



Prentice – Stone Pavilion Evaluation

May 2011

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RESEARCH PLANNING



I. EXECUTIVE SUMMARY

Purpose of the Study:

On April 14, 2011 Jacobs Consultancy, Inc. was contacted by Northwestern University with a request to provide an evaluation of the Prentice-Stone Pavilion building (333 E. Superior St.) for repurposing as a biomedical research facility. JCI formed a team of consultants including AEI Engineers (“AEI” - MEP) and Thornton Tomasetti (“TT” - Structural) and Rolf Jensen & Associates (“RJA” – Building Code) to assist in this evaluation. The team was charged with providing a fair evaluation of the capability of the building to support state-of-the-art wet laboratory research, based on contemporary design criteria in the highly competitive research market and the cost associated with the reuse. The team was further advised to consider the design with the added fourth floor removed, the building volume restored to its original design.

Process:

Northwestern University provided the team with several documents for review including:

- Contract Documents for the original 1972 Prentice Hospital Building design
- Demolition Drawings containing information on changes incorporated into the building over the years including an additional fourth floor, various additions to mechanical equipment levels and additional elevators in the building base.
- Several previous studies of alternative building uses.

In addition, the design team obtained copies of the Landmarks Illinois preservation proposal, “A New Use for a Modern Landmark” for understanding of the alternative proposal.

The team was provided time to review the above documents, after which an all-day meeting was conducted that included an in-depth tour of the Prentice-Stone facility including typical tower floors, mechanical equipment levels, building base levels, lobby level and the basement. Following the tour of the building the planning team met to confirm the design criteria for the evaluation and to study the potential program and design solutions to be tested against those criteria. Evaluations included the ability to:

- Work within the limitations of the existing tower floor to floor heights and the curved nature of the building perimeter
- Meet structural requirements for load capacity and vibration criteria
- Incorporate mechanical systems appropriate to contemporary research.
- Provide highly efficient and flexible laboratory space in accordance with competitive space standards
- Provide for collaborative opportunities and a working environment competitive to attract and retain successful research programs.

Initial Rough-Order-of Magnitude Program Model:

Based upon the above analysis a programmatic model for a state-of-the art biomedical research facility was established. The initial target assumed a building fully utilized for research with maximized research laboratory potential and all necessary components of a stand-alone research facility including research

laboratories; vivarium; office and collaborative space; core laboratory facilities and building support requirements. Based on a building gross area of 310,750 GSF and an achievable efficiency factor of 55%, a target assignable area for the building was established at 170,414 ASF. The ROM programmatic model for a potential research building, fully utilized for wet lab research was outlined as follows:

Functional Program	% of Program	Assignable Area (ASF)	Remarks
Research Laboratory	70%	119,639	
- Generic bench space (35-40%)			Represents contemporary lab distribution
- Laboratory Support space (40%)			
- Office/Office Support (20-25%)			
Core Laboratory Facilities	5%	8,546	In base or basement
Vivarium	20%	34,183	Includes Lurie overflow
Building Support	5%	8,546	Receiving, Stores, Maintenance
Totals (ASF)	100%	170,414	55% efficiency target

Program Tested Against Criteria

The above model has been tested against architectural, structural and mechanical design criteria for a state-of-the-art biomedical research building. These analyses have determined that the above program cannot be achieved in the building without a significant reduction in assignable area, loss of efficiency, compromise to space allocation standards and only with extraordinary structural remediation with results that are not compatible with preservation goals and laboratory design. The analysis of laboratory planning, structural, mechanical and building code criteria that resulted in this determination are presented in greater detail in subsequent sections of this report.

Revised Program:

A Rough-Order-of Magnitude program model that responds to the physical limitations of the Prentice-Stone Pavilion building is developed in Section III of this report. Alternate floors of the tower must be used as interstitial mechanical distribution space in order to bring the laboratory environment up to a reasonable standard. Additionally the vivarium required relocation to a pavilion floor to provide interstitial access for maintenance of its infrastructure. Therefore, only one floor and two partial floors are available for laboratory space in the pavilion base.

Conclusions:

This model described in this report results in a building that can achieve an assignable area of approximately 120,705 ASF and an assignable to gross area efficiency of 39%, well below any acceptable standard for a contemporary biomedical research building.

- The available tower floors appear to support the total required space allocation for 8 research groups as programmed. However, the floor configuration makes the correct proportion of lab, lab support and office space impossible to achieve in accordance with standards of good laboratory practice and fulfillment of program requirements.
- The floors of the pavilion “appear” to be more amenable to layout of research laboratories than are the tower floors. Sixteen research groups can be supported in that plan. However, under the

best of circumstances, efficiency is lost in the planning module derived from the 34'-0" structural bays (11'-4" module) since fewer modules can be created than an equivalent facility based on a 10'-6" module. When additional columns must be added to mitigate unacceptable vibration the modularity of the lab planning will be compromised beyond reason.

- At best, approximately 48 Principal Investigator research groups out of a possible 80 research groups can be supported in this facility due to floor to floor height restrictions; i.e., 60% of the number of investigators that the facility should accommodate if all available floors are fully utilized.
- The configuration of any laboratory space in the tower that might be possible does not support contemporary sustainability goals.
- All of the above planning limitations arise from deficiencies in the building's ability to accommodate architectural, structural and mechanical design standards.
 - Based on the standard practices for wet laboratory occupancy, both the Typical Pavilion and Typical Tower slabs are found to be inadequate for loading and vibration criterion. This study concludes that the vibration criteria cannot be met without extraordinary expense and cannot be done in a manner that is compatible with preservation goals and good laboratory design.
 - All existing building systems are obsolete and have functioned well beyond their normal life cycle. The existing systems were designed to support patient care and hospital functions, and are significantly non-compatible with today's sustainability standards, energy codes, and research laboratory environmental requirements. The existing systems including their distribution will require complete demolition and replacement with new energy efficient research laboratory type mechanical, electrical and piping systems.
 - Due to the intensity and configuration of modern research laboratory systems, the existing mechanical and electrical equipment room spaces are insufficient, even to service a reduced net square foot facility. Additional mechanical and electrical space will be required.
 - Floor to floor heights are insufficient to support almost any current modern use on the bed tower floors. To achieve a minimum ceiling height of approximately 8'-2", an interstitial floor concept is recommended. Similarly an interstitial floor concept is required for the 2nd floor vivarium area.

II. DESIGN CRITERIA FOR A STATE-OF-THE-ART BIOMEDICAL RESEARCH FACILITY

The design criteria used in this study are limited to those that impact the development potential of the Prentice Hospital facility and are derived from JCI's Functional and Technical Design Criteria as well as review of the NIH Guidelines that can potentially impact the ability to fund research. The market for top research talent in the biomedical market is extremely competitive. High quality environments are required to attract and retain the best and brightest researchers. Attracting such researchers requires an institution to provide facilities that are:

- Highly interactive and encourage collaboration
- Highly efficient so that grant support can be maximized
- Flexible and adaptable to support growth and change
- Aesthetically pleasing and comfortable to work in
- Provide the “tools” of research that permit and encourage
- Comply with all regulatory requirements
- Provide for a safe and healthy working environment
- Meet physical and environmental performance criteria necessary to support the activities and the tools of research

A. SPACE PLANNING CRITERIA

Research Space Assignment: Benchmarking of similar facilities and experience indicate that the average space per principal investigator laboratory operation, in highly competitive academic medical centers, will be in the vicinity of 1,500 ASF. This amount of space consists of the research laboratory, laboratory support space and the PI's pro rata share of office and office support space. In essence it reflects all space that can be supported by research funding through NIH or other similar programs. The amount of space is based on an assumption that the “average” principal investigator housed is supported by two RO-1 NIH grants or the equivalent. This amount of space and funding typically supports 6 to 8 FTE support staff in the laboratory.

Floor Plate Size: In contemporary laboratory planning, a floor plate area of minimum 25,000 GSF provides assignable space for 10 to 12 principal investigators, an ideal “intellectual critical mass”.

Assignable to Gross Area Efficiency: A rigorously efficient building is critical for the support of research and maintenance of the facility. At \$400 - \$600 per sq. ft. for direct and indirect cost recovery, the goal for any major research program should be to maximize grant funding potential. An overall assignable to gross area efficiency, for the building as a whole, of 55% should be considered a minimum for a biomedical research facility and is used in this study. Higher efficiencies of 60% or greater are routinely achieved, although it is recognized that there are inherent limitations in adaptive reuse projects. Commensurately, 65% or greater efficiency is a reasonable expectation for a typical laboratory floor plate on a floor designed for 8 or more Principal Investigators.

Laboratory Planning Modules: The most efficient planning module width for contemporary biomedical research laboratories is 10'-6". This dimension permits appropriate circulation space including accommodation of ADA requirements, while maximizing density for placement of benches and equipment. The National Institutes of Health recommends a planning module of 11'-0" OC for their facilities but does not insist on maintaining that dimension in situations of external funding.

Bench Efficiency: Bench efficiency is the ratio of the floor area taken up by laboratory work surfaces and equipment to the total area of the laboratory. A bench efficiency target of .40 or higher is a desirable target.

Ceilings: State of the art biomedical research facilities should have suspended ceilings for cleanliness, maintenance and environmental control.

Floor to Floor Heights: In order to accommodate the recommended laboratory ceiling heights a floor to floor height of 15'-0" to 16'-0" is recommended. Occasionally, in renovations, floor to floor heights of 12'-0" are encountered and considerable care is required in design to achieve the recommended laboratory ceiling clearances. Repurposing for laboratory use is not recommended with floor to floor heights much under 12'-0".

Ceiling heights: Ceiling heights in today's laboratories are now most commonly 9'-6" or higher to accommodate the use of indirect or direct/indirect lighting solutions which provide a high quality, shadowless, energy efficient illumination, consistent with LEED Certification requirements and working toward "Net Zero" design.

- Ceiling heights in adaptive reuse projects, involving floor to floor heights of about 12'-0" can be successful, but may require that ceiling heights be further compromised. Sometimes 9'-0" in the open laboratories and ceilings as low as 8'-0" in support zones will resolve mechanical distribution requirements.
- Ceilings below 8'-0" clear height are not acceptable under any circumstances. Heights under 8'-0" will seriously restrict the ability to locate and service fume hoods, biological safety cabinets and other user furnished instruments that rely on adequate clear height for use.

Natural Light: All laboratories and P.I. offices should have direct access to natural light. Consistent with sustainability goals, abundant natural light has become an important contributor to reducing the energy demands of laboratory lighting systems while contributing to the overall ambiance and sense of wellness in the laboratory.

