designed with a minimum of 20% spare capacity. Performance of the system will provide for silencing of audible appliances without affecting visual appliance operation.

g) Fire fighters handset will be provided at fire alarm annunciator panel to permit emergency responders to communicate with building occupants. Speakers to be zoned by floor. General alarm conditions, temporal code-three signal.

h) All circuits will be Class B. The end of line resistor will be located at the last device of the circuit; identified on drawings and in field. Limit circuits to one floor or major area. Terminal strips will be labeled.

i) Door hold open circuits will be from fire alarm panel in lieu of auxiliary contacts in the detector base.

j) Concealed initiating devices (duct smoke detectors, tamper switches, etc.) will have remote alarm indicators identifying the location of the device. Remote indicators will be located in public spaces (such as corridors). Duct smoke detectors shall have remote indicators with test stations.

k) A weatherproof exterior horn/strobe will be mounted above the sprinkler system fire department connection, powered by a notification appliance circuit.

l) An electrical outlet shall be provided within 10 ft of the fire alarm control panel.

m) Fire alarm junction box covers shall be painted red.

n) Record drawings shall document fire alarm address for each device, along with wire and cable identification numbers.

SECTION II.P.

INFORMATION TECHNOLOGY SYSTEMS
(INCLUDES VOICE, DATA, AND AUDIO/VIDEO, LIFE SAFETY, SECURITY/ACCESS SYSTEMS)

INFORMATION TECHNOLOGY SYSTEMS

I. Purpose

This Basis of Design (BOD) describes the magnitude, functions and requirements of the low voltage Information Technology (IT) cabling for the Iowa State University – Biorenewables Complex. It presents a description of the individual systems' proposed design and function, and represents decisions and information available to the design team through July 2007. It is a living document that will be modified to best meet the needs of Iowa State University (ISU) throughout the development of the project.

A. Approach

1. Identify the IT systems included in the project.
2. Coordinate the IT intrabuilding cabling plan and IT support spaces with ISU and OPN Architects.
3. Coordinate the IT interbuilding cabling plan with ISU and users.
4. Assist OPN Architects with IT systems' device location programming.
5. Coordinate IT systems' Mechanical, Electrical, Structural and Architectural needs.
6. Coordinate development of IT Design Documents with entire Project team.

B. Scope of Work

1. The IT systems in this Project will include design and implementation information for the building structured cabling system. This system will support voice, data, and video applications using equipment supplied by the Owner.
2. The structured cabling system will also include pathway to support access control and CCTV.
3. Buildings covered in this BOD
   a) Biorenewables Research Laboratory (BRL)
   b) Agricultural and Biosystems Engineering (ABE)
   c) Parking Administration Building
   d) Campus Police Administration Building
   e) Parking Structure

C. Definitions

1. Backbone Cabling - Cables connecting MDF to IDFs.
2. Cable - Assembly of one or more conductors or optical fibers within enveloping sheath, constructed to permit the use of conductors singly or in groups.
3. Cable Link - Includes SIO, station cable and termination hardware in consolidation points and MDF or IDF.
4. Cable Channel - Same as Cable Link, plus patch cords at SIO and in MDF or IDF.

5. CATV – Cable Television

6. CCTV – Closed Circuit Television

7. Consolidation Point - Interconnection point within the horizontal cabling using ANSI/TIA/EIA-568-B.2 or ANSI/TIA/EIA-568-B.3 compliant connecting hardware installed in accordance with the requirements of Clause 10 and rated for at least 200 cycles of reconnection.

8. Cross-Connect - Group of connection points, wall or rack mounted, used to mechanically terminate and administer building wiring.

9. Faceplate - Component at SIO that holds the outlet.

10. Horizontal Cabling - Cables connecting SIOs to MDF, IDFs and/or consolidation points.

11. IDF - Intermediate Distribution Frame - Used to distribute station cabling to workstation outlets and to house communications equipment.

12. Intrabuilding - Within a single building.

13. Interbuilding - Between two or more buildings.

14. IT - Information Technology

15. LAN - Local Area Network - Network or networks typically covering a small geographic area. Typically includes only Client-owned cabling and equipment.

16. MAN - Metropolitan Area Network - Network or networks typically covering a city-wide geographic area. Typically includes Client-owned equipment and service provider owned cabling and equipment.

17. MDF - Main Distribution Frame - Located on the lowest level of the main building in the complex. Incoming service enters the building in this room. Building voice, data and video services are distributed to IDFs on all levels from this room.

18. OFOI – Owner Furnished, Owner Installed

19. Outlet - See SIO

20. SIO - Standard Information Outlet - A device assembly located in work area on which station cabling terminates and which can receive modular connectors.

21. Station Cabling - See Horizontal Cabling.

22. Telecommunications - Any transmission, emission, or reception of signs, signals, writings, images, sounds, or information of any nature by wire, radio, visual, optical, or other electromagnetic systems.

23. UTP - Unshielded Twisted Pair - Balanced, 4-pair cable used for copper station cabling and multi-pair copper backbone cables.

24. WAN - Wide Area Network - Network or networks typically covering a large geographic area. Typically includes Client-owned and service provider-owned cabling and equipment.

II. Structured Cabling

A. Base Design Criteria

1. Applicable Codes, Guidelines and Standards

a) NFPA 70, National Electric Code (NEC)

b) ANSI/TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements

c) ANSI/TIA/EIA 568-B.1-4, Recognition of Category 6 and 850 nm Laser-Optimized 50/125 μm Multimode Optical Fiber Cabling

d) ANSI/TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components

e) ANSI/TIA/EIA 568-B.3, Optical Fiber Cabling Components Standard

f) ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces

g) ANSI/TIA/EIA-606-A, Administration Standard for Commercial Telecom-munications Infrastructure

h) ANSI/TIA/EIA-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications

i) BICSI TDMM, BICSI Telecommunications Distribution Methods Manual

j) Iowa State University – Facilities Planning & Management, Facilities Design Manual

2. Load Calculation Criteria

a) The following outlet quantities indicate the general outlet densities expected for the project. Specific requirements to satisfy user needs will be implemented as space programming is completed.

Area	Voice outlets per backbox	Data outlets per backbox	Backbox locations
Private Office	1	1	1 per office
Cubical Work Space	1	1	1 per work area
Classroom - Student	0	1	1 per work area
Classroom - Lecture	1	1	2 on lecture wall
Laboratory	1	1	At podium
Laboratory	1	1	At printer
Laboratory	1	0	Wall phone at entrance door
Computer Laboratory	0	2	1 per computer pair

b) Each wireless access point location will have one data outlet. Access points will be powered over the Ethernet.

c) For planning purposes, nominal density is one voice and one data per user.

3. Equipment Sizing Criteria

a) Pathways

(1) Cable pathways will be sized with a minimum of 50% spare capacity, or spare pathways will be provided to allow for growth.

(2) Interbuilding pathways will have 100% spare capacity over initially installed cabling.

(3) Intrabuilding pathways will have 50% spare capacity over initially installed cabling

(4) All pathway calculations will be based on a 40% maximum fill ration based on cross sectional area.

(5) Station pathway will be 1 inch minimum.

(6) Pathways will be installed to connect MDF and IDFs in an efficient manner.

b) Termination and Mounting Space

(1) Equipment racks and wall fields will be sized with a minimum of 40% spare capacity.

4. Copper Voice Backbones

a) Interbuilding copper voice backbones will be sized at one pairs per each required outlet, plus 50 percent growth, and then rounded up to the next common size.

b) Intrabuilding copper voice backbones will be sized at a minimum of 100 pairs per IDF and will have a 40 percent growth factor.

(1) Network electronics will be sized, furnished and installed by the Owner.

III. System Descriptions

A. General

1. The Information Technology (IT) structured cabling design will provide Iowa State University – Biorenewables Complex with a solid infrastructure to support all network-related services. This includes adequate space planning, security, power, cooling, and a high quality structured cabling system. These components will provide the foundation to support the building occupants' IT needs well into the future.

2. The structured cabling system will be provided as a CommScope certified cabling system. The manufacturer of the cable and termination components will qualify and warranty the performance of the entire system.

3. The following table lists expected system needs:

Building	Voice	Data	CATV	CCTV (support)	Access Control (support)	Audio-Visual (support)
Biorenewables Research Laboratory	X	X	X	X	X	X
Agricultural and Biosystems Engineering	X	X	X	X	X	X
Parking Administration Building	X	X		X	X	
Campus Police Administration Building	X	X		X	X	
Parking Structure	X	X		X	X	

B. Support Rooms

1. General

a) All IT support rooms have several common requirements. Each room will be provided with card access security control, standby power receptacles and continuous HVAC cooling.

b) The support rooms should be located central to the areas that they serve and have clear access to cable pathways coming in and out of the rooms. Pedestrian and equipment access should be through a door located off a building corridor and should not require access through any other locked room. Door width will be at least three feet and open outward.

c) The support rooms should be vertically stacked so that backbone cables can be run without offsets.

d) The support rooms should be located so that all work areas can be reached with a maximum length of 295 foot voice or data cable, including slack.

e) Suspended ceilings should not typically be provided, however some means of maintaining the environmental parameters of the rooms must be implemented. If a suspended ceiling is required to maintain environmental integrity, the ceiling should be installed high enough to allow all pathways and room services to come into the rooms below the ceiling. Minimum ceiling height should be 10'-0".

f) Floors, walls and ceilings in the support rooms will be treated to minimize dust and the potential for static electricity. All walls will be covered with plywood (3/4 inch thick, 8 feet high, A-C grade), painted on all surfaces with fire-retardant paint.

g) The distributed floor rating shall be greater than 250 lb-ft/ft2.

h) The concentrated floor rating shall be greater than 1000 lb-ft/ft2.

2. Main Distribution Frame (MDF)

a) The building MDF provides a protected environment for terminating all backbone cables. This room is where the building IT systems connect to the campus IT systems and distribute to the building

b) The MDF requires a minimum of 140 total square feet (10 feet by 14 feet) of clear space. The room will house voice cable terminations, data network equipment and data cable terminations.

c) The MDF also serves as an IDF.

d) Each standalone building will require an MDF. A single MDF can serve all functions that are in a common structure. As the project develops, MDF quantities and locations will be finalized.

3. Intermediate Distribution Frames (IDF)

a) IDFs provide a protected environment for terminating backbone cabling and station cabling on each floor and IT services to the floor will be provided from the IDFs. Network electronics will also be housed in the IDFs.

b) Each IDF requires a minimum of 120 square feet (10 feet by 12 feet) of clear space.

c) Each floor of each building will require a minimum of one IDF. ISU-FP&M will have the option of eliminating IDFs further on in design. For space planning purposes, there should be a minimum of one IDF per 10,000 SF.

d) Each IDF will connect to the building MDF with intrabuilding backbone cabling.

C. Backbone Cabling

1. General

a) The project will provide underground pathway from each new structure housing an MDF to the existing campus duct bank and manhole system. This pathway will carry copper and fiber optic cable to connect to campus systems. All IT services for this project will enter through the duct bank and manhole system.

b) The project will connect to existing underground pathway at Telecommunications Manhole 32.

c) Building voice and data service will be provided from the Black Engineering Node Room.

d) Existing conduit spare capacity will need to be confirmed.

e) Minimum pathway size into building will be four (4) – four inch PVC schedule 40 conduits.

f) Cable splice locations are only allowed at ISU designated locations.

g) Each standalone building will require a connection to the campus infrastructure. If buildings spaces are combined into one structure, then only one connection to the campus will be required.

2. Underground Conduit

a) Galvanized steel conduits (direct buried) or reinforced concrete encased schedule 40 PVC conduits shall be installed from the inside of the building to three feet minimum past the excavation line of the building.

b) Direct buried schedule 40 PVC shall be installed from three feet past excavation line to the manhole.

c) Minimum depth for conduit shall be 24 inches below finished grade.

d) No backbone conduit shall be routed under current or planned building foundations.

e) All conduit will include 1000 lb. test, non-corrosive graduated pull tape.

3. Interbuilding Data Backbone Cabling and Connection Hardware

a) The data system will use fiber optic cabling to bring data service into the building at the MDF. Preliminary sizing for this cable is a 24 single mode strands and 24 multimode strands.

b) All fiber strands will terminate in rack mounted patch panels in the MDF. Single mode cable will terminate on SC connectors. Multimode cable will terminate on LC connectors.

c) The installing contractor will source this cable from ISU.

4. Intrabuilding Data Backbone Cabling and Connection Hardware

a) The data system will use fiber optic cabling to distribute data service from the MDF to the IDFs. The data backbone from the MDF to each IDF will be sized at 12 total strands, including 4 single mode strands and 8 multimode strands.

b) All fiber strands will terminate on LC connectors in rack mounted patch panels in the MDF and IDFs.

5. Interbuilding Voice Backbone Cabling and Connection Hardware

a) The voice system will use high pair-count copper cabling to bring voice service into the complex at the MDF.

b) Cable type shall be ANMW style, 24 AWG, with metallic sheathing.

c) The voice backbone termination hardware will be sized with a 50 percent growth factor.

d) All cable pairs will terminate on wall-mounted system terminal blocks and be cross-connected to wall-mounted terminal blocks.

e) Acceptable splice locations, if any, shall be determined by ISU.

6. Intrabuilding Voice Backbone Cabling and Connection Hardware

a) The voice system will use high pair-count copper cabling to distribute voice service from the MDF to the IDFs.

b) The voice backbone termination hardware will be sized for up to with a 50 percent growth factor.

c) All cable pairs will terminate on wall-mounted 110-blocks.

d) Cable will be CommScope SYSTIMAX® 2010 LAN™ , 100 pair cable.

e) Cable will have 24 AWG conductors and be rated CMP.

D. Station Cabling

1. General

a) Maximum cable length is 295 feet.

b) Splicing is not allowed.

2. Data Station Cabling and Connecting Hardware

a) Each data outlet will connect to the nearest IDF with a 4-pair UTP, Category 6A cable. All four pairs will terminate at the outlet and in the IDF. All terminations will use the T568B pinout.

b) Category 6A rated 8P8C type outlets will be used at the outlet locations and rack mounted patch panels will be used in the IDFs.

c) Cables from wall and floor mounted outlets will run in conduit and cable trays to the IDFs.

d) Cables will be CommScope SYSTIMAX® GigaSPEED X10D 2091. Outlets will be CommScope MGS 500.

e) Cable will have 24 AWG conductors and be rated CMP.

f) Cables will be yellow.

g) Work area outlets will be orange. Patch panel outlets will be black.

3. Voice Station Cabling and Connecting Hardware

a) Each voice outlet will connect to the nearest IDF with a 4-pair UTP, Category 6A cable. All four pairs will terminate at the outlet and in the IDF.

b) Category 6A rated 8P8C type outlet will be used at the outlet locations and wall mounted 110-blocks will be used in the IDFs. Outlet terminations will use the T568B pinout.

c) Cables from wall and floor mounted outlets will run in conduit and cable trays to the IDFs.

d) Cables will be CommScope SYSTIMAX® GigaSPEED XL 2081. Outlets will be CommScope MGS 500.

e) Cable will have 24 AWG conductors and be rated CMP.

f) Cables will be blue.

g) Work area outlets will be ivory. Patch panels outlets will be black.

4. Patch Cables

   a) Patch cables will be provided to match the data outlet cable and termination hardware. This ensures maximum performance of the cable system by matching station cable impedance with patch cable impedance.

5. Support Equipment

   a) Innerduct

      (1) All backbone fiber optic cabling will be installed in flexible, nonmetallic innerduct. This innerduct will protect the cables and segregate conduits and conduit sleeves.

   b) Backboxes

      (1) Each work area outlet shall be supported by a double gang back box and single gang mud ring.

   c) Face Plates

      (1) All face plates shall be four position CommScope SYSTIMAX® M14L.

      (2) Unused outlet openings shall be filled with a blank insert.

      (3) Icon inserts shall be "GS" type.

   d) Equipment Racks

      (1) All copper and fiber optic patch panels will be installed in 7 foot high, standard TIA/EIA 19" equipment racks.

      (2) Vertical cable management will be provided on both sides of all equipment racks.

6. Cable Raceways

   a) The cable raceway system will consist of a combination of cable tray, conduit, cable runway and D-rings. The cable runway and D-rings will only be used in the support rooms.

   b) J-hooks will not be allowed.

   c) Surface raceway will not be allowed.

   d) Floor to ceiling and furniture to ceiling raceway will not be allowed.

   e) Cable pathways from the voice and data outlets to the IDFs will use conduit to cable tray above accessible ceilings.

   f) Vertically stacked rooms will be connected by a minimum of four-4 inch EMT conduit sleeves or equivalent cable tray.

   g) IDF floor-to-floor raceway will be for the exclusive use of telecommunications systems.

   h) Initial cabling plus growth shall not exceed 40 percent cross sectional area of any raceway.

   i) Fire alarm cables will be allowed in the center of the cable tray.

j) Building Automation cables will be allowed in the cable tray only if a divider is provided.

k) Security, CCTV, and Access Control cables will be allowed in the cable tray only if a divider is provided. Cable tray above accessible ceiling shall be basket type. Cable tray above hard ceiling shall be solid bottom with access ports every 8 feet.

l) Cable tray in exposed areas shall have smooth solid bottom construction, installed at a minimum of 8 feet above finished floor, and be painted to match ceiling color.

m) Above ceiling cable tray shall be heavy-duty wire basket with 4 inch side rail. Acceptable manufactures are GS Metals Flextray and CABOFIL E-Z Tray.

n) Access to cable tray shall occur a minimum of every 8 feet.

7. Grounding System

a) The information technology grounding system will provide equipment protection in all support rooms. Ground bars and conductors will be provided to minimize the potential difference between the grounding system and the electrical sources powering the IT equipment.

b) Voice and data outlet conduit will be grounded to cable tray.

8. MEP Requirements

a) No piping, ductwork, or conduit will pass over or through any IT support room, unless they are used to provide services to the support rooms. Piping and ductwork used to provide services to these rooms will be coordinated with the anticipated IT equipment layout within the rooms.

b) Electrical Requirements

(1) Provide NEMA 5L30 receptacle within 7 feet of equipment rack. This is in addition to convenience outlets.

(2) IT support rooms will be connected to the building normal power source. Rack-mounted UPS equipment (OFOI) will be used to maintain system operation while the standby power source comes on-line.

(3) Electrical service for the MDF will be sized at 75 watts per square foot.

(4) Electrical service for the IDFs will be sized at 50 watts per square foot.

(5) IT support rooms will be lit to a minimum of 50 foot candles between the equipment rack rows (measured at three feet above the floor) and will provide adequate vertical surface illumination to the bottom of racks.

(6) Access to IT support rooms will be controlled by the building access control system to allow the Owner to track access to the rooms.

c) Mechanical Requirements

(1) IT support rooms will be maintained at between 64 and 75 degrees Fahrenheit with 30% to 55% relative humidity at all times. Minimum air change rate should be once per hour. If the building HVAC system cannot provide continuous operation or adequate capacity to meet these criteria, supplemental cooling units will be installed.

(2) Cooling requirements for the MDF will be sized at 40 watts per square foot.

(3) Cooling requirements for the IDFs will be sized at 40 watts per square foot.

(4) Filters should be serviceable from outside the IT support room.

d) Piping Requirements

(1) Fire suppression in MDFs and IDFs will be provided by a wet pipe sprinkler system

(2) Sprinkler heads shall be protected with wire cages.

E. Additional Systems

1. Wireless Local Area Network

a) Wireless access point locations will be designated by ISU Telecommunications Office and FP&M.

b) Wireless access points and power supplies will be OFOI.

2. Audio-Visual

a) Pathway for owner provided audio-visual equipment (projectors, microphone/speaker systems, lighting controls) will be based on ISU designated locations.

b) Pathway for owner provided bidirectional distance learning equipment will be based on ISU designated locations.

3. CATV

a) The project will provide unterminated coaxial cable from the MDF to each IDF and coaxial cable from outlet locations to the MDF/IDF serving the area. Horizontal cable will be terminated at the outlet and unterminated at the IDF.

b) Minimum backbone cable size will be RG11. Minimum horizontal cable size will be RG6.

c) All indoor CATV cable will be plenum rated.

d) Iowa State University CATV provider will design and provide splitters, amplifiers, SM fiber to coax converter equipment and terminate all coax cable at the MDF/IDF's.

e) SM fiber will be used to bring the signal to the complex. This cable will originate in Black Engineering.

4. Access Control

a) Pathway for owner provided access control will be installed at locations indicated by ISU.

b) Access control pathway will be coordinated with Architect, Electrical Engineer, and access control system provider.

c) All exterior doors and the vivarium entry will have access control.

d) Additional controlled doors may be designated by ISU.

5. Security CCTV

    a) Pathway for owner provided CCTV will be installed.

    b) All exterior doors and vivarium entry will be monitored.

    c) Additional monitoring locations may be designated by ISU.

SECTION III.

TABULATION OF AREAS

ISU Biorenewables Complex - Agricultural and Biosystems Engineering Facility

November 1, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Notes:
(1) With faculty offices
(2) Near front door
(3) Keep within 1 floor of Gound Floor
(4) Yard access
(5) Can be grouped into one space
(6) Group together
(7) Prefer access to day light
(8) Can be in same h___bay as High Bay, Field M   ch, Tractor Dyno?
(9) class to Classroom - Environmental
(10) Near Water Quality
(11) Near Entry

Room Type	Room Number		Floor PD	Floor SD	DD	CD	Notes	Total Rooms PD	SD	DD	CD	Total Occupants	Occupants/Room	Room Size	NSF / Room PD	SD	NSF Total PD	SD	DD	CD	Comments
A1.0		**Admin**																			
A1.1		Department Administration																			
A1.1.1		Department Executive Officer	G	G				1	1			1	1	15'-0" x 15'-0"	225	246	225	246			
A1.1.2		Program Assistant	G	G				1	1			1	1	15'-0" x 10'-0"	150	149	150	149			
A1.1.3		Reception	G	G				1	1			5	5	15'-0" x 15'-0"	225	269	225	269			Waiting area, Administrative Assistant
A1.2		Student Help Center																			
A1.2.1		Director	G	G				1	1			1	1	15'-0" x 10'-0"	150	152	150	152			
A1.2.2		Program Advisors	G	G				3	3			3	1	15'-0" x 10'-0"	150	152	450	456			
A1.2.3		Student Assistants	G	G				1	2			1	2	15'-0" x 10'-0"	150	80	150	160			
A1.2.4		Meeting/Testing Room	G	G				3	3			12	4	15'-0" x 10'-0"	150	147	450	441			
A1.2.5		Reception	G	G				1	1			4	4	15'-0" x 10'-0"	150	255	150	255			Waiting area
A1.3		Accounting Services	U	G			1	1	1			2	2	15'-0" x 10'-0"	150	154	150	154			
A1.4		Clerical Office	U	G			1	1	1			4	4	20'-0" x 15'-0"	300	300	300	300			May be located on upper floor
A1.5		Confidential File Room	U	G			1	1	1			NA	NA	15'-0" x 10'-0"	150	152	150	152			
A1.6		Copy/Mail Room	U	G			1	1	1			NA	NA	15'-0" x 10'-0"	150	306	150	306			
A1.7		Conference Room	U	2,4			1	2	2			12	12	24'-0" x 15'-0"	360	323	720	645			
A1.8		Conference/Library/Break Room	G	3				1	1			20	20	35'-0" x 30'-0"	1,050	1,023	1,050	1,023			
A1.8.1		Kitchenette	G	3			1	1	1			NA	NA	12'-0" x 10'-0"	120	107	120	107			
A1.9		Meeting/Break Room	U	G				2				16	16	24'-0" x 20'-0"	480	534	960	543			
A1.10		IT Services																			
A1.10.1		Staff	O	2				1	1			1	1	15'-0" x 10'-0"	150	151	150	151			
A1.10.2		Student Assistants	O	2				1	1			2	2	15'-0" x 10'-0"	150	110	150	110			
A1.10.3		Server Room	O	2				1	1			4	4	15'-0" x 10'-0"	150	147	150	147			
A1.10.4		Storage	O	2				1	1			NA	NA	10'-0" x 5'-0"	50	60	50	60			
A1.11		Communication/Marketing																			
A1.11.1		Staff	O	4				1	1			1	1	15'-0" x 10'-0"	150	157	150	157			
A1.11.2		Copy/Mail Room	O	4				1	1			NA	NA	15'-0" x 10'-0"	150	192	150	192			
A1.12		Midwest Planning Services																			
A1.12.1		Staff	O	4				2	2			1	1	15'-0" x 10'-0"	150	158	300	316			
		Total Admin															6,650	6,491			
A2.0		**Grad/Post Doc Offices**																			
A2.1		Post Docs	U	2,3,4				6	6			12	2	15'-0" x 10'-0"	150	157	900	942			25 additional students located in lab area only
A2.2		Grad Student																			
A2.2.1		Cubicle Cluster	U	2,3,4				25	25			100	4	15'-0" x 10'-0"	150	156	3,750	3,900			
A2.2.2		Meeting	U	2,3				6	4			24	4	10'-0" x 10'-0"	100	149	600	596			
A2.2.3		Grad Study/Lounge	U	3,4				1	2			15	15	30'-0" x 20'-0"	600	324	600	648			
		Total Grad/Post Doc Offices															5,850	6,086			
A3.0		**Faculty Staff**																			
A3.1		Faculty Offices	U	2,3,4				33	33			33	1	15'-0" x 10'-0"	150	160	4,950	5,280			
A3.2		Visiting Faculty	U	2				2	2			4	2	15'-0" x 10'-0"	150	157	300	314			
A3.3		Emeritus Faculty	U	2				2	2			4	2	15'-0" x 10'-0"	150	157	300	314			
A3.4		Copy/Workroom	U	2				1	3			NA	NA	15'-0" x 10'-0"	150	243	150	729			
		Total Faculty Staff															5,700	6,637			

ISU Biorenewables Complex - Agricultural and Biosystems Engineering Facility

November 1, 2007

Location Preference
- B - Basement Floor
- G - Ground Floor
- U - Upper Floor
- O - Optional Floor

Notes:
- (1) With faculty offices
- (2) Near front door
- (3) Keep within 1 floor of Gound Floor
- (4) Yard access
- (5) Can be grouped into one space
- (6) Group together
- (7) Prefer access to day light
- (8) Can be in same h___bay as High Bay, Field M ch, Tractor Dyno?
- (9) class to Classroom - Environmental
- (10) Near Water Quality
- (11) Near Entry

Room Type	Room Number		Floor		Notes	Total Rooms		Total Occupants	Occupants/Room	Room Size	NSF / Room		NSF Total		Comments
A4.0		Facility Support													
A4.1		Receiving	G	G		1	1	NA	NA	20'-0" x 15'-0"	300	323	300	323	May be shared with BRL
A4.2		Chemical Storage	U	4		1	1	NA	NA	15'-0" x 10'-0"	150	156	150	156	
A4.3		General Storage	B	B		1		NA	NA	45'-0" x 30'-0"	1,350	1,394	1,350	1,394	
A4.4		Interaction	U		1	3		NA	NA	12'-0" x 10'-0"	120	0	360	0	
A4.4.1		Kitchenette	U	3,4	1	3		NA	NA	10'-0" x 6'-0"	60	0	180	0	Combine w/ copy/workroom
A4.5		Central Entrance/Display	G	G		1		NA	NA	40'-0" x 30'-0"	1,200	1,256	1,200	1,256	Coffee bar
		Total Faculty Support											**3,540**	**3,129**	
A5.0		Student Support													
A5.1		Undergrad Student Support													Learning Community Peer Mentors
A5.1.1		Learning Communities	G	G	2	4	1	20	5	15'-0" x 15'-0"	225	295	900	1,180	
A5.1.2		Student Club Offices	B/U	B		1	1	6	6	15'-0" x 10'-0"	150	208	150	208	1 desk per club
A5.1.3		Storage	B/U	B		1	1	NA	NA	10'-0" x 10'-0"	100	115	100	115	VEISHEA supplies
		Total Student Support											**1,150**	**1,503**	
A6.0		Classrooms													
A6.1		Lecture Hall	B/G	B		1	1	120	120	60'-0" x 50'-0"	3000	2900	3,000	2,900	University Space
A6.2		Classroom	O	B,2	3	2	2	120	60	40'-0" x 37'-6"	1500	1390	3,000	2,780	University Space
		Classroom Total											**6,000**	**5,680**	
A7.0		Extension													
A7.1		Storage	B	B		1	1	NA	NA	30'-0" x 20'-0"	600	627	600	627	
		Total Extension											**600**	**627**	
		TOTAL OFFICE/CLASSROOM NSF											**29,490**	**30,153**	

ISU Biorenewables Complex - Agricultural and Biosystems Engineering Facility

November 1, 2007

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- (10) Near Water Quality
- (11) Near Entry

Room Type	Room Number	Room Number PD	SD	DD	CD	Notes	Quantity PD	SD	DD	CD	Modules	Module Size	NSF / Room PD	SD	DD	CD	NSF Total PD	SD	DD	CD	Comments
A10.0	Machine Systems																				
A10.1	Research Laboratories																				
A10.1.1	Small High Bay	G	G			4	1	1			5	11'-0" x 33' -0"	1,815	1,798			1,815	1,798			
A10.2	Teaching Laboratories																				
A10.2.1	Field Machinery	G	G			4, 5	1	1			5	11'-0" x 33' -0"	1,815	1,809			1,815	1,809			
A10.2.2	Fluid Power	O	2			6	1	1			3	11'-0" x 33' -0"	1,089	1,060			1,089	1,060			
A10.2.3	Classroom - Machine Systems	O	2			6	1	1			2	11'-0" x 33' -0"	726	772			726	772			20 students
A10.3	Research & Teaching Laboratories																				
A10.3.1	Engine Dynamometer Lab	O	G			6	1	1			3	11'-0" x 33' -0"	1,089	1,088			1,089	1,088			
A10.3.2	Tractor & Vehicle Dynamometer Lab	G	G			4, 5	1	1			3	11'-0" x 33' -0"	1,089	1,050			1,089	1,050			
A10.3.3	Robotics	U	2			7	1	1			3	11'-0" x 33' -0"	1,089	1,063			1,089	1,063			Upper floor possible
A10.3.4	Machinery/Grain Handling						1	1			0	11'-0" x 33' -0"	0	0			0	0			Include in 10.1.1 Small High Bay
A10.3.5	Mechatronics	U	2			7	1	1			2	11'-0" x 33' -0"	726	694			726	694			Upper floor possible
A10.3.6	High Bay	G	G			4, 5	1	1			6	11'-0" x 33' -0"	2,178	2,600			2,178	2,600			
A10.3.7	Electronics Workshop	U	4			7	1	1			2	11'-0" x 33' -0"	726	695			726	695			
A10.3.8	Embedded Systems & Data Networks Lab	U	4			7	1	1			2	11'-0" x 33' -0"	726	695			726	695			
	Total Machine Systems										36						**13,068**	**13,324**			
A11.0	Water Labs																				
A11.1	Research Laboratories																				
A11.1.1	Porous Media	U	3				1	1			2	11'-0" x 33' -0"	726	1,048			726	1,048			
A11.1.2	Water Quality - Nutrient	U	3				1	1			2	11'-0" x 33' -0"	726	698			726	698			
A11.1.3	Water Quality - Pathology	U	3				1	1			2	11'-0" x 33' -0"	726	696			726	696			
A11.1.4	Cold Storage	U	2,3				2	2			0.5	11'-0" x 33' -0"	182	194			363	388			
A11.1.5	Freezer Storage	U	4				1	1			0.5	11'-0" x 33' -0"	182	194			182	194			
A11.1.6	Rainfall Simulator	G	G				1	1			2	11'-0" x 33' -0"	726	338			726	338			16' clear, pressurized
A11.2	Research & Teaching Laboratories																				
A11.2.1	Hydrology	G/U	3				1	1			4	11'-0" x 33' -0"	1,452	1,409			1,452	1,409			Large self contained flumes
A11.2.2	Remote Sensing	U	3				1	1			3	11'-0" x 33' -0"	1,089	1,407			1,089	1,407			
A11.2.3	GIS Precision	U	3				1	1			3	11'-0" x 33' -0"	1,089	1,046			1,089	1,046			
A11.2.4	Classroom - Environmental	G/U	3				1	1			2	11'-0" x 33' -0"	726	1,091			726	1,091			20 students - Water, Animal, Safety
A11.2.5	Ad Hoc Research Labs	U	3				3	3			2	11'-0" x 33' -0"	726	709			2,178	2,127			
A11.2.6	Dirty Lab	G	G			8	1	1			1	11'-0" x 33' -0"	363	419			363	419			
	Total Water Labs										24						**10,346**	**10,861**			
A12.0	Bio Labs																				All upper floors
A12.1	Research Laboratories																				
A12.1.1	Bio-pretreatment	U	4				1	1			2	11'-0" x 33' -0"	726	727			726	727			
A12.1.2	Bio-conversion	U	4				1	1			2	11'-0" x 33' -0"	726	697			726	697			
A12.1.3	Bio-materials	U	4				1	1			2	11'-0" x 33' -0"	726	695			726	695			
A12.1.4	Bio-mass	U	4				1	1			2	11'-0" x 33' -0"	726	695			726	695			
A12.1.5	Bio-treatment Thermo	U	4				1	1			2	11'-0" x 33' -0"	726	695			726	695			
A12.1.6	Bio-quality Control	U	4				1	1			2	11'-0" x 33' -0"	726	695			726	695			
A12.2	Teaching Laboratories																				
A12.2.1	General Biotechnology	U					1	0			0	11'-0" x 33' -0"	0	0			0	0			In BRL Building
	Total Bio Labs										12						**4,356**	**4,204**			