Floor Live Load: The recommended minimum live load capacity for laboratory space is 100 PSF. The National Institutes of Health recommends live load capacities of 125 PSF for many instances. *Refer to the structural report for a more complete analysis of this criterion as it applies to the Prentice-Stone Pavilion lab floors.*

Vibration Control: At laboratory areas, the velocity of the slab due to walker-induced or building mechanical vibration shall not exceed 2000 μ inch/second at a walking speed of 75 steps/minute. *Refer to the structural report for a more complete analysis of this criterion as it applies to the Prentice-Stone Pavilion lab floors.*

Mechanical Services: The ceiling space over laboratories must accommodate the variety of services to be distributed throughout the laboratory. The ceiling space must accommodate supply, exhaust and fume hood ductwork; supply and exhaust system controls; hot, cold reagent grade and tempered water; laboratory compressed air, vacuum and gas; pitched drain lines for sanitary and laboratory waste and steam for autoclaves with pitched condensate return.

B. ADDITIONAL CRITERIA FOR ANIMAL FACILITIES

The preferred location for animal housing facilities is at basement level, typically on slab-on-grade, convenient to receiving areas and minimizing the need for additional elevators for movement of animals or animal supplies. Basement locations also provide for greater security for animal facilities, a highest priority. Animal facilities require little or no natural daylight (except at personnel areas), so a basement location is perfectly acceptable.

Ceiling Heights: The minimum ceiling height throughout the facility should be 9'-0". The recommended ceiling height for Cage Wash facilities is 10'-0" to accommodate the large fixed equipment required.

Interstitial Access: Animal facilities in biomedical research buildings are typically "barrier" facilities, requiring higher levels of sanitation and sterilization than any other areas of the building. Contemporary animal facility design requires use of walkable interstitial levels above the vivarium, proper, for servicing the mechanical systems above the ceilings in the housing areas. The interstitial solution supports better maintenance for the complex air handling systems and restrict potential contamination of maintenance activities from entering the facility.

Topping slabs should be provided in wet areas to assure floor pitches and, in the case of framed slabs above occupied space, protect waterproof membranes. Topping slabs on existing framed floors will create a change in floor elevation that must be accommodated in the design and will reduce headroom by several inches.

Pits: Pits are required for placement of Cage Washing and Autoclaving equipment. Pit requirements can typically be accommodated when required in an existing slab-on-grade. Pits added to framed slabs above occupied space require significant structural remediation and will restrict headroom on the floor below.

Equipment Access : Clear access for the delivery and installation of bulk autoclaves, as well as the removal of same, must be maintained. An autoclave chamber is likely to be 6'-0" wide x 7'-0" high x 7'-0" long and will be packaged for delivery with a dimensional increase in each direction of about 2'-0" additional.

Vibration criteria in most instances will be similar to laboratories at 2000 μ in/sec., although a somewhat increased vibration maintained less than 4,000 μ in/sec can often be tolerated.

Live Load: Live load capacity at 100 PSF is acceptable in most areas. Some areas, such as cage wash facilities or a Cesium Irradiator will require load capability up to 200 PSF or greater.

C. BUILDING SYSTEMS CRITERIA

For additional technical criteria and analysis of the ability of the Prentice-Stone Pavilion to meet those criteria please refer to the sections on Structural Evaluation, Mechanical Evaluation and Chicago Building Code Evaluation. The structural and mechanical evaluations are included in the body of this report. Building Code overview is provided as Appendix A.

III. LABORATORY PROGRAM/CONCEPT DEVELOPMENT AND EVALUATION

A. INITIAL STUDY

The initial target assumed full building utilization, maximized research potential and all related components typical of a stand-alone facility including vivarium, collaborative space/core laboratory facilities and building support requirements. Based on a building gross area of 310,750 GSF with the added pavilion floor removed, and a very reasonable efficiency factor of 55%, a target assignable area for the building was established at 170,914 ASF. Standards for space distribution were established according to contemporary standards as follows:

Space Category	% of Space	Assignable ASF
Research Laboratory	70%	119,639
- Generic Bench Space (35-40%)		
- Laboratory Support (40%)		
- Lab Office and related (20 – 25%)		
Core Facilities	5%	8,546
Vivarium	20%	34,183
Building Support	5%	8,546
Total Area	100%	170,914

Rough Order-of-Magnitude Program

The space proportions identified above are common for highly competitive biomedical research programs and generally serve as a starting point for any program evaluation. Using an average space of 1,500 ASF per principal investigator, the research laboratory space projection, based on plan only, should support up to 80 principal investigator's programs. This assumes that the vivarium must occupy the full first floor and the top tower floor must still be used for mechanical equipment. Adaptive reuse projects will tend to reflect some reduction in building efficiency and personnel capacity due to inherent inefficiencies of an existing infrastructure that is not perfectly compatible with the laboratory occupancy.

Animal housing space is usually estimated at 15% of assignable space at the outset. The proportion for vivarium was increased at the request of Northwestern University who indicated that the vivarium in the Lurie Building would be over-subscribed when the second phase of that building is completed.

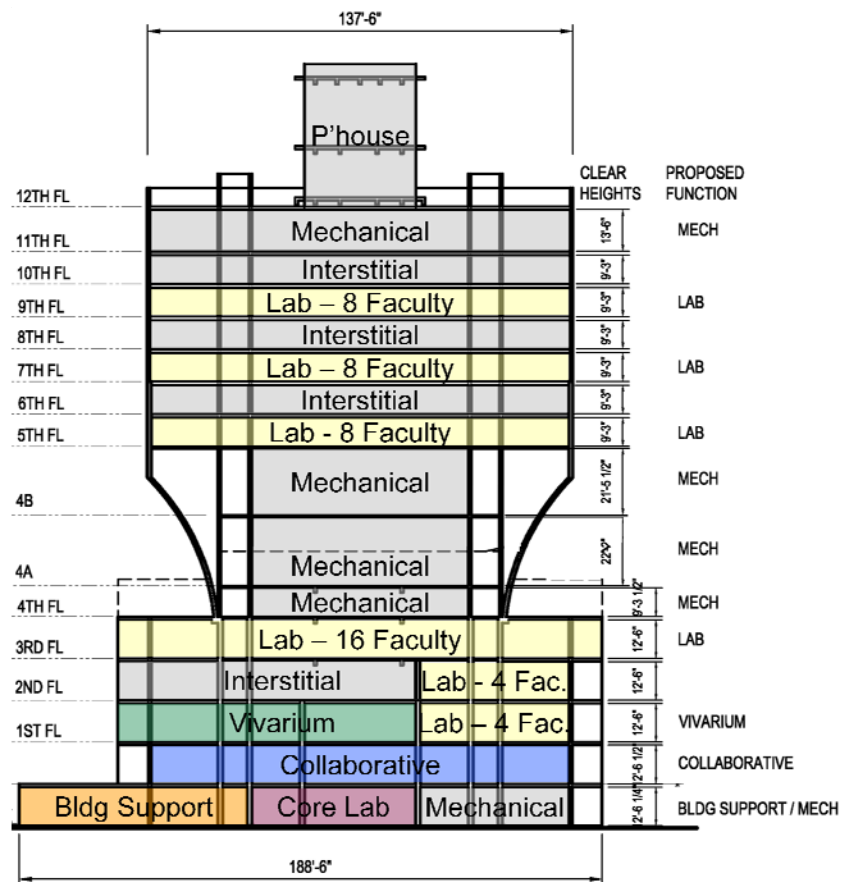
B. PROGRAM REVISED BASED ON ANALYSIS

Limitations of the existing facility tend to define the potential programs for renovation/adaptive reuse projects. Programming will be based on evaluation of what the building can provide, often working backward to arrive at an appropriate program. The programmer must determine whether the potential utilization of the building is reasonable for the function to be housed. A revised rough-order-of-magnitude program for the Prentice - Stone facility, presented in the following paragraphs, is the result of the analyses of architectural planning potential, structural capabilities, mechanical systems impact and the ability to support the new occupancy in accordance with the Chicago Building Code.

Building Stacking Potential

The following stacking diagram provides a snapshot of the scope of research program that can be accommodated in the building.

- In order to achieve a marginally acceptable clear height in the laboratories of 8'-0" alternate floors of the tower will have to be used for interstitial mechanical systems distribution. Also, due to lack of space on the penthouse levels the 11th floor must be used for mechanical equipment.
- The 13'-6" floor to floor height in the pavilion base will more readily accommodate a reasonable ceiling height for laboratories, subject to the extent that clear height is reduced by structural reinforcement.
- The vivarium cannot be accommodated at the basement level because interstitial access to systems is not possible in that location. A location on the first floor above grade in the building base is possible, provided that the floor above it (second floor) provides interstitial systems access. The space occupied by the vivarium therefore significantly reduces the space available for research laboratories on those floors.
- The vivarium will require pits for autoclaves and cage washing equipment, as well as secondary finish floor slabs that will restrict headroom on the floors below. Structural loading for cage washers and autoclaves will require significant structural remediation.
- All of the floors will require costly structural remediation to meet structural design criteria for a state-of-the-art biomedical research building.



EXISTING BUILDING SECTION

C. ROM PROGRAM SUMMARY OF GROSS AND ASSIGNABLE AREAS

Table 1 lists the estimated theoretical floor by floor program capacity of the Prentice-Stone Pavilion, corresponding to the stacking diagram. The average assignable area per Principal Investigator and the total number of investigators that the building can support are included.

Building Functional Section					
Floor	Function	GSF	Assignable Area		Remarks
			% Fir Eff	ASF	
PH	Mech	4,000	0%	0	
13th	Mech	17,250	0%	0	
12th	Interstitial	17,250	0%	0	
11th	Lab	17,250	70%	12,075	
10th	Interstitial	17,250	0%	0	
9th	Lab	17,250	70%	12,075	
8th	Interstitial	17,250	0%	0	
7th	Lab	17,250	70%	12,075	
6B	Mech	5,500	0%	0	
6A	Mech	5,500	0%	0	
5th	Mech	5,500	0%	0	5th flr addition removed
4th	Lab	34,900	70%	24,430	
3rd	Interstitial & Lab	34,900	20%	6,980	
2nd	Vivarium & Lab	34,900	60%	20,940	
Ground	Collaborative	19,800	60%	11,680	
Bsmt	BSupp, Core L & Mech	45,000	45%	20,250	
Total Building GSF		310,750			
Building Efficiency			39%		
Total Building ASF				120,705	