ISU Biorenewables Complex - Agricultural and Biosystems Engineering Facility

November 1, 2007

Location Preference
- B - Basement Floor
- G - Ground Floor
- U - Upper Floor
- O - Optional Floor

Notes:
- (1) With faculty offices
- (2) Near front door
- (3) Keep within 1 floor of Gound Floor
- (4) Yard access
- (5) Can be grouped into one space
- (6) Group together
- (7) Prefer access to day light
- (8) Can be in same h___bay as High Bay, Field M ch, Tractor Dyno?
- (9) class to Classroom - Environmental
- (10) Near Water Quality
- (11) Near Entry

Room Type	Room Number		Room Number		Notes	Quantity		Modules	Module Size	NSF / Room		NSF Total		Comments
A13.0		**Animal Production**												
A13.1		Holding												
A13.1.1		Swine Holding/Testing						0	20'-0" x 20'-0"	0	0	0	0	
A13.1.2		Feed						0	11'-0" x 33' -0"	0	0	0	0	
A13.1.3		Storage						0	11'-0" x 33' -0"	0	0	0	0	
A13.1.4		Wash Room						0	11'-0" x 33' -0"	0	0	0	0	
A13.2		Research Laboratories												
A13.2.1		Air Quality Monitoring	U	4	10	1	1	2	11'-0" x 33' -0"	726	697	726	697	For field trials
A13.2.2		Air Quality Mitigation	U	4	10	1	1	2	11'-0" x 33' -0"	726	697	726	697	
A13.2.3		Manure Treatment	U	B	10	1	1	3	11'-0" x 33' -0"	1,089	1,057	1,089	1,057	
A13.2.4		Air Quality Chemical Analysis	U	4	10	1	1	2	11'-0" x 33' -0"	726	697	726	697	
A13.2.5		Air Transmission	U	3	10	1	1	1	11'-0" x 33' -0"	363	327	363	327	
A13.2.6		Nutrient Management	U	4	10	1	1	2	11'-0" x 33' -0"	726	695	726	695	
A13.3		Teaching Laboratories												
A13.3.1		Agriculture Env. Systems (AES)	U	4	10	1	1	2	11'-0" x 33' -0"	726	695	726	695	
		Total Animal Production						14				**5,082**	**4,865**	
A14.0		**Manufacturing**												
A14.1		Teaching Laboratories												
A14.1.1		Basic Manufacturing Process - Plastics	B	B		1	1	4	11'-0" x 33' -0"	1,452	1,448	1,452	1,448	
A14.1.2		Basic Manufacturing Process - Metal	B	B		1	1	10	11'-0" x 33' -0"	3,630	3,560	3,630	3,560	
A14.1.3		Lean Manufacturing	U	2		1	1	3	11'-0" x 33' -0"	1,089	1,105	1,089	1,105	Lecture/Teaching Room
A14.2		Research & Teaching Laboratories												
A14.2.1		Automated Manufacturing	G	G		1	1	4	11'-0" x 33' -0"	1,452	1,407	1,452	1,407	
		Total Manufacturing						21				**7,623**	**7,520**	
A15.0		**Safety**												All upper floors
A15.1		Research & Teaching Laboratories												
A15.1.1		Safety Analysis (STIR)	U	4		1	1	3	11'-0" x 33' -0"	1,089	1,089	1,089	1,089	Share space w/ Electricity/Electronics
A15.1.2		Research and Teaching	U	4		2	2	1	11'-0" x 33' -0"	363	326	726	652	
		Total Safety						4				**1,815**	**1,741**	
A16.0		**General Teaching Laboratories**												
A16.1		Instrumentation	B	4		1	1	4	11'-0" x 33' -0"	1,452	1,379	1,452	1,379	
A16.2		Computer	U	2,3		2	2	5	11'-0" x 33' -0"	1,815	1,836	3,630	3,672	40 students
A16.3		Teaming	U	3	2	1	1	6	11'-0" x 33' -0"	2,178	2,108	2,178	2,108	48 students
A16.4		Student Project Area	G	G		1	1	6	11'-0" x 33' -0"	2,178	2,138	2,178	2,138	
A16.5		1/4 Scale Tractor/Departmental Shop	G	G		1	1	5	11'-0" x 33' -0"	1,815	1,772	1,815	1,772	
A16.6		Electricity/Electronics	B	4		1	1	3	11'-0" x 33' -0"	1,089	1,089	1,089	1,089	
A16.7		Open Computer Lab	G	B	2	1	1	3	11'-0" x 33' -0"	1,089	1,039	1,089	1,039	20 students
A16.8		Equipment Room	O	2,3,4		3	3	1	11'-0" x 33' -0"	363	351	1,089	1,053	
A16.9		Autoclave	U	2,3	10	2	2	0.5	11'-0" x 33' -0"	182	161	363	322	
		Total General Teaching Laboratories						33.5				**14,883**	**14,572**	
		TOTAL LAB SPACE NSF						145				**57,173**	**57,087**	

ISU Biorenewables Complex - Agricultural and Biosystems Engineering Facility
November 1, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Notes:
(1) With faculty offices
(2) Near front door
(3) Keep within 1 floor of Gound Floor
(4) Yard access
(5) Can be grouped into one space
(6) Group together
(7) Prefer access to day light
(8) Can be in same h___bay as High Bay, Field M ch, Tractor Dyno?
(9) class to Classroom - Environmental
(10) Near Water Quality
(11) Near Entry

Room Type	Room Number		Room Number	Notes	Quantity			Modules	Module Size	NSF / Room		NSF Total		Comments
A20.0		Non-programmed NSF Space												
A20.1		Public Shower and Locker Room	B		2	2			15'-0" x 10'-0"	150	258	300	516	Requirement for LEED transportation point
A20.2		Maintenance and Custodial Team Room	G		1	1			20'-0" x 16'-0"	320	442	320	442	
A20.3		Custodial Closet	B,1,3,4		4	4			10'-0" x 10'-0"	100	153	400	612	
A20.4		Electrical Closet	2,4		3	2			10'-0" x 10'-0"	100	246	300	492	
A20.5		Telecommunications Closet	B,1,3		3	3			10'-0" x 10'-0"	100	204	300	612	
		Total Non-programmed NSF Space										1,620	2,674	
		TOTAL OFFICE / CLASSROOM / LAB SPACE NSF										88,283	89,251	
A30.0		Non-programmed GSF Space												
A30.1		Public Restroom	ALL		8		32	3	25'-0" x 10'-0"	250	280	2,000	2,240	Based on building GSF, 32 fixtures
		Total Non-programmed GSF Space										2,000	2,240	
		TOTAL BUILDING GSF										149,138	-	0.60 efficiency at Programming, not applicable otherwise
A40.0		Other Area GSF												
A40.1		Atrium	B,G		1		NA	NA		8,000	12,346	8,000	12,346	Multi-level
A40.2		Skywalk			1		NA	NA	60'-0" x 15'-0"	900	0	900	0	One level connection to Howe
		Total Other Area GSF										8,900	12,346	
		TOTAL PROJECT GSF										158,038	174,793	

ISU Biorenewables Complex - Biorenewables Laboratory Facility
October 17, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Space I.D.	Room Number	Room Type	Floor P	Floor SD	Floor DD	Floor CD	Notes	Total Rooms PD	Total Rooms SD	Total Rooms DD	Total Rooms CD	Total Occupants	Occupants/Room	Room Size	NSF/Room PD	NSF/Room SD	NSF/Room DD	NSF/Room CD	NSF/Occupant	NSF Total PD	NSF Total SD	NSF Total DD	NSF Total CD	Comments
B1.0		**Admin**																						
B1.1		Reception	G	G				1	1			5	5	15'-0" x 15'-0"	225	335			45	225	335			Waiting area, receptionist
B1.2		Center																						
B1.2.1		Director	G	G				1	1			1	1	18'-6" x 10'-0"	185	183			185	185	183			
B1.2.2		Deputy Director	G	G				1	1			1	1	18'-6" x 10'-0"	185	183			185	185	183			
B1.2.3		Assistant to Director	G	G				1	1			1	1	15'-0" x 10'-0"	150	152			150	150	152			
B1.2.4		Administrative Specialist	G	G				1	1			1	1	15'-0" x 10'-0"	150	152			150	150	152			
B1.2.5		Business Manager	G	G				1	1			1	1	15'-0" x 10'-0"	150	152			150	150	152			
B1.2.6		Communication Specialist	G	G				1	1			1	1	20'-0" x 10'-0"	200	200			200	200	200			
B1.2.7		Administrative Assistant	G	G				2	2			1	1	10'-0" x 8'-0"	80	80			80	160	160			
B1.3		Sloan Center																						
B1.3.1		Director	G	G				1	1			1	1	18'-6" x 10'-0"	185	183			185	185	183			
B1.3.2		Staff	G	G				2	2			1	1	15'-0" x 10'-0"	150	152			150	300	304			
B1.3.3		Administrative Assistant	G	G				1	1			1	1	10'-0" x 8'-0"	80	80			80	80	80			
B1.4		ERC																						
B1.4.1		Director	G	G				1	1			1	1	18'-6" x 10'-0"	185	183			185	185	183			
B1.4.2		Deputy Director	G	G				1	1			1	1	15'-0" x 10'-0"	150	152			150	150	152			
B1.4.3		Visiting Scholar						0				1	1	15'-0" x 10'-0"	150				150					
B1.4.4		Administrative Specialist	G	G				1	1			2	2	25'-0" x 10'-0"	250	240			125	250	240			
B1.4.5		Administrative Assistant	G	G				1	1			1	1	10'-0" x 8'-0"	80	80			80	80	80			
B1.5		IT Services																						
B1.5.1		Staff	O	4				1	1			2	2	15'-0" x 10'-0"	150	152			75	150	152			Combined room
B1.5.2		Server/Printing	O	4				1	0			2	2	15'-0" x 10'-0"	150	152			75	150				
B1.6		Files/Storage	G	B				1	1			NA	NA	25'-0" x 10'-0"	250	322			NA	250	322			
B1.7		Mail/Copier/Kitchenette	G	G				1	2			NA	NA	20'-0" x 15'-0"	300	138			NA	300	276			Two Rooms
B1.8		Executive Conference						0				24	24	30'-0" x 20'-0"	600				25	0				
B1.9		Video Conference/Executive Conference	G	G				1	1			16	16	20'-0" x 25'-0"	500	520			31	500	520			
		Total Admin																		**3,985**	**4,009**			
B2.0		**Grad/Post Doc Offices**																						
B2.1		Post Docs	U	U				4	4			12	3	15'-0" x 10'-0"	150	152			50	600	608			
B2.2		Grad Students																						
B2.2.1		Cubilce Cluster	U	U				10	12			40	4	15'-0" x 10'-0"	150	149			37.5	1,500	1,788			Revolving student experiment assistant space
B2.2.2		Meeting	U	U				2	6			12	4	10'-0" - 10'-0"	100	186			25	200	1,116			1 per upper floor
B2.2.3		Grad Study/Lounge						0				24	12	24'-0" x 15'-0"	360				30	0				
		Total Grad/Post Doc Offices																		**2,300**	**3,512**			
B3.0		**Faculty Staff**																						
B3.1		Faculty Offices	U	U				5	7			5	1	15'-0" x 10'-0"	150	152			150	750	1,064			Office component of Faculty Labs
B3.2		Visiting Faculty	U	U				5	5			10	2	15'-0" x 10'-0"	150	152			75	750	760			
B3.3		Copy/Workroom						0				NA	NA	15'-0" x 10'-0"	150				NA	0				
		Total Faculty Staff																		**1,500**	**1,824**			
B4.0		**Facility Support**																						
B4.1		Receiving	G	G				1	1			NA	NA	20'-0" x 15'-0"	300	200			NA	300	200			Could be shared with ABE
B4.2		General Storage	O	B				1	1			NA	NA	20'-0" x 15'-0"	300	340			NA	300	340			
B4.3		Interaction	U	U				3	3			NA	NA	12'-0" x 10'-0"	120	313			NA	360	939			1 per floor
B4.3.1		Kitchenette	U	U				3	3			NA	NA	10'-0" x 6'-0"	60	0			NA	180	0			1 per floor (combine with interaction)
B4.4		Central Entrance/Display/Atrium	G	G				1	1			NA	NA	40'-0" x 30'-0"	1200	1068			NA	1,200	1,068			Coffee cart location, combine display from Admin Room for 30 people
		Total Facility Support																		**2,340**	**2,547**			
		Total Office NSF																		**10,125**	**11,892**			

ISU Biorenewables Facility
October 17, 2007

Room Type		Floor PD	Floor SD	Floor DD	Floor CD	Notes	Quantity PD	Quantity SD	Quantity DD	Quantity CD	Modules	Module Size	NSF/Room PD	NSF/Room SD	NSF/Room DD	NSF/Room CD	Total NSF PD	Total NSF	Total NSF DD	Total NSF CD	
B10.0	**Research Laboratory Space**																				
B10.1	Chemistry Theme - Low Fume Hood Density	U	U				1	1			18.5	11'-0" x 33'-0"	6,716	6,861			6,716	6,861			
B10.2	Chemistry Theme - Medium Fume Hood Density	U	U				1	1			8	11'-0" x 33'-0"	2,904	2,586			2,904	2,586			
B10.3	Microbiology Theme	G/U	G/U			1	1	1			22	11'-0" x 33'-0"	7,986	7,823			7,986	7,823			
B10.4	High Ceiling Laboratory	G	G				1	1			3	11'-0" x 33'-0"	1,089	1,464			1,089	1,464			High ceiling (16' clear), direct outside access
	Total Research Laboratory Space										51.5						**18,695**	**18,734**			
B11.0	**Research Laboratory Support Space**																				
B11.1	Sample Preparation Lab (Grinding)	G	G				1	1			1.5	11'-0" x 33'-0"	545	330			545	330			High ceiling (16' clear), dust capture, direct outside access
B11.2	Rec./Dispensing Cold/Freezer Room	U	U				1	1			1.5	11'-0" x 33'-0"	545	459			545	459			
B11.3	Equipment Room	U	U				2	5			2.0	11'-0" x 33'-0"	726	270			1,452	1,350			
B11.4	Autoclave/Glass Wash	U	2				1	1			0.5	11'-0" x 33'-0"	182	228			182	228			
B11.5	Cold/Freezer Room	U	U				1	1			0.5	11'-0" x 33'-0"	182	266			182	266			
	Total Research Laboratory Support Space										6.0						**2,904**	**2,633**			
B12.0	**Teaching Laboratory Space**																				
B12.1	Common Biorenemables Teaching Lab	G	G				1	2			6	11'-0" x 33'-0"	2,178	1,047			2,178	2,094			How many students?
B12.2	Sample Preparation Lab (Grinding)						0				0	11'-0" x 33'-0"	0				0	0			
B12.3	Rec./Dispensing Cold/Freezer Room						0				0	11'-0" x 33'-0"	0				0	0			
B12.4	Equipment Room						0				0	11'-0" x 33'-0"	0				0	0			
B12.5	Autoclave/Glass Wash						0				0	11'-0" x 33'-0"	0				0	0			
B12.6	Cold/Freezer Room						0				0	11'-0" x 33'-0"	0				0	0			
																		0			
	Total Teaching Laboratory Space										6.0						**2,178**	**2,094**			
	Total Lab NSF Space (Modular)																**23,777**	**23,461**			
B20.0	**Non-programmed NSF Space**																				
B20.1	Public Shower and Locker Room		B				2	2				15'-0" x 10'-0"	150	180			300	360			Requirement for LEED point
B20.2	Maintenance and Custodial Team Room		B				1	1				20'-0" x 16'-0"	320	348			320	348			
B20.3	Custodial Closet		B/U				4	5				10'-0" x 10'-0"	100	81			400	405			
B20.4	Electrical Closet		U				3	3				10'-0" x 10'-0"	100	76			300	228			
B20.5	Telecommunications Closet		U				3	3				10'-0" x 10'-0"	100	76			300	228			
																		0			
	Total non-programmed NSF Space																**1,620**	**1,569**			
	TOTAL NSF SPACE										63.5						**35,522**	**36,922**			
	SUBTOTAL GSF SPACE																**59,203**	**-**			0.60 efficiency at Programming, not applicable otherwise
Notes:	(1) One Microbiology Lab desireable on Gound Floor																				
B30.0	**Non-programmed GSF Space**																				
B30.1	Public Restroom						8	8				15'-0" x 10'-0"	150	156			1,200	1,248			
	Total non-programmed GSF Space																**1,200**	**1,248**			
	TOTAL GSF SPACE																**60,403**	**69,826**			

ISU Biorenewables Complex - West Campus Parking Structure
October 17, 2007

Space I.D.	Room Number	Room Type		Floor P	SD	DD	CD	Notes	Total Stalls PD	SD	DD	CD	Total Occupants	Occupants/Room	Stall Size (Includes Drive Aisle)	NSF/Stall PD	SD	DD	CD	NSF Total PD	SD	DD	CD	GSF Total	GSF/Stall	Comments
		Parking Structure																								
B			Basement Level Parking		B					93			N/A	N/A	9'-0" x 30'-3"	270	272				25,296			32,634	351	
1			Level 1 Parking		1					90			N/A	N/A	9'-0" x 30'-3"	270	272				24,480			32,624	362	
			Level 2 Parking		2					93			N/A	N/A	9'-0" x 30'-3"	270	272				25,296			32,624	351	
			Level 3 Parking		3					93			N/A	N/A	9'-0" x 30'-3"	270	272				25,296			32,624	351	
			Level 4 Parking		4					93			N/A	N/A	9'-0" x 30'-3"	270	272				25,296			32,624	351	
			Level 5 Parking		5					57			N/A	N/A	9'-0" x 30'-3"	270	272				15,504			22,737	399	
		Total Parking Stalls & Area - SD Phase								519						270	272				141,168			185,867		
			Programming Phase Targets (Low End)						450							270				121,500				155,769	346	.78 Efficiency Assumed at Programming
			Programming Phase Targets (High End)						600							270				162,000				207,692	346	.78 Efficiency Assumed at Programming
		Total Gross Square Feet / Stall																							358	

ISU Biorenewables Complex - DPS-Parking Division Offices

October 17, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Space I.D.	Room Number	Room Type	Floor P	SD	DD	CD	Notes	Total Rooms PD	SD	DD	CD	Total Occupants	Occupants/Room	Room Size	NSF/Room PD	SD	DD	CD	NSF/Occupant	NSF Total PD	SD	DD	CD	Comments
PA1.0		**Administration**																						
PA1.1		Parking Captain's Office						1	1			1 FTE		10'-0" x 15'-0"	150	160				150	160			
PA1.2		Appeals Staff						1	1			1 FTE		8'-0" x 10'-0"	80	80				80	80			
PA1.3		Program Assistant						1	1			1 FTE		10'-0" x 12'-0"	120	120				120	120			
PA1.4		Accounting						1	1			1		10'-0" x 12'-0"	120	120				120	120			
PA1.5		Data Entry / Accounts Receivable						1	1			1		10'-0" x 12'-0"	120	120				120	120			
PA1.6		Dispatch Staff						1	1			1 FTE		8'-0" x 10'-0"	80	80				80	80			Acoustically Private
PA1.7		Parking & Transportation Supervisors (Enforcement)						1	1			2 FTE		10'-0" x 16'-0"	160	160				160	160			
PA1.8		Future Staff						1	1			1 FTE		10'-0" x 12'-0"	120	120				120	120			
		Total Administration NSF																		**950**	**960**			
PA2.0		**Student Administration**																						
PA2.1		Appeals Students						2	2			1		6'-3" x 8'-0"	50	50				100	100			
PA2.2		Student Magistrate						1	1			1		6'-3" x 8'-0"	50	50				50	50			
PA2.3		Student Parking Manager						1	1			1		6'-3" x 8'-0"	50	50				50	50			
PA2.4		Maps Student						1	1			1 ST		6'-3" x 8'-0"	50	50				50	50			
PA2.5		Data Entry Student						1	1			1 ST		6'-3" x 8'-0"	50	50				50	50			
PA2.6		Dispatch Student						1	1			1 ST		6'-3" x 8'-0"	50	50				50	50			Acoustically Private
		Total Student Admin NSF																		**350**	**350**			
PA3.0		**Support**																						
PA3.1		Reception (Appeals)						1	1					10'-0" x 15'-0"	150	142				150	142			See Note Below, Clear Distinction between Permits & Appeals, Adjacent to Front Desk Queuing Area (Permits)
PA3.2		Office Support Waiting/Reception						1	1					10'-0" x 10'-0"	100	50				100	50			Combined Area w/Appeals Reception (Above), Near Administration Staff
PA3.3		Front Desk Queuing Area (Permits) and Student Staff						1	1			4 ST		24'-0" x 16'-8"	400	408				400	408			Queuing Area adjacent to reception (appeals), Front Desk Staff - students adjacent to front desk staff
PA3.4		Front Desk Staff						1	1			1 FTE		10'-0" x 12'-0"	120	137				120	137			Adjacent to Front Desk Queuing Area (Permits) and Front Desk Staff - Students
PA3.5		Workroom						1	1					15'-0" x 10'-0"	150	150				150	150			
PA3.6		Multipurpose Room						1	1					20'-0" x 30'-0"	600	610				600	610			50 SF for Lockers/Mailboxes, Break Area also included here
		Total Support NSF																		**1,520**	**1,497**			
PA4.0		**Storage**																						
PA4.1		Filing						1	1					12'-0" x 16'-8"	200	198				200	198			
PA4.2		General Storage						1	1					15'-0" x 16'-8"	250	250				250	250			Includes 100 s.f. for temporary sign board storage
PA4.3		Secured Storage						1	1					10'-0" x 15'-0"	150	160				150	160			
PA4.4		Secured Storage Money Handling						1	1					10'-0" x 5'-0"	50	50				50	50			
PA4.5		Dispatch Ticket Writing Equipment Storage & Support						1	1					10'-0" x 6'-0"	60	70				60	70			Monitored Visually by Staff
PA4.6		Student Enforcement Queuing & Equipment Storage						1	1					10'-0" x 6'-6"	65	75				65	75			Monitored Visually by Staff, (Keys, Radio Storage)
		Total Storage NSF																		**775**	**803**			
PA5.0		**Meeting Spaces**																						
PA5.1		Parking Conference Room						1	1			8-10		20'-0" x 12'-0"	240	240				240	240			
		Total Meeting Space NSF																		**240**	**240**			
		TOTAL PARKING DIVISION NSF																		**3,835**	**3,850**			

ISU Biorenewables Complex - DPS-Parking Division Offices

October 17, 2007

Location Preference

B - Basement Floor

G - Ground Floor

U - Upper Floor

O - Optional Floor

Space I.D.	Room Number	Room Type	Floor P	Floor SD	Floor DD	Floor CD	Notes	Total Rooms PD	Total Rooms SD	Total Rooms DD	Total Rooms CD	Total Occupants	Occupants/Room	Room Size	NSF/Room PD	NSF/Room SD	NSF/Room DD	NSF/Room CD	NSF/Occupant	NSF Total PD	NSF Total SD	NSF Total DD	NSF Total CD	Comments
		Non-Programmed Spaces (Part of Gross)																						
		Women's Restroom						1	1					20'-0" x 10'-0"	200	197				200	197			
		Men's Restroom						1	1					20'-0" x 10'-0"	200	197				200	197			
		Total Non-Programmed Spaces																		400	394			
		SUBTOTAL GSF INTERIOR SPACE																		6,392	6,365			60% Efficiency at Programming Phase
PA6.0		Exterior Spaces																						
PA6.1		Staff Parking						6	6					9'-0"x30'-0"	270	270				1,620	1,620			Adjacent to building
PA6.2		Customer Parking						4	4					9'-0"x30'-0"	270	270				1,080	1,080			
		Total Exterior Spaces																		2,700	2,700			
		TOTAL GSF SPACE																		9,092	9,065			

ISU Biorenewables Complex - DPS-Police Division Offices
October 17, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Space I.D.	Room Number	Room Type	Floor P	SD	DD	CD	Notes	Total Rooms PD	SD	DD	CD	Total Occupants	Occupants/Room	Room Size	NSF/Room PD	SD	DD	CD	NSF/Occupant	NSF Total PD	SD	DD	CD	Comments
PO1.0		Administration																						
PO1.1		Director's Office		G				1	1			1		10'-0" x 18'-0"	180	143				180	143			
PO1.2		Patrol Commander's Office		G				1	1			1		10'-0" x 15'-0"	150	143				150	143			
PO1.3		Investigative Commander's Office		G				1	1			1		10'-0" x 15'-0"	150	150				150	150			
PO1.4		Technical Services Captain		G				1	1			1		10'-0" x 15'-0"	150	150				150	150			
PO1.5		Records Office		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			
PO1.6		Police Account Specialist		G				1	1			1		10'-0" x 16'-0"	160	200				160	200			
PO1.7		Administrative Lt Office		G				1	1			1		10'-0" x 12'-0"	120	120				120	120			Adjacent to Evidence
PO1.8		Detective Lt Office		G				1	1			1		10'-0" x 12'-0"	120	120				120	120			
PO1.9		Detective Office Space		G				2	2			1		10'-0" x 10'-0"	100	100				200	200			
PO1.10		Detective Sergeants		G				2	2			1		10'-0" x 10'-0"	100	100				200	200			
PO1.11		Dispatch Coordinator		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			Adjacent to Dispatch, Secure
PO1.12		Training Lt		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			
PO1.13		Future Clerical Staff		G				4	4			1		10'-0" x 8'-0"	80	80				320	320			
PO1.14		Sergeant Office -Patrol Work Stations		G				1	1			3		10'-0" x 15'-0"	150	150				150	150			
PO1.15		Lts Office -Patrol Work Stations		G				1	1			3		10'-0" x 15'-0"	150	150				150	150			
PO1.16		Officer's Report Work Stations		G				1	1			4		10'-0" x 16'-0"	160	160				160	160			Adjacent to Briefing Room
PO1.17		Student Officers		G				1	1			1		10'-0" x 8'-0"	80	80				80	80			
PO1.18		Community Service Officers		G				1	1			1		10'-0" x 8'-0"	80	80				80	80			
		Total Administration NSF																		2,670	2,666			
PO2.0		Support																						
PO2.1		Reception / Walk-In Service Counter		G				1	1			6		12'-0" x 16'-8"	200	278				200	278			
PO2.2		Dispatch		G				1	1			3		18'-0" x 18'-0"	324	325				324	325			Secured (No Windows), Adjacent to Dispatch Coordinator and Dispatch Toilet, Near Booking
PO2.3		Dispatch Area Toilet		G				1	1			1		6'-0" x 8'-0"	48	48				48	48			Adjacent to Dispatch
PO2.4		Booking		G				2	2			1		10'-0" x 12'-0"	120	105				240	210			Near Dispatch
PO2.5		Interview Room (Interrogation)		G				2	2			3		10'-0" x 8'-0"	80	83				160	166			Adjacent to Video Equipment and Viewing Room
PO2.6		Video Equipment and Viewing Room		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			Adjacent to Interview Room
PO2.7		Evidence Room		G				1	1			1		30'-0" x 30'-0"	900	970				900	970			Near Exterior Wall w/OH Door, Secured, Adjacent to Administrative Lt Office and Lab Processing Room
PO2.8		Lab/Processing Room		G				1	1			1		10'-0" x 15'-0"	150	150				150	150			Adjacent to Evidence
PO2.9		Forensics Lab		G				1	1			2		10'-0" x 15'-0"	150	150				150	150			
PO2.10		Server Room / Lt Office		G				1	1			1		10'-0" x 15'-0"	150	150				150	150			Near Records Room
PO2.11		Records Room		G				1	1			1		12'-0" x 16'-8"	200	200				200	200			Near Server Room
PO2.12		Workroom		G				2	2			1		10'-0" x 15'-0"	150	143				300	286			
PO2.13		Community Outreach		G				1	1			1FTE, 3 ST		10'-0" x 12'-0"	120	123				120	123			
PO2.14		State Wide Outreach		G				1	1			2 FTE, 2 ST		15'-0" x 16'-8"	250	123				250	123			
PO2.15		SART		G				1	1			1 FTE, 2 ST		15'-0" x 16'-8"	250	240				250	240			2 Student Intern Workstations
PO2.16		Break Room		G				1	1			20		18'-0" x 20'-0"	360	360				360	360			Currently Shared with Parking
PO2.17		Women's Locker Room		G				1	1			35		32'-6" x 20'-0"	650	666				650	666			
PO2.18		Men's Locker Room		G				1	1			35		32'-6" x 20'-0"	650	666				650	666			
PO2.19		Fitness Room		G				1	1			10		20'-0" x 25'-0"	500	477				500	477			1 Multi-Station Weight Mach, 2 treadmills
		Total Support NSF																		5,702	5,688			
PO3.0		Storage																						
PO3.1		General Storage		G				1	1			1		10'-0" x 15'-0"	150	143				150	143			Shared with Parking ?
PO3.2		State Wide Outreach Storage		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			
PO3.3		Community Outreach Storage		G				1	1			1		10'-0" x 10'-0"	100	100				100	100			
PO3.4		Agency Property (Unusual Occurrence) Storage		G				1	1			1		30'-0" x 30'-0"	900	975				900	975			Near Exterior Wall w/OH Door
PO3.5		Police Bike Storage		G				1	1			1		13'-6" x 28'-0"	378	471				378	471			
		Total Storage NSF																		1,628	1,789			

ISU Biorenewables Complex - DPS-Police Division Offices
October 17, 2007

Location Preference
B - Basement Floor
G - Ground Floor
U - Upper Floor
O - Optional Floor

Space I.D.	Room Number	Room Type	Floor P	SD	DD	CD	Notes	Total Rooms PD	SD	DD	CD	Total Occupants	Occupants/Room	Room Size	NSF/Room PD	SD	DD	CD	NSF/Occupant	NSF Total PD	SD	DD	CD	Comments
PO4.0		Meeting Spaces																						
PO4.1		Squad Room (Briefing Room)		G				1	1			20		20'-0" x 27'-0"	540	540				540	540			Adjacent to Officer's Report Work Stations
PO4.2		Training / Emergency Operations Center		G				1	1			50		40'-0" x 30'-0"	1,200	1197				1,200	1,197			
PO4.3		Administrative Conference Room		G				1	1			20		25'-0" x 12'-0"	300	300				300	300			
PO4.4		Detective's Conference Room		G				1	1			12		20'-0" x 12'-0"	240	240				240	240			
		Total Meeting Space NSF																		2,280	2,277			
		TOTAL POLICE DIVISION INTERIOR NSF																		12,280	12,420			
		Non-Programmed Spaces																						
		Women's Restroom		G				1	1			100		22'-0" x 13'-0"	285	172				285	172			
		Men's Restroom		G				1	1			100		22'-0" x 13'-0"	285	172				285	172			
		2-3 Vending Machines																						
																				570	344			
		Total Non-Programmed Spaces																						
		SUBTOTAL GSF SPACE																		20,467	19,730			60% Efficiency at Programming Phase
PO5.0		Exterior Spaces																						
PO5.1		Outdoor Secured Evidence Storage		G				1	1			NA		20'-0" x 25'-0"	500	500				500	500			Room size to be verified
PO5.2		Outdoor Secured Storage		G				1	1			1		30'-0 x 33'-4"	1000	1000				1,000	1,000			
PO5.3		Future Secured Garage		G				1	1			1		40'-0 x 45'-0"	1800	1800				1,800	1,800			Operates as a Sally port, Also will hold evidence in future
PO5.4		Parking		G																				
PO5.4.1		Squad Car Parking						15	15			N/A		9'-0"x 30'-0"	270	270				4,050	4,050			Quick exit-Do not exit thru parking structure
PO5.4.2		Public Parking						5	5			N/A		9'-0"x 30'-0"	270	270				1,350	1,350			Public Parking separate from police vehicles
		Total Exterior Spaces																		8,700	8,700			
		TOTAL PROJECT GSF																		29,167	28,430			

SECTION IV.