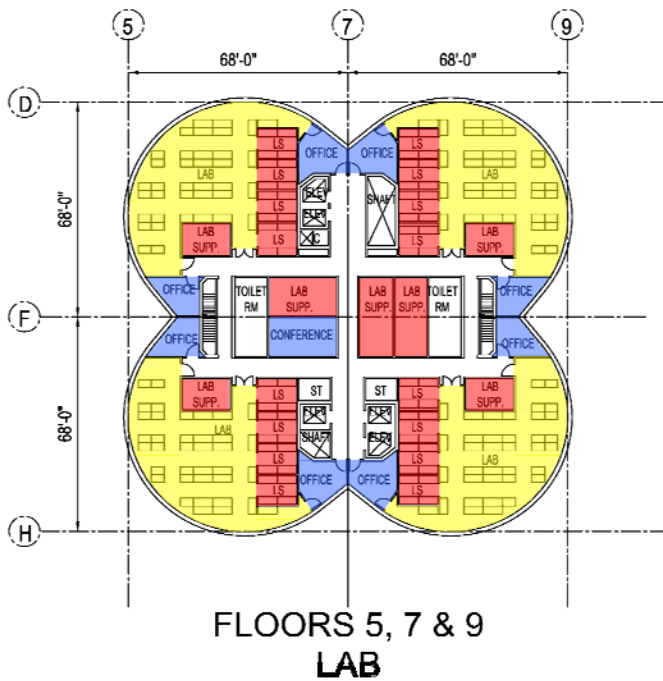
Program Area Targets			
Program Category	% of Total ASF	ASF	Remarks
Research Laboratory	61%	73,635	Located in Tower and Podium
Generic Bench Space (35-40%)			Assume average group size at Faculty + 7.5 staff, or 1,500
Laboratory Support (40%)			ASF/Faculty. Total accommodated: 48
Lab Office/Conf/Break (20-25%)			
Core Lab	9%	11,000	Target: 15% of Res Lab; Bsmt location for low vibration eqmt
Vivarium	12%	14,940	Target: 20% of Res Lab
Collaborative Space	10%	11,880	Conference Rms, Seminar Rms
Building Support	8%	9,250	Dock, Matis Mgmt, Stores
Total ASF	100%	120,705	

D. CONCEPT DIAGRAMS / UTILIZATION ESTIMATES

Conceptual plan layouts have been developed to reflect the proposed space distribution in the building. Each plan uses the facility in a logical way and does not exactly reflect the Rough-Order-of Magnitude program above.

The bed tower, converted for research will only accommodate 3 out of 7 floors of assignable laboratory space when designed to acceptable design criteria. Each floor provides adequate space for the 8 Principal investigator research groups at or near the programmed target of 1,500 ASF per Principal Investigator.

The typical tower plan, Figure 2, reflects an approach to laying out the laboratory floor such that all functional areas – lab, lab support and office facilities meet their percentage targets. The floors utilize the portion of the floor plate between the towers to provide as much additional lab support space as possible. Laboratory space is arranged to maximize the apparent open space to maximize access to natural light and adaptability of the lab area. The plan also assumes that passenger elevators will be provided in the north elevator core and service elevators will be provided in the south core. Unused elevator shaft space is used for main mechanical distribution risers to minimize the potential for additional penetrations through the slabs. A rough area take off of the plan, as interpreted here reflects the following:



Typical Tower Floor as Research Laboratory

**Note: Floor plans were reconstructed from available information and may vary slightly from actual building areas.*

This area take off reveals that proper ratios of lab, support and office space will be difficult to achieve, primarily due to the inefficiency of the curved wall and the low proportion of internal space. Some improvement is may be possible with continued design input.

- Gross Floor Plate: 16,150 GSF*
- Assignable Area - 11,885 ASF
- Lab Space: 6,175 ASF - 52%
- Lab Support: 4,075 - 34%
- Office/Office Support: 1,675 - 14%
- Space per PI: 1,485 ASF

Offices cannot realistically be clustered on the exterior except in pairs (as shown).

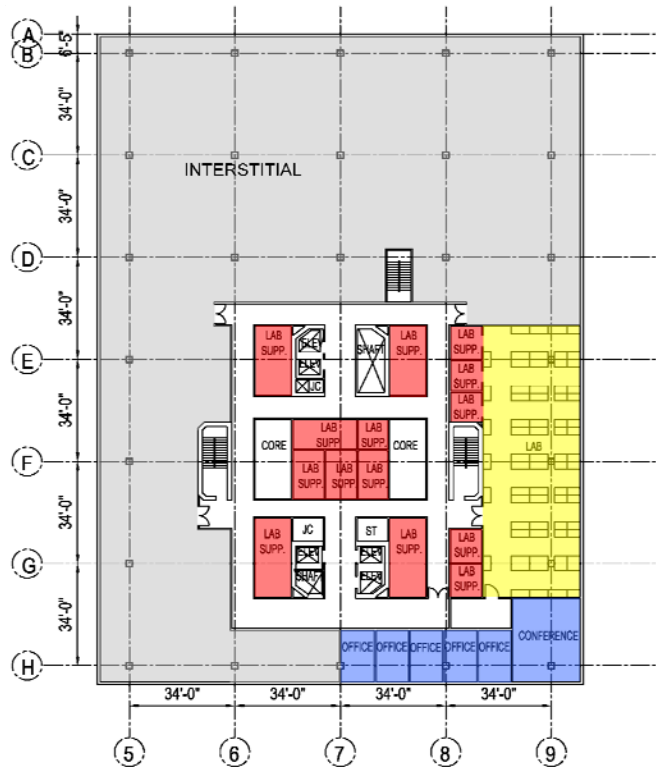
Pavilion 3rd Floor – Full Laboratory Use

The podium levels, with 13'-6" floor to floor height fare better as floor plans for laboratory use.

The third floor of the Pavilion Building provides reasonable laboratory space for 16 Principal Investigators. The 34'-0" structural bay generates 11'-4" laboratory modules resulting in a slightly inefficient bench to floor area ratio and an artificially high lab space ratio. Lab support is on the low side. Adjustments to improve the lab support ratio can be accomplished with further design effort. The third floor will require significant structural remediation to meet laboratory design criteria.

- Gross Floor Plate: 33,225 GSF*
- Assignable Area – 24,440 ASF
- Lab Space: 11,330 ASF - 46%
- Lab Support: 8,110 - 33%
- Office/Office Support: 5,000 - 21%
- Space per PI: 1,527 ASF





**SECOND FLOOR
INTERSTITIAL & LAB**

Pavilion 1st and 2nd Floors – Animal facility and Interstitial over Animal Facility – 4 PI Laboratories each

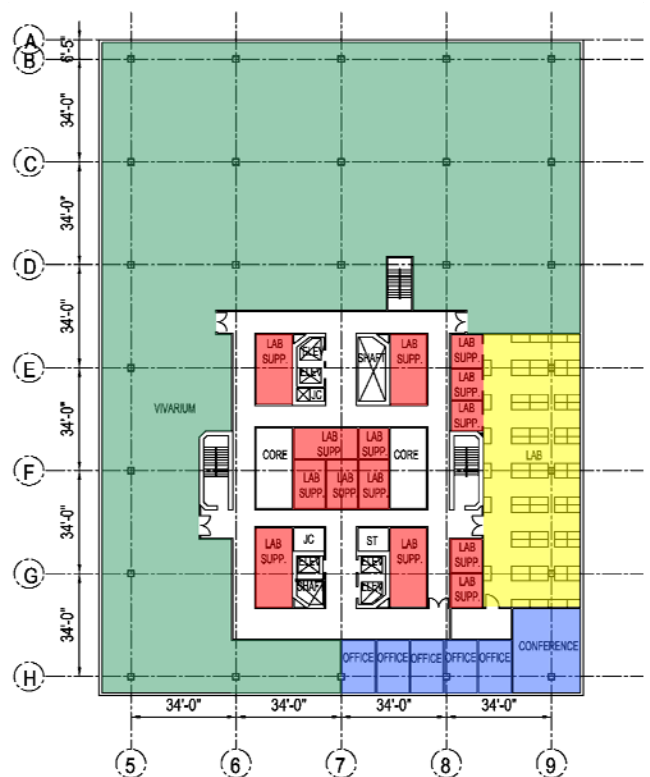
The second floor provides interstitial access to the vivarium mechanical systems including all mechanical controls, plumbing and mechanical valves and major power distribution. Electrical and data distribution closets can be located on this level as well. The space requirement for the interstitial space approximates the footprint of the vivarium. Space for four laboratory programs occupies the remaining space. In this case, design to visually and physically connect to the first floor in order to create a collaborative critical mass will be desirable.

- Gross Floor Plate: 33,225 GSF*
- Interstitial – 19,730 ASF
- Lab Space: 2,890 ASF - 40%
- Lab Support: 2,710 - 38%
- Office/Support: 1,600 - 22%
- Space per PI: 1,800 ASF

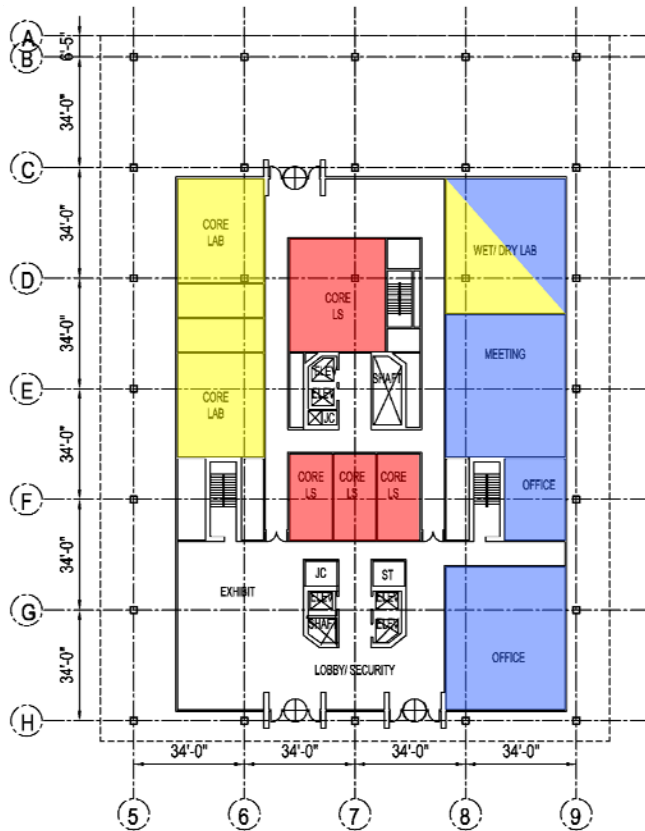
Pavilion 1st Floor – Vivarium with 4 PI Laboratories

The first floor of the pavilion is the only realistic location for an animal housing facility (vivarium) in the Prentice-Stone Facility. The target area for the Vivarium is 14,940 ASF or 20% of research space. The space available to meet the program without using the full floor (and losing additional research space) is 19,730 GSF and at 60% internal efficiency would yield a program of 11,840 ASF a shortfall of 3,100 ASF. This is equivalent to the requirement for this building but would not support the Lurie overflow.

- Gross Floor Plate: 33,225 GSF*
- Vivarium – 19,730 GSF/11,840 ASF@ 60% eff.
- Lab Space: 2,890 ASF - 40%
- Lab Support: 2,710 - 38%
- Office/Off. Support: 1,600 - 22%
- Space per PI: 1,800 ASF



**FIRST FLOOR
VIVARIUM & LAB**



Podium Ground Floor – Collaborative Facilities

Programs on this level should be compatible with its somewhat more public nature. This level provides opportunity for larger meeting and conference facilities with the possibility of some exhibit space and/or commercial space provided to activate that floor. There is some potential to provide core research facilities on that floor as well – particularly if vibration is not a concern.