STATEMENT OF PROBABLE CONSTRUCTION COST

STATEMENT OF PROBABLE CONSTRUCTION COST

See separately provided statement of probable construction cost estimate.

SECTION V.

OTHER DOCUMENTS

SECTION V.A.

DESIGN STANDARDS EXCEPTION

DESIGN STANDARDS EXCEPTIONS

Following are areas where we propose to deviate from the ISU Design Standard:

I. Exterior Wall: None

II. Roofing

A. Proposing a TPO roof in lieu of EPDM.

1. ISU has expressed dissatisfaction with EPDM.

2. TPO roof has integral color throughout and is heat weldable.

III. Interior Construction

A. Optional finishes for consideration

1. Laboratories: Rubber or Linoleum tile in lieu of VCT. Rubber or linoleum is considered "greener" materials.

2. Main floor corridors, atrium and auditorium prefunction: Polished integral color concrete in lieu of terrazzo. Give buildings a "working" building feel.

3. Determine if floor hardener needed in any of the ABE heavy equipment labs/classrooms.

4. Use of gypsum board on metal studs in lieu of cmu at corridors for BRL.

IV. Special Construction

V. Mechanical and Plumbing Systems

VI. Building Automation System

VII. Electrical System

VIII. Life Safety and Security Access System

IX. Voice/Data/Audio-Visual Systems

X. Space and Site Diagram

SECTION V.B.

PROJECT SCHEDULE

PROJECT SCHEDULE

Department of Agricultural and Biosystems Engineering

Design of the ABE facilities will proceed through Schematic Design. This effort will be concurrent with the Schematic Design for BRL and the West Campus Parking Structure so that the design for the three facilities is coordinated and integrated. State appropriations for ABE have been requested for FY2009 and FY2010; some private gifts have all ready been secured.

Completion of design and commencement of construction for ABE will occur as funding is available. The budget will be adjusted at that time for any possible cost escalation.

Since site infrastructure development such as utility extension, landscaping, and campus walks and drives for the entire project needs to be done with the first projects (BRL and Parking), and since the infrastructure development will eventually serve ABE as well, a proportionate share of these costs will be borne by the ABE budget.

March 2007	Design Professional Selection
April – September 2007	Programming
August – December 2007	Schematic Design
Unknown	Design Development – Construction Administration
Unknown	Construction

Biorenewables Research Laboratory

Funding for the construction of BRL has been approved. Following completion of this Pre-Design (Programming Phase), design of this portion of the project will continue to allow for a summer 2008 start of construction.

2007	Board of Regents Approval
March 2007	Design Professional Selection
April – September 2007	Programming
August – December 2007	Schematic Design
October 2007 – January 2008	Design Development
February 2008	Board of Regents Approval
February – June 2008	Construction Documents
June – August 2008	Review and Bidding
September 2008 – December 2009	Construction

West Campus Parking Structure

The Parking Division will fund the West Campus Parking Structure. This funding will come from parking fees and other sources. Design of this portion of the project will proceed through Schematic Design. This effort will be concurrent with the design of ABE and BRL so the site design and access requirements as well as the general appearance of the parking structure can be coordinated and integrated with the planning for ABE and BRL. The following is the schedule for the parking structure only; the schedule will be revised if administrative space is included.

March 2007	Design Professional Selection
April – September 2007	Programming
August – December 2007	Schematic Design
Unknown	Design Development – Construction Administration
Unknown	Construction

SECTION V.C.

STATE BUILDING CODE NARRATIVE

BIORENEWABLES RESEARCH LABORATORY

BUILDING CODE SUMMARY

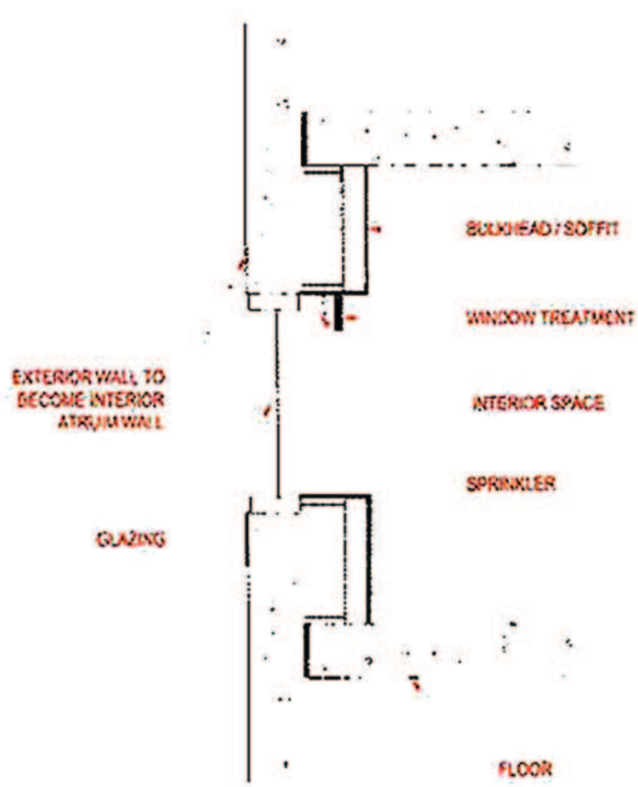
1.0 INTRODUCTION

1.1 SCOPE

This documentation outlines Major Fire and Life Safety issues affecting the design of the Biorenewables Research Laboratory (BRL), Fire and Life Safety Criteria are summarized from the 2006 International Building Code (IBC), unless noted otherwise.

The BRL building is a four-story, plus basement, laboratory building constructed as Phase I of a potential multi-phase project. The type of construction for this phase will allow for multiple additions in the future without the inclusion of fire walls.

The future ABE portion of the project includes an atrium as an addition to one of the BRL exterior walls. The BRL spaces would be required to be separated from the atrium with either fire resistive construction or sprinklers on glass. The detail section shows how this could be maintained in the future by designing now for conveniences, such as window treatments. Since atrium requirements have not changed much in the last 15 years, we do not anticipate significant changes to atrium requirements in the near future editions of the IBC.



1.2 APPLICABLE CODES

The following code summary utilized the following codes as adopted by the State of Iowa:

- 2006 International Building Code (IBC)
- 2003 Uniform Plumbing Code (UPC)
- 2005 National Electrical Code (NFPA 70, NEC)
- 2006 International Fire Code (IFC)
- 2006 International Mechanical Code (IMC)
- 2006 International Fuel Gas Code (IFGC)
- The Americans with Disabilities Act (ADA) and Accessibility Guidelines (ADAAG)
- Iowa Administrative Code

2.0 CONSTRUCTION CLASSIFICATIONS

2.1 OCCUPANCY GROUP CLASSIFICATIONS

- Storage — Incidental (Table 508.2)
- Laboratories and Administrative Offices — Group B (Section 304.1)

It is our understanding that the maximum quantities of hazardous material within control areas will not be exceeded. Thus, this building will not qualify as a Group H occupancy.

2.2 TYPES OF CONSTRUCTION CLASSIFICATION

- Type I-B (Section 602.2)

2.3 ALLOWABLE AREA AND HEIGHT (TABLE 503):

	ALLOWABLE
Area per story (square feet)	Unlimited
Total area (square feet)	Unlimited
Height (feet)	160
Height (number of stories)	11

3.0 FIRE RESISTIVE OCCUPANCY AND USE SEPARATION

3.1 USE SEPARATIONS

Fire resistive separations and enclosures are intended to address individual use hazards and are identified below.

Use/Occupancy	
Electrical transformer room	Dry type transformer more than 112 1/2 KVA, 1-hour fire resistive enclosures -NEC Article 450.21 1-hour rating not required for Class 155 or higher insulating systems for transformers that are completely enclosed except for ventilation openings The Electrical Engineer should be contacted on type of transformer specified
Electrical transformer vault	Dry type transformer rated over 35,000 volts is required to be installed in a vault - NEC Article 450.21 Vaults not protected with an automatic sprinkler or suppression system are required to be 3-hour fire resistive enclosures C3-hour doors); sprinklered vaults may be 1-hour (60-minute doors) -NEC Article 450.42 Vaults in contact with the ground are required to have a minimum 4 inches of concrete slab for a floor Studs and wallboard construction are not permitted - NEC Article 450.42 Doors are required to be locked with access to qualified people only, must swing out, and be equipped with panic bars or push pads - NEC Article 450.42
Service entrance conductors	Encased in 2 inches of concrete, listed 2-hour electrical circuit protective system, or in a vault - NEC Article 230.6
Information technology equipment room	Room is required to be separated with 1-hour fire resistant rated walls, floors and ceilings with protected openings. Ducts extending through assembly are required to be provided with fire/smoke dampers –NEC Article 654.2
Fire pump feeder conductors	Enclosed in 2 inches of concrete or listed 1-hour electrical circuit protective system - NFPA 20, Section 6.3.1.1

3.2 INCIDENTAL USE AREAS

Furnace rooms where largest piece of equipment is over 400,000 Btu per hour input	1-hour or provide automatic fire extinguishing system - Table 508.2
Stationary lead acid battery systems more than 100 gallons for standby and emergency power or UPS	2-hour rooms in Group A occupancies 1-hour room in Group B occupancies - Table 508.2
Boilers over 15 psi and 10 horsepower	1-hour or provide automatic fire extinguishing system - Table 508.2
Refrigerant machinery rooms	1-hour or provide automatic fire extinguishing system - Table 508.2
Laundry and storage rooms over 100 square feet	Smoke tight - Table 508.2
Emergency generator	1-hour room - Section 909.11
Fuel storage for emergency generator	1-hour if within the exempt amounts of Table 307.7(1); otherwise H occupancy - Table 307.7(1)
Fire Pump, if provided	1-hour when building is fully sprinklered -NFPA20.

3.3 OCCUPANCY SEPARATIONS

The IBC does not require occupancy separations between different occupancies in a building utilizing a non-separated use approach. This approach means that the type of construction for the building is determined by the most restrictive height and area provisions for each occupancy and applies to the entire building. The most restrictive fire protection system requirements apply to each occupancy. Occupancy separations are not required under this approach, Section 508.3.2.

3.4 CONTROL AREAS

A control area is defined as a space within a building where quantities of hazardous materials do not exceed the maximum allowed quantities. The number of control areas and the percentage of quantities permitted per control area is listed below:

Floor	Percentage	Number of control Areas Permitted	Fire Resistance rating for the fire barriers (in hours)
1	100	4	1
2	75	3	1
3	50	2	1
4	12.5	2	2

4.0 FIRE RESISTIVE REQUIREMENTS FOR ELEMENTS OF THE STRUCTURE

4.1 ACCEPTABLE MATERIALS

Structural elements of Type I-B resistive buildings are limited to non-combustible materials (Section 602.2).

Fire retardant plywood or other wood products are permitted as sheathing or applied directly on studs within non-bearing partitions where the required fire rating is 2-hours or less (Section 603.1, Exception 1).

Incidental 2 x blocking is permitted if of fire retardant treated wood. Fire retardant treated plywood is permitted *within* 1 or 2-hour walls that are not part of a shaft. Specific instances should be evaluated individually.

4.2 STRUCTURAL, INTERIOR, AND EXTERIOR ELEMENTS

- Passive fire resistance for the structural frame insures that stability of the building as a whole can be maintained during the anticipated fire condition. The structural frame is defined as columns, as well as trusses, girders, and beams having direct connection to columns. Beams and trusses not having direct connection to columns are considered secondary elements. Depending on where they occur, these secondary elements may be classified as an element of either a roof or floor assembly for purposes of determining fire resistance requirements.

- Restrained versus unrestrained designations. All fire resistive assemblies should be viewed as unrestrained, except where the Structural Engineer has demonstrated otherwise.

- Floors (including shafts) and exit enclosure walls provide interior compartmentation and means of egress protection.

- Exterior walls provide exposure protection.

The following fire resistive requirements are documented from IBC Table 601 and other applicable sections.

Building Element - Type I-B Construction	Fire Resistance/Code Section
Primary columns	2-hour
Primary beams	1-hour if supporting roof only - Table 601
	2-hour
	1-hour if supporting roof only - Table 601
	0-hour for roof beams located 20 feet or more above the floor below - Table 601
	Lintels spanning greater than 6 feet, 1–hour - Section 713.6

Floor assembly, including secondary beams and trusses	2-hour - Table 601
Roof assembly, including secondary beams and trusses	1-hour 0-hour if 20 or more feet above the floor below except in areas of S-I occupancy - Table 601
Walls:	
Exterior bearing walls	2-hour - Table 601
Exterior non-bearing walls (distances measured to center line of street or assumed imaginary lot line between buildings)	1-hour, 30 feet or less 0-hour, if more than 30 feet - Table 602
Interior bearing walls	2-hour (protection of openings may be required depending on wall location) Reduced to 1-hour if supporting roof only - Table 601
Shaft enclosures (including mechanical shafts and elevator hoistways)	2-hour based on 2-hour rated floors - Section 707.4 Shaft is required to extend from the lowest floor opening through successive floor openings and must be enclosed at the top and bottom with 2-hour construction except as follows (Sections 707.11 and 707.12): At the top: Enclosure at the top is not required where the shaft extends through the roof or to the underside of the roof deck At the bottom: Bottom of shafts need not be enclosed when protected by fire dampers or where they terminate in 1-hour rooms related to the use of the shaft
Exit stair enclosures and exit passageways (i.e., connection of stair enclosures to the exterior)	2-hour (protection of openings is required - Section 1019.1)
Corridors	0-hour - Table 1017.1
Elevator lobbies	0-hour - Section 707.14.1, exception 4

Other permanent partitions	0-hour, non-combustible or 1-hour if containing fire retardant treated wood –Sections 602 and 603(1)
Roof covering	Class B - Table 1505.1
Stairs	Non-combustible - Section 1009.5
Projections (e.g., canopies)	0-hour, non-combustible – Section 704.2.1
Penthouses (less than 1/3 of the roof area, otherwise it is a story)	May be of non-combustible and non fire resistive construction if located 20 feet or more from adjacent lot lines or center lines of public ways - Section 1509.2.1, Exception 3

5.0 FIRE RESISTIVE PROTECTION OF OPENINGS/PENETRATIONS

5.1 OPENINGS IN EXTERIOR WALLS (TABLE 704.8)

Unlimited unprotected openings because the fire separation distance to a property line or center line of street is greater than 30 feet

5.2 OPENINGS IN INTERIOR WALLS

Openings in stairway enclosures	2-hour stair enclosures require 90-minute opening protection - Table 715.4
	Doors are not required to be labeled for 450°F temperature rise at the end of 30 minutes of testing - Section 715.4.4, Exception
	No openings other than exit doors from normally occupied spaces allowed –Section 1020.1.1
	Penetrations limited to sprinkler piping, standpipes, and electrical conduit for enclosure use only - Section 1020.1.2
	No HVAC duct penetrations are permitted except for pressurization ducts - Section 1020.1.2
Openings in vertical shaft enclosures	90-minute opening protection in 2-hour rated shafts
	Combination fire/smoke are required–Table 715.4, Section 716.5.3

5.3 OPENINGS IN FLOORS/CEILING AND ROOF/CEILING ASSEMBLIES

Ceilings	Where the ceiling is part of a fire resistive floor/ceiling or roof/ceiling assembly, HV AC duct openings are required to be provided with ceiling type fire dampers - Section 716.6.1
Floors	Openings are required to be enclosed in a shaft - Section 707.2
	Unenclosed two-story space is not required to be enclosed in a shaft unless adjacent to a 1-hour corridor and not part of required means of egress - Section 707.2, Exception 7
	Penetrations may be fires topped; in this case a shaft is not required - Section 707.2, Exception 3
	A shaft enclosure is not required for floor openings complying with the provisions for atriums - Section 707.2, Exception 5
Roofs	Roofs may have unprotected openings - Section 711.4