**GROUND FLOOR
COLLABORATIVE & CORE LAB**

Basement: The basement will house expanded mechanical and electrical equipment rooms. In addition loading docks, receiving and materials handling space and scientific core facilities will be housed on this level.

Mechanical Equipment Requirements: Mechanical space requirements are covered in the MEP report and are generated based on updated code requirements, estimated loads and growth of the size of a system over that required for a hospital facility.

- **Receiving Dock:** All agreed that the existing ramps and dock could be utilized in a repurposed building.
- **Building Support Space** includes all requirements for handling incoming and outgoing materials and shall be located adjacent to the receiving dock. The building support zone will include a small amount of dedicated and controlled space for receiving materials for the vivarium.
- **Core Lab Support:** The allowance for Core Laboratory Support is 15% of research lab. Most of this space will be housed in the basement for placement of vibration –sensitive analytical instrument based research. Some of the Core Facilities may be located on ground level. That area may also include a central glassware washing facility which can be appropriately located on the basement level.
- **Collaborative space,** estimated at 10% of the building assignable area can include Conference Rooms, Seminar Rooms, Multipurpose Area for Exhibits or special events and some of the Core Facilities.

IV. Evaluation of Landmarks Illinois document “A New Use for a Modern Landmark”.

This section of the report is a response to the proposed laboratory utilization model in “A New Use for a Modern Landmark” and focuses specifically on its use as a biomedical research laboratory facility. The document indicates how a bed-tower floor might be converted to laboratory space. It also provides an example of a mixed use floor in the pavilion. It is unclear as to the program intention of that level.

We see a number of deficiencies in the tower floor plan but, as a stand-alone floor plan, many of those deficiencies can be overcome. There is no representation of a program for a complete biomedical research building. Without a complete program, a floor plan layout is not necessarily meaningful.

- Elements of research – animal housing facilities, core research facilities and building support functions are not addressed and these can have a profound impact on the viability of the labs.
- The building has too many technical deficiencies to provide state-of-the-art laboratory space.

The reader is referred to other components of this report that define the technical limitations of the building to perform as a research laboratory and a program that results from addressing those limitations.

Following is a critique of the Tower floor plan:

“The structural flat slab floor system and floor to floor height (10’-6”) is conducive to an exposed utility system, a popular trend in contemporary lab design”

- Actually, exposed utility systems are not a popular trend in contemporary lab design. In particular, in biomedical research where maintenance of the laboratory space is a priority, suspended ceilings are almost universally utilized. Exposed grids have an application in physical sciences buildings that require intensive connection of equipment to overhead utilities.
- The thickness of the structural slab results in a clear height of 9’-3”. Even without a suspended finished ceiling, the ceiling plane – lighting, diffusers – will likely be less than 7’-6” – aesthetically uncomfortable to work in and programmatically limiting.

“A typical lab quadrant size is 3,145 USF and can support up to 16 principal researchers or 64 researchers per floor”.

- The floor area of each quadrant is not in question. The drawing appears to indicate benches and seating for 16 researchers in each quadrant. However, space for laboratory support functions appears to be below standard for a state of the art research building, as is space for sinks, shared benches, fume hoods and equipment.
- The spaces for desks located in the curved portions dramatize the inefficiency of the building’s shape.
- A space standard for highly rated medical research programs would be approximately 1500 ASF per Principal Investigator, inclusive of laboratory, laboratory support space, PI Office and pro-rata share of necessary office support functions - conference space and break space. On that basis, there should be 8 Principal Investigators and a minimum of 8 offices on each lab floor. Floor plates of 25,000 GSF or more will support 10 to 12 PI’s creating an “intellectual critical mass.”
 - If the bathrooms indicated at the perimeters within the labs are, in fact, required, one would not use valuable perimeter space for that purpose.
 - We don’t understand the repetition of multiple conference rooms. One conference room on the floor, sized to accommodate a PI and his research group (320 ASF) would be appropriate.

- Natural daylight is an important factor in the design of efficient laboratories. In addition to the ambiance of daylight, day-lighting supplements artificial light in reducing energy costs. As a laboratory facility, the bed floors of this facility are daylight-poor to begin with – the percentage of glazing to solid is quite low compared to most state-of-the-art laboratories. Locating lab support and office space in the best area of the lab may help to resolve the geometry problem but is functionally and aesthetically unappealing.
- Principal Investigators will tend to object to interior offices, even if adequate vision glass is provided to bring daylight in.

“A shared Central Collaboration Space provides for interactive breakout space that fosters communication and a sense of lab community”.

- A sense of lab community can be encouraged when a reasonable number of investigators are organized together so that communication is encouraged in a variety of ways. It does not require a large public space, but rather opportunities for contact throughout the workday in a variety of situations. Clusters of PI offices, break rooms, conference rooms circulation with nodes and intersections can all be places of interaction – whether planned or incidental.
- The space shown in this diagram is excessively larger than needed, contributes to a shortage of lab support space and the amount of space on the floor that could be grant-funded.
- The central collaboration space exits through the laboratory. Exiting through a higher hazard occupancy is illegal under the Chicago Building Code.

“An open lab design allows for multiple researchers and collaborative support areas both along the exterior and internally (atrium to floors below and above)”.

- The labs are somewhat open but rather fixed in their layout, very much limited by the support/office block and the open desk space along the curves.

“Lab module is designed for flexibility, convertibility and energy efficiency. The modules are able to change with the needs of researchers. Floor plate dimensions allow for functional relationships among lab work areas and service, support spaces and office areas”.

- There are actually two lab module types within the same space and they really can't change very much. We find that adaptability of benches within primary lab space more frequently accommodates short term changes in utilization and that unrestricted rectangular floor plates best support long-term flexibility.

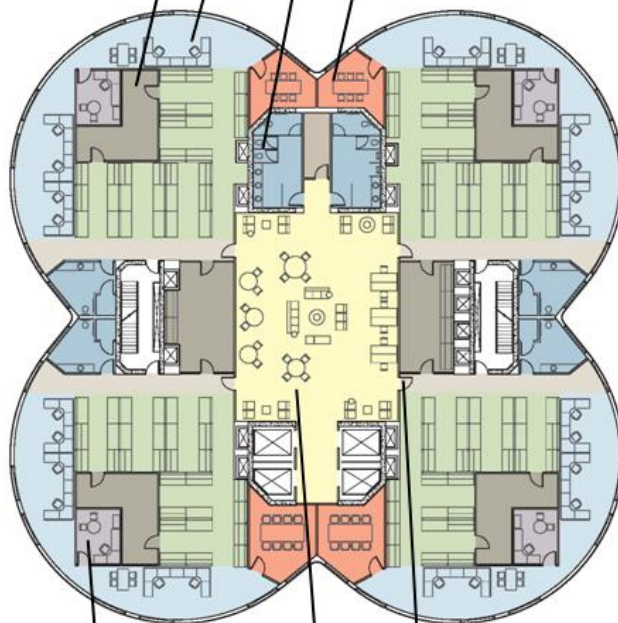
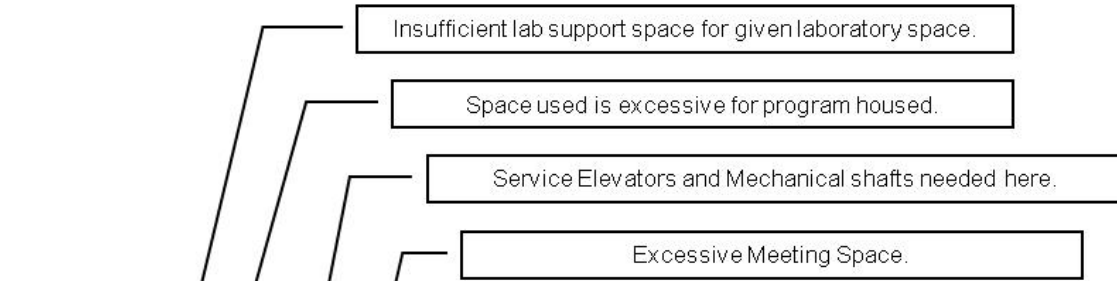
“The existing structural core elements and chases allow for flexible access options and potential riser space for lab specific utilities”.

- Shafts, utility chases, electrical closets, telecom rooms require a significant amount of space on the floor. The amount of existing shaft space shown on the plan is inadequate to meet the needs of a contemporary biomedical research facility.
- Additional shaft space will be needed. Our structural study addresses the challenges of locating shafts on the tower floors. The result of that study suggested that the best way to move services vertically through the building would be to make use of the existing elevator shafts, where not required for vertical transportation. The toilet rooms would have to be relocated to accommodate such a system.

It's difficult to address the typical floor of the pavilion. The kind of mixed use indicated would not likely occur in a biomedical research building. Depending on the intended occupancy, code review suggests

that the floor populations will exceed the exit capacity indicated. This plan also indicates requirement for illegal egress through higher hazard space.

Summary of Remarks:



TYPICAL RESEARCH LAB PLAN | FLOORS 7 THRU 13

The open-floor plan of the tower makes it highly flexible for conversion to research labs, which are organized around a shared central space. The floor's perimeter, which is lined by windows, would be open office space.



RESEARCH LAB REUSE

Highlights:

- The structural flat slab floor system and floor to floor height (10'-6") is conducive to an exposed utility system, a popular trend in contemporary lab design.
- A Typical Lab quadrant size is 3,145 USF and can support up to 16 principal researchers, or 64 researchers per floor.
- Total Lab Researchers for the tower would be 448 (an additional 364 researchers could be accommodated in the building base).
- The proposed floor plan would foster discrete securable research team zones, ranging from a full floor team to four separate teams, without compromising access and egress. Individual closed labs can directly access a larger, shared, open lab.
- A shared central "Collaboration Space" provides for interactive breakout space that fosters communication and a sense of lab community.
- An open lab design allows for multiple researchers and collaborative support areas (conference rooms, modular offices, lab support) both along the exterior and internally (atrium to floors below/above).
- Lab module is designed for flexibility, convertibility, and energy efficiency. The modules are able to change with the needs of the researchers. Floor plate dimensions allow for functional relationships among lab work areas and services, support spaces, and office areas.
- The existing structural core elements and chases allow for flexible access options and potential riser space for lab specific utilities.
- The open lab floor design allows sight lines to the exterior windows.
- Labs could either be designed as wet or dry labs.

LEGEND

- LAB
- COLLABORATIVE SPACE
- PRIVATE OFFICE
- CONFERENCE ROOM
- OPEN OFFICE
- SUPPORT
- WASHROOM
- STORAGE | JANITORIAL
- COMMON AREA | CIRCULATION



Illegal exit from lower to higher hazard area.

Excessive space given to non-fundable function at the expense of funded programs & missing infrastructure.

Faculty will want perimeter offices, preferably not through lab. Co-location faculty offices improves interaction.

STRUCTURAL REPORT



STATE-OF THE-ART WET LAB FEASIBILITY STUDY

Table of Contents

- I. Purpose of Study
- II. Description of Existing Structure
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 - A. Design Loads
 - B. Service Criteria
- IV. Summary of Slab Capacity Studies
 - A. Typical Tower Slab
 - B. Typical Pavilion Slab
- V. Additional Considerations
 - A. Condition of Exterior wall
 - B. Floor level and flatness
 - C. Restriction of riser size and location of existing prestressed members
 - D. Cost considerations for structural renovations
- VI. Limitations of Study and Recommendations for Further Investigation

I. PURPOSE OF STUDY

On April 14, 2011 Thornton Tomasetti received a request from Jacobs Consulting to provide a structural study of the Prentice – Stone Pavilion Building. The purpose of this study is to review the existing drawings provided to the team by Northwestern University and determine if it is possible to create a state-of-the-art wet laboratory occupancy using the existing facility.

The structural information included in this report focuses on the structural capacity of the floor slabs of a typical tower floor and a typical pavilion floor with respect to current codes and then proceeds to address the feasibility of wet lab use. Additional considerations are also discussed as they affect the total cost of renovating the space.

II. DESCRIPTION OF EXISTING STRUCTURE

The existing Prentice-Stone Pavilion Building comprises a four-story reinforced concrete structure (Pavilion) plus one basement level, plus a Tower. Most of the Pavilion concrete uses mild steel reinforcement; however some of the floors have prestressed concrete beams that span across the core. The Tower structure comprises mechanical floors plus 7 stories of a clover-leaf floor plate. The Tower floors are mild steel reinforcement with the exception of the story-deep cantilevered exterior wall “beams” that support the exterior walls and slabs above the fifth level. This fifth floor system uses prestressed construction to resist the pull-out tension resulting from the cantilever. The Tower supports a Mechanical Penthouse.

Post 1972, an additional floor was constructed of structural steel and concrete deck that is supported on the old roof of the Pavilion, and a steel frame floor was added within the mechanical stories.

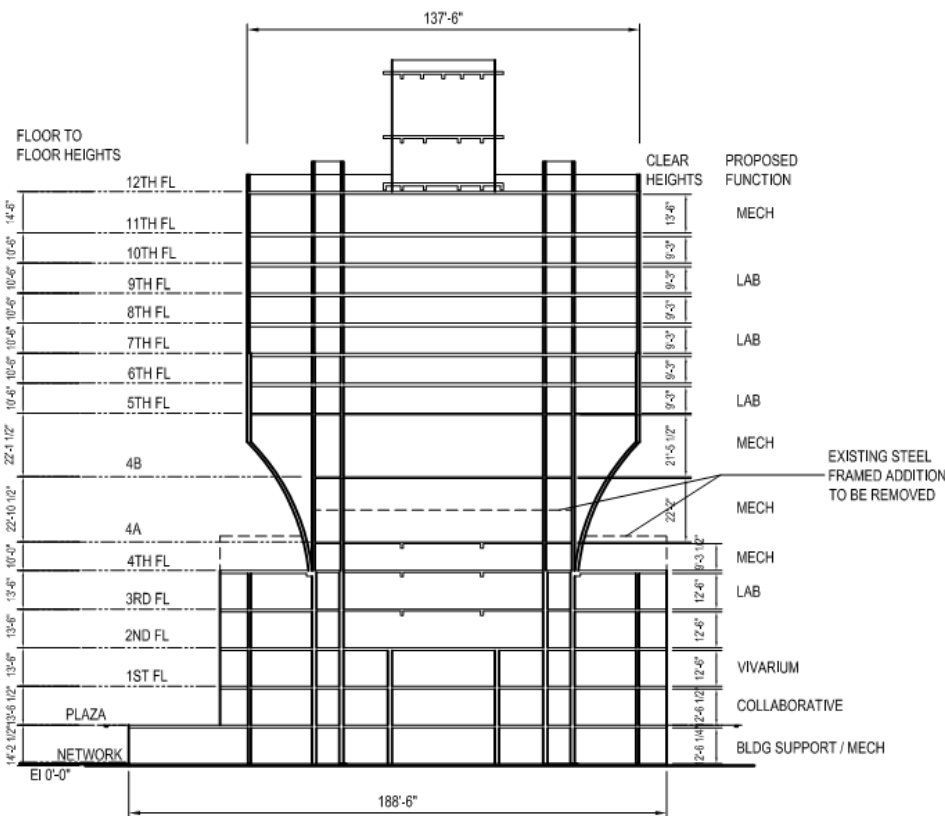


Figure 1 - Building Elevation

See Figure 1 for a building elevation which indicates the 1972 floor level designations, story heights, and clear heights, as well as the proposed occupancies for a wet laboratory conversion. The levels without proposed occupancy serve as interstitial mechanical levels.

III. STATE-OF-THE-ART WET LABORATORY CRITERION

A. Design Loads

Based on guidelines from the National Institute of Health (NIH), the minimum live loads for various laboratory occupancies vary from 104 psf for animal research facilities with small animals to 125 psf for research with primates and aquatic facilities. Areas such as cagewash are as high as 209 psf. General laboratories are considered to be 104 psf. For the purposes of this study, we assumed the minimum recommended LL = 104 psf.

The superimposed dead loads (SDL) include ceiling weight, flooring, suspended MEP systems, and cmu partition walls if present. The 20 psf SDL assumed for this study is toward the low end of anticipated loading, given MEP systems are generally fairly extensive and heavy in laboratory buildings.

Original Prentice Design Loads		Current Required Loads	
Tower (Floors 5 - 11)		Laboratory	
	PSF		PSF
DL - Structural Floor - 15" LWC Slab	150	DL	150
SDL - Mech, Elec, & Hung Ceiling	10	SDL - C/M/E/P	20
SDL - Partitions	15		
Total Dead Load	175	Total Dead Load	170
LL - Bedrooms	40	LL	104
LL - Corridors	100		
Average Live Load	60	Total Live Load	104
Pavilion (Floors 1 - 4)		Vivarium	
	PSF		PSF
DL - Structural Floor - 12" LWC Slab	120	DL	120
SDL - Mech, Elec, & Hung Ceiling	20	SDL - Mech	20
SDL - Partitions	15		
Total Dead Load	155	Total Dead Load	140
LL	100	LL	104
Total Live Load	100	Total Live Load	104

B. Service Criteria

According to the NIH guidelines, "The structural system shall be stiff to the extent that any transmitted vibration occurs at high frequencies, as these are more easily dampened with instrumentation vibration dampening systems and isolation tables than vibrations occurring at lower frequencies." The NIH recommended maximum value for General Laboratory occupancies is approximately 2000 μ in/sec. This is the same as a Vibration Criteria (VC-A). Animal research facilities such as the vivarium area have a recommended value of 4000 μ in/sec. However many laboratory planners recommend using 2000 μ in/sec.

IV. SUMMARY OF SLAB CAPACITY STUDIES

A. Typical Tower Slab

The Tower slabs (noted as level 5, 7 and 9 in the 1972 drwgs) are 15 inches thick and are constructed with a concrete strength of $f'_c = 5$ ksi and using lightweight concrete. The walls supporting both the exterior and interior edges are very thick and there are significant dowels extending into the slab which creates a fixed end condition. This is the most favorable configuration for distributing loads and stiffening the slab against vibration. See Figure 2.

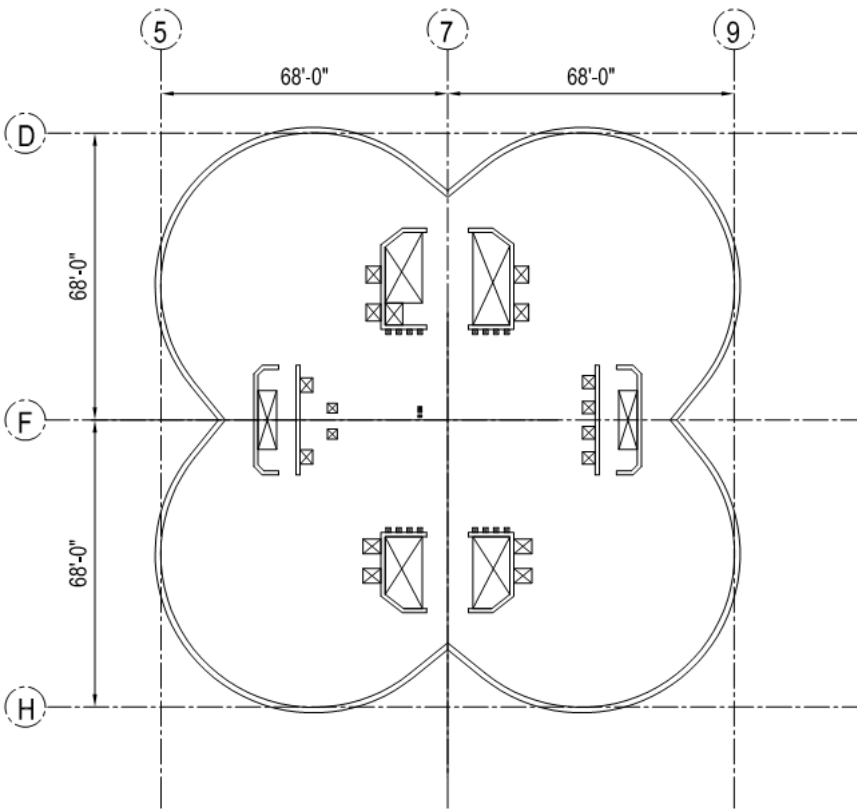


Figure 1 - Original Fifth Fl (1972)

Given these parameters, using the openings shown on the 1972 drawings, and assuming no other significant openings exist, the slab appears to be adequate for flexure (~ 60% ratio of stress versus capacity) and for controlling long-term deflection. However, the prevalence of openings around the cores, results in 35% overstress in areas of localized punching shear. The slab is therefore inadequate for localized punching shear.

Additionally, the maximum anticipated vibration velocity due to a moderate walking pace of 75 steps/minute exceeds the 2000 $\mu\text{in}/\text{sec}$ limit for laboratories.

B. Typical Pavilion Slab

The Pavilion slabs (noted as levels 1 to 3 level in the 1972 drawings) are generally 12 inches thick with 20.5 " drop panels and are constructed using a concrete strength of $f'_c = 5$ ksi and lightweight concrete. The bays studied are north of the core along grid line C and are 34 ft x 34 ft. See Figure 3.