5.4 PENETRATIONS

Walls	Penetrations are required to be sealed with a listed firestop assembly having an F-rating equal to the walls rating - Section 712.3.1.2
	Metal pipe or conduit (6 inch or smaller) penetrating concrete or masonry walls may be grouted solid - Section 712.3,1, Exception 1
	Membrane protection is not required for steel electrical boxes (16 square inches or smaller), separated by 24 inches horizontally and not exceeding 100 square inches per 100 square feet of wall - Section 712,32, Exception 1
	Alternatively, listed boxes may be used per their listing - Section 712.3.2, Exception 2
	Penetrations are not permitted to exceed 100 square inches per 100 square feet in assemblies tested and listed without penetrations; electrical boxes of any material are permitted, provided they are listed for this application - Section 712A1.1, Exception 2
Ceilings	Ceiling penetrations are required to be provided with a listed firestop system with F and T-ratings - Section 712.4.1.2, Exception 4
	Penetrations caused by sprinklers are permitted, provided the annular space is covered by a metal escutcheon plate
Floors	Floor penetrations are required to be firestopped with listed assemblies having CUI F and T-rating equal to the floor rating, but not less than 1-hour - Section 712.4.1.1.2
	A T-rating is not required for floor penetrations located in the cavity of a wall- Section 712.4.1.1.2, Exception
	Materials greater than 6 inches may be required to be installed in a chase or wall, because a T-rating for firestopping is not readily available for installation
Roofs	Roofs may have unprotected penetrations - Section 711.4

5.5 FIRE AND SMOKE DAMPERS

Building Element	Requirement
Exit stair enclosure	HVAC duct penetrations are not permitted – Section 1020.1.2
0-hour corridors and elevator lobbies	No dampers are required
HVAC shafts	Combination fire/smoke dampers are required
Separations per Part III of this report	Fire dampers are required
Ceiling part of a floor/ceiling or roof/ceiling assembly	Fire dampers are required

5.6 CONSTRUCTION JOINTS

Expansion joints	Joints used to accommodate wind, seismic, or expansion movement are required to be provided with the same fire resistance of the wall or floor in which they are installed by the use of listed assemblies .- Section 713
Vertical fire spread	Voids created at the intersection of the exterior curtain wall and the fire resistive floor assembly are required to be sealed with an approved protective equal to the fire resistance rating of the floor - Sections 713.4 and 711.6 Joints created between the floor and exterior wall required to be protected by an approved fire resistant joint system - Section 713.4

6.0 FIRE RESISTIVE INTERIOR FINISHES

6.1 WALL AND CEILING FINISHES

The following tables summarize Table 803.5 requirements in sprinklered buildings.

FLAME SPREAD CLASSIFICATIONS	
WALL & CEILING FINISH	SECTION 803
Flame spread 0-25, smoke developed 0-450	Class A
Flame spread 26-75, smoke deve1oped 0-450	Class B
Flame spread 76-200, smoke developed 0-450	Class C

MAXIMUM FLAME SPREAD CLASS			
Occupancy Group	Vertical Exits and Exit Passageways	Exit Access Corridors and Other Exit Ways	Room or Enclosed Spaces
B	A or B	A, B, or C	A, B, or C

Textile wall coverings — Materials such as those having tufted, looped, non-woven, woven, or similar surfaces: Class A and protected by automatic sprinklers - Section 803.6.1

Carpets on ceilings and expanded vinyl wall coverings — Class A required and protected by sprinklers - Sections 803.6.2 and 803.7

6.2 FLOOR FINISH

Rooms — Material complying with DOC FF-1 "Pill Test" (CPSC 16, CFR 1630) - Section 804.4.1

Exit stairs, exit passageways, rated and non-rated corridors — Material complying with DOC FF-l "Pill Test" (CPSC 16, CFR 1630) - Section 804.4.1

6.3 PLENUMS

Plenums are defined as any space used for air movement - IMC Section 602.1

Exposed materials within plenums are required to have a flame spread index of 25 and a smoke developed rating of 50 –IMC Section 602.2.1

For requirements on wiring, plastic sprinkler piping, and pneumatic tubing see Section 602.2.1 of the IMC

Use of corridor as plenum — Use of corridor as a source of make up air for exhaust systems of rooms that open directly onto such corridors is permitted provided make up air rate is less than supply of outdoor air to the corridor –Section 10 17.4, Exception 1

Hazardous Materials Exhaust Duct — Not permitted to extend into or through ducts or plenums - Section 414.3

6.4 FOAM PLASTIC (E.G., RIGID INSULATION)

Required to have a flame spread rating of 75 or less and a maximum smoke developed rating of 450 - Section 2603.3

Required to be separated from the building interior by a thermal barrier 1/2 inch regular gypsum board or equivalent means having an index of 15 - Section 2603.4

May be used in roofing and exterior walls if part of a fire resistive assembly –Sections 2603.4.1.5 and 2603.5.1

May be used as interior trim if covering is no more than 10% of walls or ceilings - Section 2604.2

7.0 EXIT REQUIREMENTS

7.1 GENERAL EXIT CRITERIA

7.1.1 Occupant Load Factors

Mechanical or storage spaces	300 square feet per person- Table 1004.1.1
Office/laboratories	100 square feet per person - Table 1004.1.1
Locker rooms	50 square feet per person- Table 1004.1.1
Conference rooms	15 square feet per person - Table 1004.1.1

7.1.2 Number of Exits

Two exits from each floor required; three exits required in areas where there are 501 to 1,000 persons; four exits required in areas where there is more than 1,000 persons - Section 1019.1

Two exit doors required from a room (or floor) in the following conditions Table 1015.1:

Mechanical or storage rooms	Serving 30 or more people
Office and laboratories	Serving 50 or more people

7.1.3 Arrangement of Exits

Where two exits are required, they must be placed a minimum distance apart of 1/3 the overall diagonal dimension of the room or building (also see Section 7.9 of this report) - Section 1015.2.1, Exception 2

Doors: Where three or more exits are required, at least two must be separated by 1/3 the diagonal- Section 1015.2.2

Additional exits are required to be separated such that if one becomes blocked, the others remain available

7.1.4 Capacity of Exits

7.1.4.1 Non-Smoke Protected

Door	80 people per foot (0.15 inches per person) - Section 1005.1
Stair	60 people per foot (0.2 inches per person) - Section 1005.1

7.1.5 Travel Distance

250 feet to an exit - Section 1025.7

Note: Travel distance is measured to an "exit". By definition, an "exit" is one of the following: an exterior door, a stair enclosure, an exit passageway, or a horizontal exit (i.e., a 2-hour wall subdividing a floor plate).

7.1.6 Common Path of Travel

75 feet (100 feet in office and storage spaces) - Section 10143, Exception 1

7.2 DOOR CRITERIA

Maximum leaf width	48 inches - Section 1008.1.1
Minimum leaf width	Wide enough to allow minimum clearance width of 32 inches when open - Section 1008.1.1
Minimum clear width	32 inches - Section 1008.1.1
Minimum clear height	6 feet, 8 inches - Section 1008.1.1
Exit door swing	Exit doors are required to be swinging type - Section 1008.1.2 Some exceptions allowed to allow other swings and will be reviewed as the design progresses Exit doors serving 50 or more persons or high hazard or refrigeration uses are required to swing in the direction of egress - Section 1008.1.2
Doors in series	Doors in series required to swing in the same direction or away from the space in between a minimum of 48 inches plus one door width between doors - Section 1008.1.7
Panic hardware requirements	Required on latched doors serving assembly areas having an occupant load of 50 or more - Section 1008.1.9

7.3 CORRIDORS

Minimum height	7 feet, 6 inches - Section 1208.2
Minimum width	44 inches serving an occupant load of more than 50 - Section 10172
	36 inches serving an occupant load of 50 or less - Section 1017.2, Exception 2
Maximum allowable dead-end corridor	20 feet (50 feet in office) - Section 1017.3
Construction	0-hours - Section 1017.1
Projections	Not permitted except when doors are fully opened; obstruction may project no more than 7 inches into the required width - Section 1005.2
	Doors in any position cannot reduce the required width by more than half
	Fixtures and furnishings may project up to 4 inches on either side into the required width between heights of 27 and 80 inches - Section 1003.3.3
	Ceiling projections may extend below the ceiling but not less than 80 inches above the finished floor for not more than 50% of the ceiling - Section 1003.3.1

7.4 STAIRWAY CRITERIA

7.4.1 Stair Riser

Maximum	7 inches - Section 1009.3
Minimum	4 inches - Section 1009.3
Open risers	Not permitted - Section 1009.3.3

7.4.2 Stair Treads

Maximum	N/A - Section 1009.3
Minimum	11 inches - Section 1009.3

7.4.3 Stair Width

44 inches minimum - Section 1009.1

7.4.4 Stair Headroom

6 feet, 8 inches - Section 1009.2

7.4.5 Landing Criteria

Minimum length	Width of stair - Section 1009.4
	Need not exceed 48 inches when the stair has a straight run
Doors at landings/ projections	Doors in the fully open position cannot reduce the landing width by more than 7 inches - Section 1009.4, Exception 2
	Door swing over stair landings shall not reduce a landing dimension more than half the required width
Maximum height between landings	12 feet - Section 1009.6

7.4.6 Use of Space within Exit Stairway Enclosures

Not permitted - Section 1020.1

7.4.7 Handrails

	Required to be continuous the full length of the stairs on both sides - Section 1009.1004
Height	34-38 inches - Section 1012.2
Extensions	Required - Section 1012.5
Top	Handrail required to extend 12 inches beyond the top riser and run parallel to the walking surface - Section 1012.5
	Shorter extensions are permitted where handrails are interrupted by a stair doorway - Section 1012.4, Exception 3
Bottom	Handrail required to extend parallel to the stair for 12 inches and run parallel with the walking surface - Section 1012.5
Termination	Returned to wall, guardrails, or be continuous - Section 1012.5
Handgrip	1 [redacted] - 2 inches in diameter or shape shall provide an equivalent gripping shape having a perimeter of 4.0-6.25 inches with a maximum cross-section dimension of 2.25 inches - Section 1012.3 (ADAAG Section 4.26.2 – 1 1/4 - 1 1/2)
	A minimum radius of 0.01 inches is required at edges - Section 1012.3

Distance from a wall	In stairs, a minimum of 1 1/2 inches clear space is required between the rail and the wall- Section 1012.6
Guardrails	42 inches high with intermediate rails to prevent the passage of a 4 inch sphere up to 34 inches high; 8 inch sphere from 34 to 42 inches - Sections 1013.2 and 10133

7.4.8 Access to Roof

Required - Section 1009.11 and IMC 603.3

If roof is unoccupied, access may be by a roof hatch providing a minimum of 16 square feet with a 2 feet minimum dimension - Section 1009.11.1, Exception

If roof is occupied, a stair with a penthouse structure is required - Section 1009.11.1

7.4.9 Exit Discharge Requirements

Discharge directly to the outside through enclosed exit passageways from enclosed exit stairs - Section 1024.1

50% of the number and capacity of exit enclosures may discharge through a lobby or vestibule - Section 1024.1, Exception 2

7.5 OTHER EXIT ISSUES

Exit access through adjoining spaces	Permitted
	No limitations on number of exits or number of occupants limited by travel distance provided the space is accessory and is not considered storage, kitchen, or higher hazard space - Section 1014.2

7.6 EXIT PROVISIONS FOR THE DISABLED

Number of exits	Two accessible exits are required when two or more exits are required - Section 1007.1
	Required to be provided in the same number as required for exits - ADAAG 4.1.3(9)
Area of refuge	Not required
	IAC amends IBC Chapter 11 to indicate that if the structure complies with ADAAG, then it has been deemed to comply with IBC requirements, thus removing the area of refuge requirements

Areas not required to be accessible	Elevated sound booths, video rooms, camera platforms, and the like are not required to be accessible - Section 1103.2.9 Storage elements, including lockers, in accessible spaces are not required to be accessible - Section 1109.8

7.7 EXIT SIGNS AND EXIT LIGHTING

Exit lighting requirements	Required for means of egress with a minimum intensity of one footcandle at floor level; emergency power is required - Section 1006.2 (see Section 1006.4 for performance parameters)
Exit sign requirements	Required for means of egress from a room or space where two or more exits are required - Section 1011.1 Required to be illuminated at all times and be provided with emergency power - Section 1011.2

7.8 SPECIAL HAZARDS

Rooms containing fuel fired equipment	Any room containing a boiler, furnace, incinerator, or other fuel fired equipment shall be provided with two exits when an individual piece of fuel fired equipment exceeds 400,000 Btu/hour input and the room exceeds 500 square feet Doors must be separated by 1/2 the diagonal distance - Section 1015.3 A fixed ladder access is allowed in lieu of one of the required two exit doors
Refrigeration machinery rooms	Two exits required when 1,000 square feet or larger - Section 1015.4 Half the diagonal separation is required one exit may be a ladder Travel distance within the rooms to be 150 feet maximum Doors to swing in the direction of egress

8.0 FIRE PROTECTION ISSUES

8.1 FIRE SUPPRESSION

Automatic sprinklers	Required - Section 903.2.1.4
	Quick response sprinklers are required in light hazard occupancies - Section 903.3.2
	Automatic sprinkler systems are required to be designed to conform to 2002 Edition of NFPA 13 - Section 903.3.1.1
Standpipes	Class I standpipes required for sprinklered buildings with highest floor level less than 30 feet or more above the lowest level of fire department access –Section 905.3.1

8.2 SMOKE CONTROL

Atrium	Atrium not provided in the BRL Phase I portion of this project, thus smoke control is not required
Hoistways	Vents to the exterior are not required –Section 3004.1, Exception 1

8.3 FIRE ALARMS

Manual pull stations	Manual pull stations are not required because the building is sprinklered –Section 907.2.1, Exception
Visual	Visual alarms are required to be installed in accordance with ADAAG and 2002 Edition of NFPA 72 - Section 907.9
Audible	Audible alarms are required by the ADA to provide a sound intensity exceeding the average ambient sound level by 15 dBA or a level which exceeds the maximum sound level by 5 dBA with a duration of 60
	The minimum required sound pressure levels are 90 dBA in mechanical and equipment rooms and 60 dBA elsewhere - Section 907.9.2
	Voice/alarm communication is required -Section 907.2.1.1
	Sprinkler valves controlling water supply and water flow switches are required to be connected to the fire alarm system; these devices are required to be electrically supervised for alarm, supervisory, and trouble signals - Section 903.4

8.4 F'IRE AND SMOKE DETECTION

Smoke detection required to shut-off heating or cooling air systems 2,000 cfm capacity or serving more than one occupancy

Smoke detection is required at elevator lobbies and machine rooms to initiate fireman's service (Phase 1) recall –Section 3003.2

Heat detector with a shunt trip device required in sprinklered machine rooms –ANSI AI7.1, Section 2.8.2.3

Smoke detector(s) provided in conjunction with smoke dampers and hold open doors - NFPA 72

8.5 BACK-UP POWER

Exit signs and exit lights	Emergency power is required; may be unit batteries - Sections 1006 and 1011.5.3
Smoke control system	Standby power is required - Section. 909.11
Elevator	Required - Section 1007.5
Spaces with Hazardous Material	Required when failure of mechanical system could create an unsafe condition, based on types of hazardous materials –Section 414.5.4

9.0 MISCELLANEOUS ISSUES

9.1 TOILET FIXTURE COUNT

Based on Table 4-1 of the UPC assuming 50% male, 50% female.

	Water Closets		Lavatories		Urinals	Drinking Fountains
	Male	Female*	Male	Female		
Rule	3 per 55 1 per 40 for the remainder	4 per 55 1 per 40 for the remainder	1 per 40	1 per 40	1 per 50	1 per floor

* The total number of fixtures for women is required to equal to the total required water closets and urinals.

9.2 ROOM HEIGHT CRITERIA

Office spaces	7 feet, 6 inches - Section 1208.2
Corridors	7 feet, 6 inches; means of egress (i.e., including rooms) - Section 1208.2
Doors	6 feet, 8 inches minimum - Section 1008.1.1
Exit stairs (headroom)	6 feet, 8 inches minimum - Section 1009.2
Bathrooms	7 feet - Section 1208.2

9.3 ELEVATOR

Hoistway vents	Not required - Section 3004.1
Elevator lobbies	Not required - Section 707.14.1, exc. 4
Stretcher	A 24 inch by 84 inch space to accommodate a stretcher in a horizontal position is required - Section 3002.4
Standby power	Required - Section 1007.5

PARKING STRUCTURE

PARKING STRUCTURE CODE SUMMARY

1.0 INTRODUCTION

1.1 SCOPE

This documentation outlines major fire and life safety issues affecting the design of the garage building. Fire and life safety criteria are summarized from the 2006 International Building Code (IBC). Miscellaneous issues are also documented.

1.2 BUILDING DESCRIPTION

This is a multi-level open car parking garage.

1.3 BUILDING CODE APPROACH

All levels are naturally ventilated (i.e., open), unsprinklered, and constructed of Type II-B construction (i.e. non-combustible, non-fire resistive).

1.4 SPECIAL FEATURES

Class I dry, manual standpipes are required to be located as required for Class II Standpipes (i.e., such that every portion of the building is within 130 feet of an outlet), per Section 905.3.1, Exception 3.

2.0 CONSTRUCTION ISSUES

2.1 OCCUPANCY GROUP CLASSIFICATION(S)

Naturally ventilated (i.e. open) parking garage: 5-2 (Section 311.3)

2.2 TYPE OF CONSTRUCTION

Above grade levels are classified as Type II-B construction (i.e. non-combustible, non fire resistive).

2.3 ALLOWABLE HEIGHT AND AREA

The allowable height and area for the open parking garage is as follows (Table 406.3.5):

	ACTUAL	AS ALLOWED BY CONSTRUCTION TYPE II-B
Number of tiers	TBD	8
Area per tier (square feet) (largest tier)	TBD	50,000*

* Allowable area may be increased based on openness and height of the building. A Type II-B garage may be unlimited in area when open on all sides and limited to 75 feet in height (Section 406.3.6).

2.4 GUARDRAILS (SECTION 406.2.3)

Rails and protective barriers are required in specific locations: adjacent to walking surfaces and occupied spaces where a 30 inch change in elevation occurs. These locations include:

- Unenclosed floor and roof openings
- Open and glazed sides of stairways, landings, ramps, balconies, or porches

Guardrails are required to be a minimum of 42 inches in height with openings limited such that a four inch sphere cannot pass through (Section 1013.3). The triangular space formed by the riser, tread, and rail bottom may allow passage of a six inch sphere.

2.5 VEHICLE BARRIERS (SECTION 406.204)

Vehicle barriers are required when any parking surface is more than one foot above grade. Barriers are required to have a minimum height of two feet and located at the ends of drive lanes and parking spaces. Please refer to IBC, Chapter 16 for structural requirements.

2.6 STAIR CONSTRUCTION

Stairs are required to be of non-combustible construction (Section 1009.5).

3.0 FIRE RESISTIVE REQUIREMENTS FOR ELEMENTS OF THE STRUCTURE

3.1 ACCEPTABLE MATERIALS

Structural elements of Type II-B buildings are required to be of non-combustible materials (Section 602.2).

3.2 STRUCTURAL, INTERIOR, AND EXTERIOR ELEMENTS

Fire resistive requirements are summarized from the IBC below. This criteria includes three principle types of concerns: fire resistive capacities for structural elements, exterior elements providing property protection, and interior elements providing internal protection.

Passive thermal fire resistance for the structural frame insures stability of the building can be maintained during the anticipated fire condition. The structural frame (Table 601 footnote a) is defined as columns, as well as trusses, spandels, and beams having direct connection to columns. Beams, spandels, and trusses not having direct connection to columns are considered secondary elements. Depending on where they occur, these secondary elements would be classified as part of either a roof or floor assembly for purposes of fire protection.

The fire resistive requirements are listed for each Type of Construction proposed as follows:

A. Type II-B Construction (Open Parking Garage)

Element	Fire Resistance
Columns and beams/girders	0-hour
Floors (including beams, joists, trusses not framed into columns)	0-hour - Table 601
Roof assembly (including beams/joists/trusses not framing into columns)	0-hour - Table 601 0-hour for roof which is >20 above floor level- Table 600, footnote CI
Roof covering	Minimum Class C roof covering - Table 150.5.1
Walls:	
• Interior non-bearing wall not associated with a fire resistive corridor	0-hour - Table 601
• Interior bearing wall	0-hour - Table 601
• Exterior hearing and non—bearing walls (for opening protection see Part V)	0-hour 0-hour where walls are ten feet or more from property line or center line of adjoining right-of-way

Shafts (for opening protection see Section V)	Enclosure of vertical openings in floors is not required to be rated even if provided - Section 406.3.11
• Hoistways and elevator machine rooms not required to be rated - Section 406.3.11	Elevator hoistway enclosures are Hoistways may be open to machine rooms (ANSIA17.1 Rules 101.1a(2) and 100.la(2))
• Exit stair enclosure	Enclosed stairways are not required to be rated in open parking garages – Section 1 005.3.2, Exception 5
• HV AC, plumbing, and electrical shafts	Enclosures are not required to be in a shaft - Section 406.3.11

4.0 FIRE RESISTIVE PROTECTION OF OPENINGS PENETRATIONS

4.1 OPENINGS IN EXTERIOR WALLS

Distance to real or assumed property line, center line of adjoining publicpercent of exterior wall area right-of-way	Area of non fire resistive openings as - Table 704.8
0 to less than 5 feet	0
5 feet to less than 10 feet	10%
10 feet and more	100%

4.2 OPENINGS IN INTERIOR WALLS

Not required to be protected. Openings required to be maintained per Section 406.3.3.1

4.3 OPENINGS IN FLOORS/CEILING AND ROOF/CEILING ASSEMBLIES

Floors	Openings in the open parking garage are permitted - Section 406.3.11

4.4 PENETRATIONS

Walls	Penetrations are required to be sealed with a listed fires top assembly having an F-rating equal to the wall rating - Section 711.3 Metal pipe or conduit (six inch or smaller) penetrating concrete or masonry walls may be grouted solid Membrane protection is not required for steel electrical boxes (16 square inches or smaller), separated by 24 inches horizontally, and not exceeding 100 square inches per 100 square feet of wall; alternatively, listed boxes may be used per their listing
Floors	Floor penetrations of the open parking garage are not required to be protected –Section 406.3.11

4.5 FIRE/SMOKE DAMPERS

No requirements

4.6 CONSTRUCTION JOINTS

Joints used to accommodate wind, seismic, or expansion movement are required to be provided with the same fire resistance of the wall or floor in which they are installed by the use of listed assemblies except in open parking garages - Section 712.1, Exception 5

4.7 EXTERIOR WALLIFLOOR JOINTS

Voids at the intersection of exterior wans and fire resistive floor assemblies are not required to be sealed with an approved material - Section 713.4

Not required in open parking garages - Section 713.1, Exception 5

4.8 FLAME BARRIERS

Flame barriers are not required between openings in adjacent floor levels that are naturally ventilated - Section 704.9, Exception 3

5.0 FIRE RESISTIVE INTERIOR FINISHES

5.1 WALL AND CEILING FINISHES

The following table summarizes Table 803.5 requirements in non-sprinklered buildings.

FLAME SPREAD CLASSIFICATIONS

WALL & CEILING FINISH	CLASS
Flame spread 0-25, smoke developed 0--450	Class A
Flame spread 26-75, smoke developed 0-450	Class B
Flame spread 76-200, smoke developed 0-450	Class C

Location	Finish Requirement
Enclosed vertical exitways (including exit passageways)	Class A or B
Other exitways (corridors and hallways)	Class A or B
Rooms	Class A, B, or C

5.2 FLOOR FINISH

Rooms	Material complying with DOC FF-I "Pill Test" (CPSC 16, CFR 1630) - Section 804.5.1

5.3 FOAM PLASTIC (E.G., RIGID INSULATION)

Required to have a flame spread rating of 75 or less and a maximum smoke developed rating of 450 - Section 2603.3

Required to be separated from the building interior by a thermal barrier having an index of 15 or by a 112 inch regular gypsum board - Section 2603.4

May be used as interior trim if covering is no more than 10% of walls or ceilings. For further requirements see Section 2604.2.

6.0 EXIT REQUIREMENTS

6.1 GENERAL EXIT CRITERIA

Occupant Load Factors:

Open parking garage	200 square feet/person - Table 1004.1.2
Storage/mechanical spaces	300 square feet/person

6.1.1 Arrangement of Exits

Where two exits are required, they must be placed a minimum distance apart of one-half overall diagonal dimension of the room or building. Section 1015.2.1

6.1.2 Capacity of Exits

Doors	60 people/foot (0.2 inches/person) - Table 1005.1
Stairs	40 people/foot (0.3 inches/person) -Table 1005.1

6.1.3 Travel Distance

300 feet - Section 1016.1

Note: Travel distance is measured to an "exit". By definition, an "exit" is one of the following: an exterior door, a stair enclosure, an open stair in an open parking garage, an exit passageway, or a horizontal exit (i.e., a 2-hour wall subdividing a floor plate).

6.1.4 Common Path of Travel

75 feet, Section 1013.3

6.2 DOOR CRITERIA

Maximum leaf width	48 inches - Section 1008.1.1
Minimum leaf clear width	32 inches - Section 1008.1.1
Minimum clear height	6 feet, 8 inches - Section 008.1.1
Exit door swing	Exit doors are required to be swinging type - Section 1008.1.2
Panic hardware requirements	Not required - Section 1008.1.9

6.3 STAIRWAY CRITERIA

6.3.1 Stair Riser

Maximum	7 inches - Section 1009.3
Minimum	4 inches - Section 1009.3
Open risers	Not permitted - Section 1009.3

6.3.2 Stair Treads

Maximum	N/A - Section 1009.3
Minimum	11 inches - Section 1009.3

6.3.3 Stair Width

44 inches minimum - Section 1009.1

6.3.4 Stair Headroom

6 feet, 8 inches - Section 1009.3

6.3.5 Landing Criteria

Minimum length	Width of stair need not exceed 44 inches when the stair has a straight run -Section 1009.4
Doors at landings/projections	Doors in the fully open position cannot reduce the landing width by more than 7 inches - Section 1005.2 Door swing over stair landings shall not reduce a landing dimension more than half the required width
Maximum height between landings	12 feet - Section 1009.6

6.3.6 Use of Space

Within exit stairway enclosures	Not permitted - Section 1019.1.9

6.3.7 Handrails

	Required to be continuous the full length of the stairs on both sides -Section 1009.11
Height	34-38 inches - Section 1009.11.1
Extensions	Required - Section 1009.11.5
Top	Handrail required extending 12 inches beyond the top riser and running parallel to the walking surface

Bottom	Handrail required extending parallel to the stair incline for one tread depth
Termination	Returned to wall, guardrail, or IS continuous - Section 1009.11.5
Handgrip	1 1/2 -2 inches in cross-sectional area or shape shall provide an equivalent gripping shape having a perimeter of 4-6.25 inches with a maximum cross-section dimension of 2.25 inches; a minimum radius of 0.125 inches is required at edges (ADAAG Section. 4.26.2: 1 % - 1 1&) - Section 1009.11.3
Distance from a wall	In stairs, a minimum of I-Y2 inches clear space is required between the rail and the wall - Section 1009.11.6
Guardrails	42 inches with intermediate rails to prevent the passage of a four inch sphere - Sections 10 13.2 and 10 13.3

6.3.8 Exit Discharge Requirements

Open egress stairs may discharge to the exterior through open parking garages - Section 1024.1, Exception 3

6.4 OTHER EXIT ISSUES

Exit access through adjoining spaces	Permitted; no limitations on number of exits or number of occupants limited by travel distance - Section 10 13.2

6.5 EXIT PROVISIONS FOR THE DISABLED

Number of exits	Required to be provided in the same number as required for exits - Section 1007.1 When an exit is not accessible, an area of refuge is required
Area of refuge	Not required in open parking garages

6.6 EXIT LIGHTING AND EXIT SIGNS

Exit lighting requirements	Required for means of egress with an average intensity of one footcandle at floor level including exit discharge; emergency power is required - Section 1006
Exit sign requirements	Required for means of egress from a room or space where two or more exits are required - Section 1011.1 Required to be illuminated at all times and be provided with emergency power - Section 1011.5.3

7.0 FIRE PROTECTION ISSUES

7.1 FIRE SUPPRESSION

Automatic sprinklers	Not required - Section 903.2.9
Standpipes	Class I manual dry standpipes are required to be provided at locations as required for Class II - Section 905.3.1, Exception 3
	There are no hose requirements
	Standpipe design is required to conform to the 2002 Edition of NFP A 14

7.2 FIRE AND SMOKE DETECTION

Not required

7.3 MISCELLANEOUS FIRE PROTECTION ISSUES

Portable extinguishers	Required by the International Fire Code - Section 906

7.4 SMOKE CONTROL

Elevator hoistways are required to be vented to the outside; the area of vents is required to be a minimum of 3.5 % of the area of the shaft but not less than 3 square feet per elevator car - Sections 3004.1 and 3004.3

7.5 EMERGENCY POWER

Exit signs and exit illumination	Emergency power is required; may be unit batteries - Section 1003 .2.11.2

8.0 MISCELLANEOUS ISSUES

8.1 PLUMBING FIXTURES

There are no requirements for plumbing facilities for Parking Garage in the 2006 IBC.

8.2 VENTILATION CRITERIA

Open parking garages utilize exterior openings for natural ventilation (Section 406.3.3. I). Openings are required to be provided on at least two sides. Openings are required to provide a total area of at least 20% of the perimeter wall area of each tier. In addition, the aggregate length of the openings is required to be a minimum of 40% of the perimeter of each tier. Interior walls require at least 20% open with uniformly distributed openings.

8.3 ROOM HEIGHT CRITERIA

Parking garages	7 feet clear minimum to any ceiling, beam, pipe, or other construction -Section 406.2.2
	98 inches clear minimum for van accessible parking spaces and driving routes – ICC/ANSI All 7.1

8.4 ACCESSIBLE PARKING SPACES

More than 1,000 parking spaces provided require 20 plus 1 % accessible parking spaces. One out of every eight accessible parking spaces is required to be van accessible (Table 1106.1 and Section 1106.5).

SECTION V.D.

LIFE CYCLE COST NARRATIVE

LIFE CYCLE COST NARRATIVE

Life Cycle cost analysis for the project will be completed during the Design Development phase of the project for the Biorenewables Research Laboratory. Parameters for the analysis are being set based upon the sustainable options currently under review by ISU.

SECTION V.E.

LEED NARRATIVE

LEED NARRATIVE

This section of the report applies only to the ABE/BRL buildings and connection atrium.

I. Goals

A. The development of a building with numerous sustainable features and a high-level of performance.

B. ISU has identified the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, with the goal of Certification at the Silver Level.

1. In pursuit of these goals numerous sustainability strategies have been identified for integration into the project.

2. An Integrated Design Workshop was held with various representatives of the user groups, Facilities Planning and Management, and the design team to further focus and prioritize the list of possible strategies.

3. During the Schematic Design phase this list of strategies was refined and applied to the various building schemes under consideration.

4. The current list of strategies is organized below using the five LEED Impact Categories.

5. These various sustainability strategies, and others that may arise during the design process, will be evaluated against multiple criteria including: environmental or energy efficiency impact, educational value, and project budget.

6. The Iowa Department of Natural Resources requires life-cycle cost analysis of some building systems which will also inform certain of these decisions.

C. The fund-raising potential of visible sustainable strategies should not be overlooked.

II. Strategies

A. Primary Site Strategies

1. Green roofs for stormwater detention

2. Raingardens for stormwater detention and treatment

3. Green facades and site planting for sun control

The city storm sewer is distant from the project site and is currently operating at or near capacity. Consequently, treating and infiltrating stormwater on the project site is both a budget priority and a sustainability opportunity. There is currently some stormwater runoff from the turf grass and paving on site. This amount of existing runoff can be taken as a baseline, with a project goal of not exceeding the baseline when the project is complete.

As the project will drastically increase the amount of impervious surface on the site, strategies to clean, detain, infiltrate and use the water onsite will be essential. Strategies under consideration include vegetated roofs and bio swales or rain gardens. Harvesting stormwater for use in the building can further reduce the volumes that must be dealt with onsite; this strategy is discussed below under Water Efficiency.