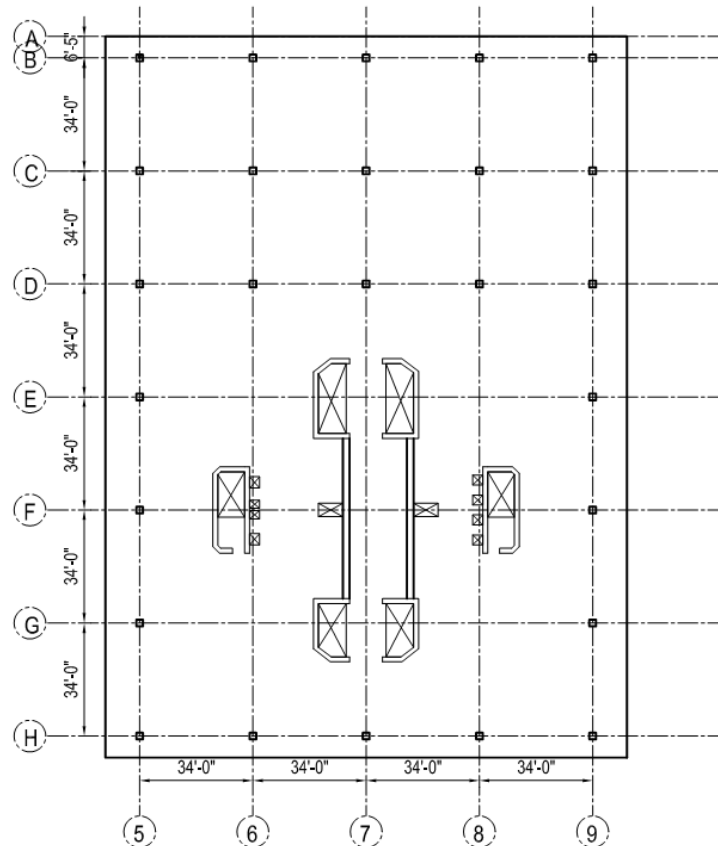


Figure 2 - Original Third Fl (1972)

Given these parameters, assuming no significant openings exist as per the 1972 drawings, the slab appears to be inadequate. The flexure capacity of the slab is overstressed by 30%. The long-term deflection predictions are approximately $L/190$, which exceeds the usual acceptable criterion of $L/240$ and therefore not acceptable by typical standards. Punching shear stress equals the punching shear capacity with no allowance for openings of layout flexibility.

The maximum anticipated vibration velocity due to a moderate walking pace of 75 steps/minute significantly exceeds both the $2000 \mu\text{in}/\text{sec}$ limit for laboratories and the vivarium limit of 2000 to $4000 \mu\text{in}/\text{sec}$.

This study concludes that the vibration criteria cannot be met without extraordinary expense and cannot be done in a manner that is compatible with preservation goals and good laboratory design.

V. ADDITIONAL CONSIDERATIONS

A. Condition of Exterior wall

Concrete spalling and exposed reinforcing bars were observed at many locations along the exterior wall during TT's site visit on April 28, 2011. (See TT Photos #1-4.) Extensive repair is required to address these current defects. Furthermore, the condition of the wall is expected to continue to deteriorate with limited options for remediation, necessitating continual repair throughout the service life of the building.

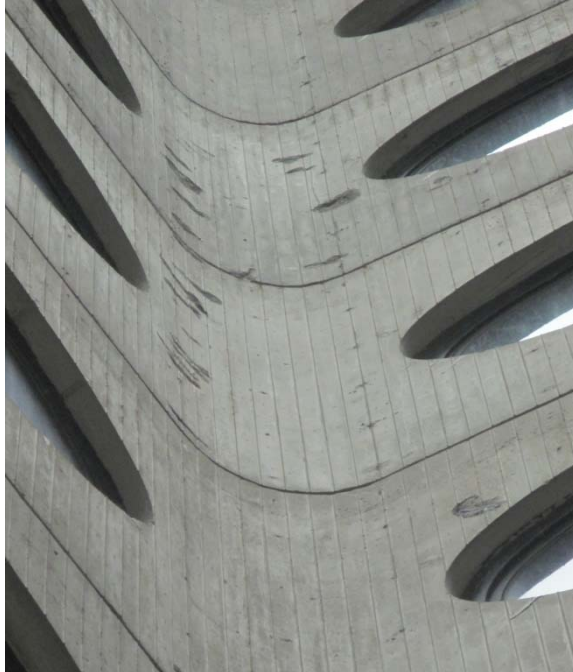
See photos #1 to #4 below for examples of current conditions.



TT Photo #1: Concrete spalling at exterior wall



TT Photo #2: Exposed rebar due to concrete spalling



TT Photo #3: Concrete spalling at exterior wall



TT Photo #4: Exposed rebar due to concrete spalling

B. Floor level and flatness

According to NIH, “Floor flatness (FF) and floor levelness (FL) numbers shall be specified when the installations of finish materials, functional conditions, or equipment dictates tight control to assure top slab surface is constructed essentially ‘dead-level’.”

At a site visit on April 28, 2011, some of the tower slab floors were observed to have perceptible floor levelness and flatness issues. As this was not anticipated, no measurements were taken during the visit, but it was generally agreed to by those on the site visit, that the floors would need remediation if they were to be level and flat enough for wet laboratory use. An additional leveling slab could increase the superimposed dead loads, which would make unacceptable capacities even worse.

C. Restriction of riser size and location of existing prestressed members

The proposed laboratory layout is likely to require additional MEP risers through the core of the Pavilion and at the fifth floor Tower floor in the vicinity of existing prestressed members. Conventional construction wisdom mandates great care when executing demolition in the areas of prestressed construction. The fifth floor prestressed system supports the exterior wall and slabs of the upper Tower stories on the cantilevered elliptical beams. The potential locations for new risers will be limited when evaluating the risks of demolishing / removing / coring near areas of prestressed concrete.

D. Cost considerations for potential structural renovations

This structural study is limited to comparing state-of-the-art wet laboratory construction to the current capacity based on 1972 drawings. Any new openings introduced to accommodate mechanical openings would need to be evaluated and a structural system would need to be developed to strengthen the wet laboratory occupancy overstressed floor conditions. Identifying the location of rebar of all new openings using X-ray processes would be a must to eliminate the number of bars cut for new openings. Additionally, the vivarium would have cagewash areas that need new recessed pits, which would require additional openings in the slab.

VI. LIMITATIONS OF STUDY

This study found that the current slabs are not adequate to support a State-of-the-Art Wet Laboratory conversion. Other structural members, such as the fifth floor cantilever beam support, exterior and interior walls, columns and foundations were not investigated since the first line of support – the slab - was found to be inadequate for both strength and vibration.

The drawings used for this study are design documents from nearly 40 years ago and do not include field modifications such as the fifth floor addition, or as-built information. Any modifications that may have been made over the years have not been considered in this study. The material properties and dimensions per the design documents were the basis of this study and have not been verified with testing or site measurements.

Additionally, the drawings are incomplete in terms of prestressing forces for the fifth floor cantilever. Without a set of as-built information there is considerable information lacking to determine the actual reserve capacity of the 1972 built structure. Further investigation would be required.

Additional openings required by the MEP study for this conversion will only further compromise the existing slab.

This structural study is based on the following structural drawings provided to Thornton Tomasetti by Northwestern University:

Dwg Set	Dwg #	Dwg Title	Dwg Date	Latest Rev Date
1972 Bid Set		Drawing Index	1/24/1972	
1972 Bid Set	S1	Location Plan and General Notes	2/7/1972	6/29/1972
1972 Bid Set	S2	General Section	2/7/1972	6/29/1972
1972 Bid Set	S3	Caisson Layout and Schedule	6/29/1972	
1972 Bid Set	S4	Foundation Slab Layout & Top Reinf.	6/29/1972	
1972 Bid Set	S5	Foundation Slab Layout & Bottom Reinf.	2/7/1972	6/29/1972
1972 Bid Set	S6	Foundation Sections	6/29/1972	
1972 Bid Set	S7	Sections and Details	2/7/1972	6/29/1972
1972 Bid Set	S8	Column Schedule & Miscellaneous Details	2/7/1972	6/29/1972
1972 Bid Set	S9	Ramp Details	2/7/1972	6/29/1972
1972 Bid Set	S10	Shaft A Details	2/7/1972	6/21/1972
1972 Bid Set	S11	Shaft B Details	2/7/1972	6/29/1972
1972 Bid Set	S12	Shaft C & D Schedules	2/7/1972	6/29/1972
1972 Bid Set	S14	Plaza Level Bottom Reinforcing	2/7/1972	
1972 Bid Set	S15	Plaza Level Top Reinforcing	2/7/1972	
1972 Bid Set	S16	Plaza Level Sections	2/7/1972	6/29/1972
1972 Bid Set	S19	Floor 1 Top Reinforcing	2/7/1972	
1972 Bid Set	S20	Floor 2 Layout & Bottom Reinforcing	2/7/1972	
1972 Bid Set	S21	Floor 2 Top Reinforcing	2/7/1972	
1972 Bid Set	S22	Floor 3 Layout & Bottom Reinforcing	2/7/1972	
1972 Bid Set	S23	Floor 3 Top Reinforcing	2/7/1972	
1972 Bid Set	S24	Floor 4 Layout & Bottom Reinforcing	2/7/1972	
1972 Bid Set	S25	Floor 4 Top Reinforcing	2/7/1972	
1972 Bid Set	S26	Floor 1, 2, 3, 4 Sections	2/7/1972	
1972 Bid Set	S27	Stair 3 Details	2/7/1972	
1972 Bid Set	S28	Transfer Arch Geometry & Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S29	Transfer Arch Reinforcing	2/7/1972	
1972 Bid Set	S30	Floor 4A Layout & Reinforcing	2/7/1972	
1972 Bid Set	S31	Floor 4B Layout & Reinforcing	2/7/1972	
1972 Bid Set	S32	Typical Tower Floor Layout	2/7/1972	6/29/1972
1972 Bid Set	S33	Floor 5 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S34	Floor 6 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S35	Floor 7 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S36	Floor 8 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S37	Floor 9 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S38	Floor 10 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S39	Floor 11 Reinforcing	2/7/1972	6/29/1972
1972 Bid Set	S40	Roof Layout	2/7/1972	6/21/1972
1972 Bid Set	S41	Penthouse	2/7/1972	6/21/1972
1972 Bid Set	S42	Penthouse Details	2/7/1972	
1972 Bid Set	S43	Tower Wall Details	2/7/1972	
1972 Bid Set	S44	Exterior Wall Construction	2/7/1972	
1972 Bid Set	S45	Bridge Link Details	2/7/1972	6/21/1972

MEP REPORT



PURPOSE OF STUDY

On April 14, 2011 AEI received a request from Jacobs Consulting to provide a study of the Prentice – Stone Pavilion Building’s mechanical, electrical and piping systems. The purpose of this study is to review the existing drawings and other documentation provided to the team by Northwestern University, visiting the building and determine if it is feasible to create a state-of-the-art wet laboratory occupancy using the existing facility.

The mechanical, electrical and piping information included in this report focuses on the inability of existing systems to service the proposed wet laboratory facility. The study also proposes several new mechanical, electrical and piping system concepts to support wet laboratory functions that consider existing inherent building floor to floor height and structural limitations.

SUMMARY

Nearly all existing building systems are obsolete and have functioned well beyond their normal life cycle. The equipment and systems associated with the 5th floor addition completed in the 1990’s is less than 25 years old and is in fair condition. The existing systems were designed to support patient care and hospital functions, and are significantly non-compatible with today’s sustainability standards, energy codes, and research laboratory environmental requirements. The existing systems including their distribution will require complete demolition and replacement with new energy efficient research laboratory type mechanical, electrical and piping systems.

Due to the intensity and configuration of modern research laboratory systems, the existing mechanical and electrical equipment room spaces are insufficient, even to service a reduced net square foot research facility. Additional mechanical and electrical space will be required.

Lastly, floor to floor heights are insufficient to support almost any current modern use requiring substantial ventilation levels on the bed tower floors. To achieve a minimum ceiling height of approximately 8’-2”, an interstitial floor concept is recommended. Similarly an interstitial floor concept is recommended for the 2nd floor vivarium area.

EXISTING CONDITIONS:

The study team toured the Prentice – Stone Pavilion on April 28, 2011 for the purpose of viewing the existing building and systems. The tour included mechanical equipment spaces and the roof where one of the cooling towers is located. The study team had the opportunity to discuss operational issues with building engineers during the tour. The study team was also provided with existing building plans and subsequent reports and studies of the building.

MECHANICAL SYSTEMS:

The original Prentice-Stone mechanical, electrical and plumbing/piping systems were designed and constructed with the original hospital facility in the early 1970’s to support hospital and hospital related functions. The 5th floor addition was accomplished in the 1990’s and included new, separate mechanical, electrical and plumbing/piping equipment and systems at that time. The building utilizes off-site Northwestern University campus generated steam for heating and humidification purposes. Chilled water for environmental cooling is produced on site. Municipal services such as domestic water, fire protection, sewer and gas all source from local utilities.

Nearly all original building systems and components are nearing forty years of age while the systems installed as a part of the 5th floor addition are approximately 25 years old. Most major systems

components have not been replaced and are original equipment. The original major MEP equipment and their systems are in a significantly deteriorated condition as would be expected from the vintage. It is generally accepted by all major building equipment and systems publications that equipment and systems life cycle are between 25 and 35 years old. Major equipment components such as air handling units exhibit significant corrosion around coil frames, drain pans, and the entire unit bottom. Domestic hot water main piping has an extreme number of leaks, measuring in the hundreds, of which almost all were indicated to have been patched with pipe clamps. One section of piping was recently replaced to avoid patching pipe leaks over previously installed patches. Pumps are worn and corroded. Exhaust fans are corroded and located in areas very difficult to properly maintain. Duct distribution systems are inefficiently configured with many hard elbows and turns required to conform the geometry of the building.



Significant corrosion and deterioration in air handling unit fan section



Worn and Corroded Pumps



Roof Fans on Existing 5th Floor – Exhaust Air is required to be Re-Directed to the Roof

The ventilation exhaust air for the building pedestal floors is nearly all exhausted beneath the bed-tower floors. Since this air is generally considered non-hazardous in nature, the current exhaust condition likely has minimal impact on surrounding building environments. However laboratory and vivarium exhaust from the proposed reuse of pedestal floors will be required to be discharged at the building roof level to minimize the re-entrainment of laboratory and vivarium contaminants into adjacent building environments. This will require the development of significant vertical duct shaft space throughout the full building height to accommodate the quantity of exhaust air. Existing elevator shaft space is considered one solution to this situation.

The building was cooled originally by two 900 ton centrifugal chillers located in the basement equipment room (shown below). A smaller third chiller was installed in the mezzanine equipment room when the 5th

floor addition was constructed. The third chiller has not been operated for several years. The two original 900 ton chillers have been modified since their original installation to be less ozone depleting through conversion to R-123 refrigerant, however this refrigerant continues to be considered an ozone depleting refrigerant. Additionally, the original chillers are significantly energy inefficient compared with modern centrifugal water chiller equipment. The basement equipment room also houses the buildings primary heating equipment, pumps and pumping equipment, steam entry and reducing stations, domestic hot water generating equipment, fire pump, metering equipment, and other water based plant equipment.



One of two 900 ton chillers located in the Basement Equipment Room



900 ton Cooling Tower located on the Prentice Roof

There are two cooling towers associated with the water chillers. One of the primary cooling towers is located on the penthouse roof (shown above), while a second cooling tower serving the Prentice chillers is located on the RIC building located across the street South of Prentice. The cooling tower on the Prentice-Stone roof is in poor condition as indicated by the image below. The tower located on the RIC facility was not observed. Due to the unknown future of the RIC facility, it is strongly recommended that full cooling tower capability be recreated on the roof of Prentice, possibly impacting the aesthetic nature of the rooftop.

Building environmental controls were originally fully pneumatic that were typical of the early 1970's (see image below). DDC controls were installed after the original construction to control terminal temperature and humidity elements at a later date, although pneumatic controls were indicated to be the primary means of controlling air handlers, fans, pumps, and other major environmental equipment. The Johnson Controls DSC 8500 DDC system was discontinued for installation in the mid-1990's, and is considered a very obsolete controls system today. Modern DDC control systems control entire systems, including air handling units, fans, pumps, chillers, etc, as well as terminal devices.



A newer DDC control panel adjacent to original pneumatic control panels



Maintenance Area is extremely limited in many areas of existing Prentice

In general, the existing equipment rooms are well short of the necessary adequate space required to conduct significant maintenance procedures including coil pull as indicated in the above image. Due to the unique configuration and geometry of the building there are many segregated “sub-equipment spaces” within the mezzanine and penthouse equipment spaces. Corners and access corridors are extremely limiting for major maintenance and equipment replacement. Most major equipment of any scale would be required to be cut into smaller components for removal. Installation of new replacement equipment of scale in many cases would require disassembly of other equipment and distribution. This creates an untenable situation for either the current hospital function or proposed research laboratory function during catastrophic failure situations.

ELECTRICAL SYSTEMS:

The existing building electrical system remains largely intact, dating back to the original building construction in the early 1970's. The system did undergo a significant upgrade in conjunction with the addition of the fifth floor during the late 1990's. A description of the system components is the subject of the remainder of this section.

Basement Electrical Equipment

Main electrical service to the building originates in a ComEd transformer vault, furnishing 480 Volt, 3 phase, 3-wire power to three (3) 2000 Ampere main building switchgear lineups. The main service gear is housed in a dedicated space at the southeast corner of the basement level. Transformers in the ComEd vault are arranged in a “spot network” configuration, with three service laterals connected to feed power to the building. Each of these service laterals terminates at a 2000A, 3 phase, 3-wire network protector, and in turn feeds the three (3) main service switchgear lineups. Each of the switchgear lineups contains multiple drawout air circuit breakers, removable with integral overhead trolley/winch assemblies.



Switchgear Breaker Winch Assembly



Main Building Switchgear Lineup

The main service gear is manufactured by General Electric, and is original to the building. All of the original air circuit breakers have been retrofitted with Siemens breakers as part of an upgrade project. Working clearance around this equipment is exceptionally tight, and does not satisfy the City of Chicago Electrical Code. The use of 3-wire service equipment is no longer permitted by the Code in Chicago either. The computed capacity of the main building service equipment is 4.98 MVA, or 14.65 VA/SF. This capacity will not support a modern laboratory building.■



Main Building Switchgear Lineup

The main service room houses additional distribution panels and transformers, which supply power to building lighting, receptacles, and equipment. The room is completely full, and has no expansion capability.



Existing Generator Day Tanks

Emergency/standby power to the facility is supplied from two self-contained diesel engine generator sets, housed in a dedicated basement level space north of the main electric service room. The machines are rated 600kw/750kva, 208Y/120 volts, 3-phase, 4-wires, 60hz and 900kw/1125kva, 480 volts, 3-phase, 4-wires, 60hz. The machines are manufactured by Caterpillar – Model No. 3412 and 3508 respectively.



Existing Emergency Generators

*

The units are each configured with remote radiator cooling, floor mounted starting batteries, and day tanks with integral rupture basin. The machines are regularly serviced, and are in excellent condition.

These generators replaced original equipment in conjunction with the Fifth Floor expansion project. This room houses automatic transfer switches and distribution equipment serving the hospital's critical equipment and life safety systems. The placement of automatic transfer switches in a generator room does not satisfy the current City of Chicago Electrical Code.



The automatic transfer switches, manufactured by Russelectric are replacement equipment installed in conjunction with the Fifth Floor expansion project. Critical and emergency distribution panels were replaced simultaneously with this effort.

The basement houses major mechanical equipment as well, including chillers, pumps, and fans. This equipment is powered from three main motor control centers located in two mechanical rooms. The motor control equipment is original, manufactured by General Electric, and is obsolete. A number of issues are worthy of note in relation to the existing installation in mechanical rooms. Motor Control Centers MCC-1 & 8 are wall mounted, with wet piping systems routed over the entire length of this equipment.



This is a significant code violation. The second item of note relates to the main building refrigeration chillers. The main starter/disconnecting means is located at the far end of the room from its corresponding chiller. This installation stretches the "in sight" requirement for motorized equipment beyond what is reasonable or safe. All of the motor control and/or distribution equipment in these rooms is obsolete and in need of replacement.

The chiller room houses the main building fire pump and controller assembly. Both pump and controller appear to be more recent additions, and are in good condition.



Main Fire Pump Controller



Obsolete Motor Control Center

Building Electrical Equipment

Levels 1 through 4 contain branch circuit and distribution panels housed in electric closets, and service lighting, critical, and essential loads in all areas of the hospital. All of this equipment is original, and in need of replacement.

Levels 4A/4B house major mechanical equipment serving the occupied areas of the hospital. There is a considerable amount of obsolete, original equipment in this space.

This is particularly true of the motor control centers.



Obsolete Mechanical Room Equipment



Obsolete Motor Control Center

The Fifth Floor Addition in the late 1990's was accompanied with the installation of new panels and distribution. All of this additional equipment is in serviceable condition, but lacks the capacity and redundancy required for a modern replacement laboratory.



Newer Electrical Distributed Equipment

The tower floors contain branch circuit panels housed in core area electric closets. It does not appear that these closets are 2-hour fire rated to meet the current Chicago Code. All of these panels appear to be original and are in need of replacement.

The penthouse levels contain distribution and motor control centers supporting mechanical and elevator loads. The equipment is in very poor condition, and has been compromised by age and a substandard operating environment.