Whatever stormwater strategies are chosen, they should be undertaken with an understanding of and respect for the native soils and hydrology of Iowa and with a view towards restoration of natural systems. As well, the design of stormwater systems should be undertaken with an eye to exposing the process and creating educational and symbolic value. The site design can be seen as an opportunity to innovate and define the direction of future campus development.

Plants are central to the mission of both programs to be housed in the project; vegetated roofs and facades as well as site planting have potential as strong symbols of, and tools for, the educational and research programs housed in the complex. Carefully placed deciduous or annual site plantings can contribute significantly to building energy performance, shading facades during the growing season and allowing sunlight penetration in the winter when thermal gain is desired. The shading contribution of vegetated roofs and walls can also yield significant, and potentially greater, energy savings.

B. Primary Water Efficiency Strategy

1. Stormwater storage and reuse

   a. Stormwater can be seen as an onsite resource for the building and effectively harnessed for use.

   b. Potential building uses for stormwater include toilet flushing and process water for the lab spaces.

   c. Even relatively clean roof water will need some filtering and purifying before being used, but this technology is well established and easily implemented.

   d. Other possible sources of water for reuse are cooling coil condensate and rejected water from reverse osmosis treatment.

   e. Storage is likely the greatest challenge given the size and cost of cisterns or tanks. The design team has produced a preliminary water budget for the project, comparing water supply with reuse potential, and projected an optimum cistern size of 25,000 gallons.

C. Primary Materials and Resources Strategies

1. Bio materials

   Since part of the mission of the BRL is to develop building materials from biomass, appropriately sourced rapidly renewable materials will be an obvious focus when finish materials are selected.

2. Locally manufactured products

   Attempts will also be made to identify locally or regionally manufactured or extracted materials for use.

D. Primary Energy and Atmosphere Strategies

1. Exterior shades for sun control

   a. Shading in the form of strategic planting can be effective in reducing energy demand for cooling.

   b. Where plantings are not possible or desirable building-mounted sunshades will be deployed to the same effect.

c. Another passive system, the building envelope, is even more important than shading in reducing energy demand. Analysis of solar gain and heat loss will help the design team to optimize insulation, customize glazing selection for differing thermal conditions, and locate areas of glazing for the greatest benefit.

2. Heat recovery wheels for energy efficient heating and cooling

   a. Once energy demand is optimized, building systems must be designed to use any required energy efficiently.

   b. Humidity is a concern year round in Ames, supply air being dehumidified in the summer and humidified in the winter. For this reason an enthalpy wheel that transfers both heat and humidity from exhaust or intake air should be considered for the project.

   c. Also known as "Total Energy Recovery Ventilators", heat wheels provide energy recovery for both sensible and latent heat transfer.

   d. These mechanical components have increased in use in laboratory environments for all exhaust air streams and have been shown to be up to 85% effective at heat transfer.

   e. The current ASHRAE standard requires energy recovery with an effectiveness of at least 50% for buildings such as the Biorenewables Complex and thus heat wheels should be analyzed for all spaces.

   f. Additionally, a by pass strategy will be considered for any heat recovery during non-recovery periods to lower static pressure in the fan system during these periods.

3. Solar domestic hot water heating

   a. Solar thermal systems can offer reasonable pay back periods while addressing the relatively constant energy demand inherent in domestic hot water for constant use facilities.

   b. An analysis is recommended to determine the energy savings associated with a solar thermal domestic hot water system sized for the entire building domestic hot water load.

   c. A system of this nature will require significant surface area on the building enclosure as well as square footage for interior storage capacity

4. Ground Source Heat Pump for efficient heating and cooling

   a. Given that campus steam and chilled water are remote from the site, alternates to extending those utilities will be considered for the project.

   b. A ground source heat pump system has been singled out for consideration as an alternative. In depth analysis of this type of system remains to be done, including comparison of building loads with available site area.

5. Displacement ventilation or infusers

   a. Displacement ventilation could be used in office areas as well as high bay spaces to limit fan power energy and the amount of building volume that is actively conditioned by mechanical means.

      (1) Advancements in displacement ventilation allow for the implementation of this concept without the need for a raised floor.

b. Another possible approach to space conditioning is the use of infusers.

(1) This concept involves the use of low temperature, low humidity air distribution through supply air terminals, called infusers, which induce mixing at the space through the use of induction nozzles.

(2) The concept results in the virtual elimination of reheat energy at the space as air mixing occurs through the induction process.

6. Avoid reheat

7. Demand Control Ventilation

a. Supplementing an all outside air system with a return air system would provide significant energy savings in shop areas.

b. A return air system could be implemented with the use of an air quality monitoring system (demand control ventilation) to ensure proper air quality by varying the amount of outside air introduced to the return air system.

8. Active lab air flow control

a. The Aircuity Optinet system offers an opportunity to actively control air flow quantities to laboratory spaces based on the presence (or absence) of contaminants in the occupied zone.

9. Scrutinize air changes

a. Recent benchmark studies have shown laboratory spaces to be below contaminant thresholds for 99.7% of the time at only four air changes per hour.

b. A reduction in average annual air change rates from six to four would offer significant energy savings.

10. Rightsizing of equipment

a. Specific areas of the ABE/BRL complex may be candidates for unconditioned or minimally conditioned space or a wider temperature range than is typical.

b. There is significant program area dedicated to the atrium, high bay space and shop areas.

c. The energy conservation benefits of unconditioned space are readily apparent and should be quantified in the next phase of project work so that a balance can be made between conditioning these spaces and the overall goals of energy efficiency.

11. Rational Layout for low pressure drop

a. A building and mechanical layout which provides for relatively direct and straight duct and piping runs can reduce pressure drop in the mechanical system.

b. Savings in pump and fan energy can be significant in such a system as ventilation alone typically accounts for between 20 and 40% of the total energy use in lab buildings.

c. Reducing static pressure in the ventilation system directly corresponds to energy savings in this large energy use category.

d. Other static pressure reduction strategies include decreased velocity across heat transfer coils, lower velocity air distribution, lower supply temperature distribution systems, and many other components.

12. Extended range of control or minimal conditioning for energy savings

13. Radiant systems for efficient heating and cooling

a. Similar to the "decentralized cooling" strategy discussed above, spot conditioning may offer an alternative to totally unconditioned space.

(1) In this strategy efficiency is gained by conditioning only specific areas of a program space such as locations where humans will be present.

(2) Example concepts for this strategy include radiant panels, air curtains, in-floor radiant heat, and passive chilled beams.

14. Heat recovery from lab processes

a. A final strategy which requires more investigation is heat recovery from lab processes.

b. Any equipment which produces significant heat and is commonly operated may be connected to a heat exchanger and the waste heat used for domestic hot water or space heating.

E. Indoor environmental quality

1. Daylighting for energy savings and inspiration

a. Daylight in occupied spaces has been proven to increase satisfaction and human performance in various settings, and should be considered a priority in this project.

b. Admitting daylight deep into interior spaces while effectively controlling heat gain and glare is a complex but achievable goal for the design team.

c. Glazing selection and layout is crucial for effective daylighting of interior spaces and will also be a criterion by which envelope design is judged.

2. Natural ventilation and operable windows

a. Several program areas of the ABE/BRL project may be candidates for natural ventilation or operable windows.

(1) This strategy would be limited to spaces without specific ventilation safety issues (laboratory spaces) and where pressure differential between adjacent spaces is not of acute concern.

(2) This strategy is a possibility for use in such spaces as Atriums, connectors, and offices.

F. Other Strategies

A. Quantitative display for demonstration and teaching

1. Just as the building will seek to put teaching and research on display, exposing building systems with the idea of educating and informing users and visitors should be considered.

B. Wind energy for stormwater pumping

1. Opportunities have been identified to quantitatively display water storage, move stormwater with wind energy in a nod to agricultural practice, and expose site functions.

2. Other such opportunities should be sought for similar measures that exhibit a clear purpose for the building or site.

III. Preliminary LEED Score Card

See following.

Iowa State University Biorenewables Complex — Preliminary LEED Scorecard — ZGF Architects, LLP 10/23/2007

30 High - Likely Points	Total Rating System Possible Points: 69
11 Medium - Reasonable Chance - Needs Review	Total Potential Points Available to this Project: 55
14 Low - Unlikely - Not Yet Ruled Out	
14 Not Possible or Not Reasonable to Target	
	Currently Projected Points (all of High points plus 1/2 of Medium points): 36

Certified 26 to 32, **Silver** 33 to 38, **Gold** 39 to 51, **Platinum** 52 and over

High	Med	Low	No				
7	1	3	3	**Sustainable Sites**	**Possible Points**	**14**	**Comments**
Y				Prereq 1	Construction Activity Pollution Prevention		Prerequisite - required for any level of LEED certification - best practice
1				Credit 1	Site Selection	1	Site assumed to meet credit requirements - not farmland, floodplain, wetland, etc.
			1	Credit 2	Development Density & Community Connectivity	1	Site unlikely to meet density requirements - verify connectivity
			1	Credit 3	Brownfield Redevelopment	1	Not applicable - site assumed to be unpolluted
1				Credit 4.1	Alternative Transportation: Public Transportation Access	1	CyRide appears to have six routes operating adjacent to the site on Bissell
1				Credit 4.2	Alternative Transportation: Bicycle Storage & Changing Rooms	1	Currently in program - changing rooms and showers are a valuable amenity for users besides bicycle commuters
			1	Credit 4.3	Alternative Transportation: Low-Emitting and Fuel-Efficient Vehicles	1	Unlikely to match ISU needs/priorities
		1		Credit 4.4	Alternative Transportation: Parking Capacity	1	A possibility - will depend upon campus carpool parking policies/priorities
		1		Credit 5.1	Site Development: Protect or Restore Habitat	1	Requires landscaping 50% of unbuilt site with native or adapted plants, unlikely given site program requirements
		1		Credit 5.2	Site Development: Maximize Open Space	1	Requires setting aside adjacent vegetated space equal to the building footprint - agreement to do so in perpetuity
1				Credit 6.1	Stormwater Design: Quantity Control	1	Onsite detention/infiltration is an ISU priority
1				Credit 6.2	Stormwater Design: Quality Control	1	Onsite treatment is an ISU priority
1				Credit 7.1	Heat Island Effect: Non-Roof	1	Achievable with good site design
1				Credit 7.2	Heat Island Effect: Roof	1	Achievable with white roofing/green roof - best practice for energy conservation
	1			Credit 8	Light Pollution Reduction	1	Achievable in a campus setting but requires review regarding nighttime safety

5	0	0	0	**Water Efficiency**	**Possible Points**	**5**	**Comments**
1				Credit 1.1	Water Efficient Landscaping: Reduce by 50%	1	Standard ISU practice is no irrigation, assume any irrigation used is harvested stormwater
1				Credit 1.2	Water Efficient Landscaping: No Potable Water Use or No Irrigation	1	Standard ISU practice is no irrigation, assume any irrigation used is harvested stormwater
1				Credit 2	Innovative Wastewater Technology	1	Cost implications of rainwater harvesting for toilet flushing need further review
1				Credit 3.1	Water Use Reduction: 20% Reduction	1	Likely achievable with low-flow fixtures
1				Credit 3.2	Water Use Reduction: 30% Reduction	1	Likely achievable with waterless urinals

5	4	3	5	**Energy & Atmosphere**	**Possible Points**	**17**	**Comments**
Y				Prereq 1	Fundamental Commissioning of the Building Energy Systems		Prerequisite - required for any level of LEED certification - best practice
Y				Prereq 2	Minimum Energy Performance		Prerequisite - required for any level of LEED certification - best practice
Y				Prereq 3	Fundamental Refrigerant Management		Prerequisite - required for any level of LEED certification - best practice
5	1	2	2	Credit 1	Optimize Energy Performance	1 to 10	Initial goal of 25% energy use reduction
		1	2	Credit 2	On-Site Renewable Energy	1 to 3	Not a project priority - possibility of a demonstration-scale effort
	1			Credit 3	Enhanced Commissioning	1	Especially appropriate for high-performance/lab buildings - ISU decision
	1			Credit 4	Enhanced Refrigerant Management	1	Achievable if campus chilled water is not used
	1			Credit 5	Measurement & Verification	1	Especially appropriate for high-performance/lab buildings - ISU decision
			1	Credit 6	Green Power	1	Unlikely - power production existing on campus

Iowa State University Biorenewables Complex — Preliminary LEED Scorecard — ZGF Architects, LLP 10/23/2007

High	Med	Low	No				
3	1	4	5	**Materials & Resources**	**Possible Points**	**13**	**Comments**
Y				Prereq 1	Storage and Collection of Recyclables		Prerequisite - required for any level of LEED certification
			1	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1	Not applicable - no existing building
			1	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & Roof	1	Not applicable - no existing building
			1	Credit 1.3	Building Reuse: Maintain 50% of Interior Non-Structural Elements	1	Not applicable - no existing building
1				Credit 2.1	Construction Waste Management: Divert 50% from Disposal	1	Best practice
		1		Credit 2.2	Construction Waste Management: Divert 75% from Disposal	1	Need to verify level of recycling possible through local haulers
			1	Credit 3.1	Material Reuse: 5%	1	Not typically feasible on past, similar projects
			1	Credit 3.2	Material Reuse: 10%	1	Not typically feasible on past, similar projects
1				Credit 4.1	Recycled Content: 10% (post-consumer + 1/2 pre-consumer)	1	Typically achievable
		1		Credit 4.2	Recycled Content: 20% (post-consumer + 1/2 pre-consumer	1	A possibility, more difficult to achieve without a steel frame
	1			Credit 5.1	Regional Materials: 10% Extracted, Processed, and Manufactured Regionally	1	Possible, local sources need to be identified
		1		Credit 5.2	Regional Materials: 20% Extracted, Processed, and Manufactured Regionally	1	20% threshold may be difficult to meet, local sources need to be identified
1				Credit 6	Rapidly Renewable Materials	1	Use of bio-based materials is a project priority
		1		Credit 7	Certified Wood	1	Achievable with good planning and contractor buy-in; price premium assumed for FSC in Iowa market

6	4	4	1	**Indoor Environmental Quality**	**Possible Points**	**15**	**Comments**
Y				Prereq 1	Minimum IAQ performance		Prerequisite - required for any level of LEED certification - best practice
Y				Prereq 2	Environmental Tobacco Smoke (ETS) Control		Prerequisite - required for any level of LEED certification - University policy is compatible
	1			Credit 1	Outdoor Air Delivery Monitoring	1	Best practice
	1			Credit 2	Increased Ventilation	1	Energy impacts need review
1				Credit 3.1	Construction IAQ Management Plan: During Construction	1	Best practice
	1			Credit 3.2	Construction IAQ Management Plan: Before Occupancy	1	Requires careful scheduling, owner and contractor coordination
1				Credit 4.1	Low-Emitting Materials: Adhesives & Sealants	1	Best practice
1				Credit 4.2	Low-Emitting Materials: Paints & Coatings	1	Best practice
1				Credit 4.3	Low-Emitting Materials: Carpet Systems	1	Best practice
	1			Credit 4.4	Low-Emitting Materials: Composite Wood & Agrifiber Products	1	Bio-based materials focus may outweigh concerns about adhesive emissions
1				Credit 5	Indoor Chemical & Pollutant Source Control	1	Best practice
		1		Credit 6.1	Controllability of Systems: Lighting	1	Review requirements in light of program/functions
		1		Credit 6.2	Controllability of Systems: Thermal Comfort	1	Review requirements in light of program/functions
1				Credit 7.1	Thermal Comfort: Design	1	Best practice
		1		Credit 7.2	Thermal Comfort: Verification	1	A possibility - ZGF currently beginning a series of Post Occupancy Evaluations
		1		Credit 8.1	Daylight and Views: Daylight 75% of Spaces	1	Review requirements in light of program/functions
			1	Credit 8.2	Daylight and Views: Views for 90% of Spaces	1	Review requirements in light of program/functions

4	1	0	0	**Innovation in Design**	**Possible Points**	**5**	**Comments**
1				Credit 1.1	Water Use Reduction to 40%	1	TBD
1				Credit 1.2	Innovation in Design	1	TBD
1				Credit 1.3	Innovation in Design	1	TBD
	1			Credit 1.4	Innovation in Design	1	TBD
1				Credit 2	LEED Accredited Professional	1	Numerous team members accredited