Deteriorated Motor Control Center

The capacity of this equipment is insufficient to support a modern replacement laboratory. All of this equipment requires replacement.

Code Issues

The current building electrical installation is in violation of the Chicago Building Code in a number of areas. These violations can be summarized as follows:

- Main building service switchgear is configured as a 480 volt, 3 phase, 3-wire service as opposed to a 480/277 volt, 3 phase, 4-wire service required by code.
- Working clearance around main building service switchgear does not meet minimum code requirements.
- There is only one exit in the ComEd vault, main building switchgear, and generator rooms. The minimum requirement is two.
- Basement mechanical room motor control centers are impacted with wet piping routed over the length of the gear.
- Main chiller disconnecting means are out of sight from motor location.
- The emergency system automatic transfer switches are not segregated into separate rooms as required by the Chicago Electrical Code.
- Floor by floor electrical closets are not in 2-hour fire rated rooms as required by code.
- Electrical distribution equipment in penthouse violates accessibility requirements.
- The building lighting systems violate the Chicago Energy Code in the following areas:
 - Excessive load density versus allowable
 - Lack of code compliant lighting controls

All of these issues will require remediation with a comprehensive renovation plan.

SUSTAINABILITY:

The overall building and building systems are nearing 40 years old. Their design and function are typical of the vintage with regard to sustainability. The building systems are high energy consuming and coupled with the exceptionally limited maintenance areas, are not sustainable in concept.

Examples of existing non-sustainable systems include;

- Existing ventilation systems that are of the constant volume reheat configuration with high velocity air distribution that consume considerable energy. Current system design would be variable air volume configuration with low friction drop characteristics.
- Exhaust air heat recovery—existing Prentice has no exhaust air heat recovery technologies. Current exhaust air heat recovery technologies can be as much as 70% to 80% effective, significantly reducing the amount of fossil fuels required for environmental heating, cooling and humidification.
- Mechanical equipment motors do not generally have variable frequency drives and many motors continue to be of the older low efficiency type design. Current system design would include variable frequency drives on virtually all motors of any size for demand control limits.
- Air conditioning chillers are older high energy consuming equipment modified to operate with HCFC 123 refrigerant. While considerable less ozone depleting than HFC refrigerants, HCFC refrigerants are to be phased out with production cuts of 90% by 2015. Additionally, current technology has enabled chiller manufacturers to produce equipment with non-ozone depleting refrigerants that are considerably more energy efficient than retrofitted 1970's technology.
- Plumbing fixtures are of the high water consuming type. Current technology would reduce water consumption to a fraction of that existing in the current Prentice facility.
- The building construction is also of late 1960's/early 1970's vintage with substandard thermal insulations. Insulation codes have been upgraded significantly since the 1970's, increasing thermal building insulation as well as piping and ductwork insulation effectiveness.
- Current glazing in many areas consists of single pane glazing. Current glazing technologies and codes would require double insulated glazing products.

MECHANICAL CONCEPTS

The hospital mechanical system design of the 1970's is wholly inadequate for current healthcare/hospital functions and for current research laboratory function. Mechanical systems in hospital uses are designed significantly for people comfort, while research laboratory systems are designed for stringent research environments and protection of building occupants from hazardous materials.

The Prentice-Stone hospital mechanical ventilation systems design did not include systems redundancy of any type. Heating water generation and pumping appears to have an N+1 configuration as is typical for many northern climate institutional buildings. The two existing 900 ton water chillers and cooling towers do provide some redundant cooling capability when weather conditions are moderate.

Current research laboratory design is based on a preponderance of redundant systems to protect valuable research that is often in process for many months or years. Major equipment including supply and exhaust ventilation, laboratory vacuum, laboratory air, electrical power, and other systems as programming dictates are designed with some redundant protections. Vivarium design is especially mandated to have fully redundant environmental system sources for the protection of the animal and to meet certain accreditation standards. Additionally, any laboratory and/or vivarium facility constructed to meet National Institute of Health design standards is mandate to have fully redundant mechanical and power supply systems, including cooling and heating plant systems redundancy as well.

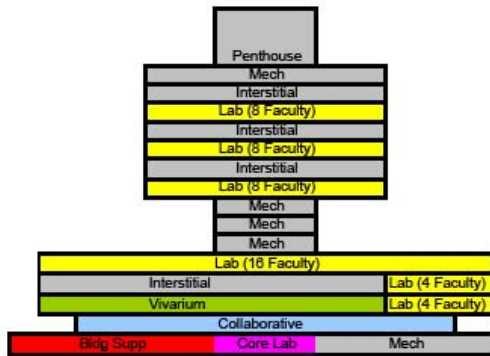
Research laboratory buildings require considerable space to house mechanical and piping/plumbing equipment. An analysis of the ventilation requirements was performed to determine overall ventilation

system sizing, mechanical room space requirements, vertical shaft space needs, and ceiling space to house distribution and laboratory infrastructure. Mechanical ventilation concepts include central station variable air volume distribution with once through air and exhaust systems for all laboratory and vivarium spaces. A total of approximately 240,000 CFM of ventilation air will be required to service a laboratory building based on the interstitial design concept described below. The chart below also indicated where interstitial floors are required and where mechanical spaces are required to service the proposed conversion to a laboratory facility.



Prentice-Scott Building Ventilation Model
Restore To Original Building Envelope

JCI/AEI/TT
29-Apr-11



Building Functional Section

Floor	Function	GSF	Assignable Area	
			% Fir Eff	ASF
PH	Mech	4,000	0%	0
13th	Mech	17,250	0%	0
12th	Interstitial	17,250	0%	0
11th	Lab	17,250	70%	12,075
10th	Interstitial	17,250	0%	0
9th	Lab	17,250	70%	12,075
8th	Interstitial	17,250	0%	0
7th	Lab	17,250	70%	12,075
6B	Mech	5,500	0%	0
6A	Mech	5,500	0%	0
5th	Mech	5,500	0%	0
4th	Lab	34,900	70%	24,430
3rd	Interstitial & Lab	34,900	20%	6,980
2nd	Vivarium & Lab	34,900	80%	20,940
Ground	Collaborative	19,800	80%	11,880
Bsmt	BSupp, Core L & Mech	45,000	45%	20,250
Total Building GSF		310,750		
Building Efficiency			39%	
Total Building ASF				120,705

Floor	Function	CFM	supply shaft duct	exhaust shaft duct	supply duct (sf)	exhaust duct (sf)	total shaft sq feet	total shaft x 1.5 (sf)		
PH	Mech	0		3-80X80		133	133	199.5		
13th	Mech	0		3-80X80		133	133	199.5		
12th	Interstitial	0	70X70	3-80X80	34	133	167	250.5		
11th	Lab	21500	60X60	3-72X80	34	120	154	231		
10th	Interstitial	0	60X60	3-72X80	25	120	145	217.5		
9th	Lab	21500	60X60	3-84X80	25	105	130	195		
8th	Interstitial	0	42X40	3-84X80	12	105	117	175.5		
7th	Lab	21500	42X40	2-76X100	12	105	117	175.5		
6B	Mech	0		2-76X100	105	105	210	315		
6A	Mech	0		2-76X100	105	105	210	315		
5th	Mech	0		2-76X100	105	105	210	315		
4th	Lab	43625		2-76X100	105	105	210	315		
3rd	Interstitial & Lab	0		2-76X76	80	80	160	240		
2nd	Vivarium & Lab	80,000		76X60	80	80	160	240		
Ground	Collaborative	19,800		48X60	33	33	66	99		
Bsmt	BSupp, Core L & Mech	35,000		48X60	20	20	40	60		
		242,925								

Mechanical Ventilation and shaft sizing

The existing basement mechanical room is sufficiently sized to house new chillers, heat exchangers, water heaters, RO/DI system, pumps, laboratory air compressors, laboratory vacuum, and most other non-ventilation air based mechanical systems. The mid-level mechanical rooms (floors 5, 6A and 6B) would house air handling units and ventilation equipment to service the pedestal floors of the building, including the redundant systems required for the vivarium. The existing penthouse equipment spaces are insufficient to house both redundant exhaust systems for the entire building and supply air handling equipment required for the Bed Tower floors, and thus the 13th floor was necessary for conversion to an equipment room. The 13th floor is a low floor to floor height and thus its use as an equipment floor will be considerably less efficient than a more normal floor spacing. The 13th floor would house air handling units and related humidification and fans to support the Bed Tower laboratory floors. The existing penthouse

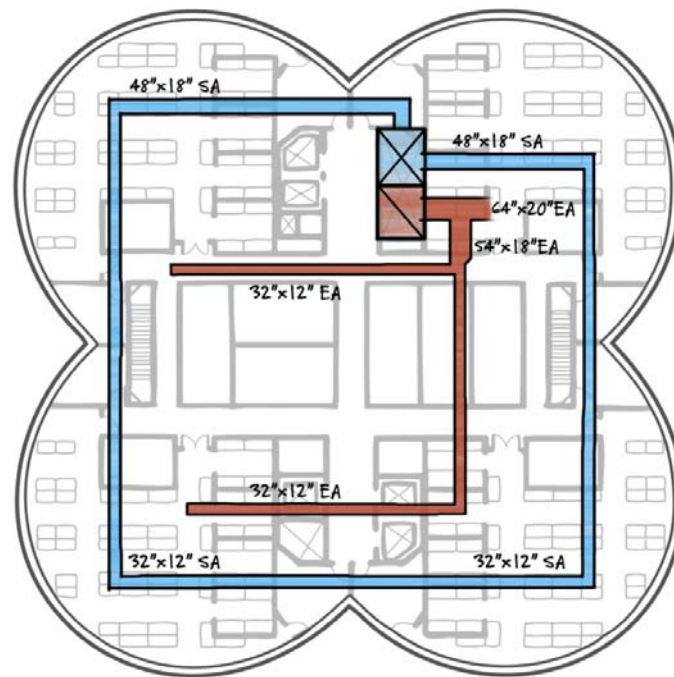
areas will continue to house upgraded elevator equipment, but will also house exhaust fans for the entire building. It is estimated that between 12 and 18 fans will be required, including standby exhaust fans. Fan discharges must be configured in such a way as to limit laboratory and vivarium contaminants from entering nearby building ventilation systems. Exhaust stacks are generally employed to disperse laboratory exhaust air at great discharge velocities for such purpose. Acoustic controls will be required to reduce noise generated by the exhaust systems.

The extraordinarily low floor to floor heights, especially on the bed tower floors, create an extremely challenging situation for the design of state of the art research laboratory space. Floor to Floor structure consists of 10'-6" with 15 inches of concrete floor slab that yields 9'-3" clear (refer to structural report sections). The installation of any horizontal ductwork in conjunction with fire protection piping, lighting systems, electrical conduit, and wet laboratory water, laboratory gas, and drainage and vent piping will result in head room of between 7' and 7'-6" maximum, assuming the structure as the ceiling.

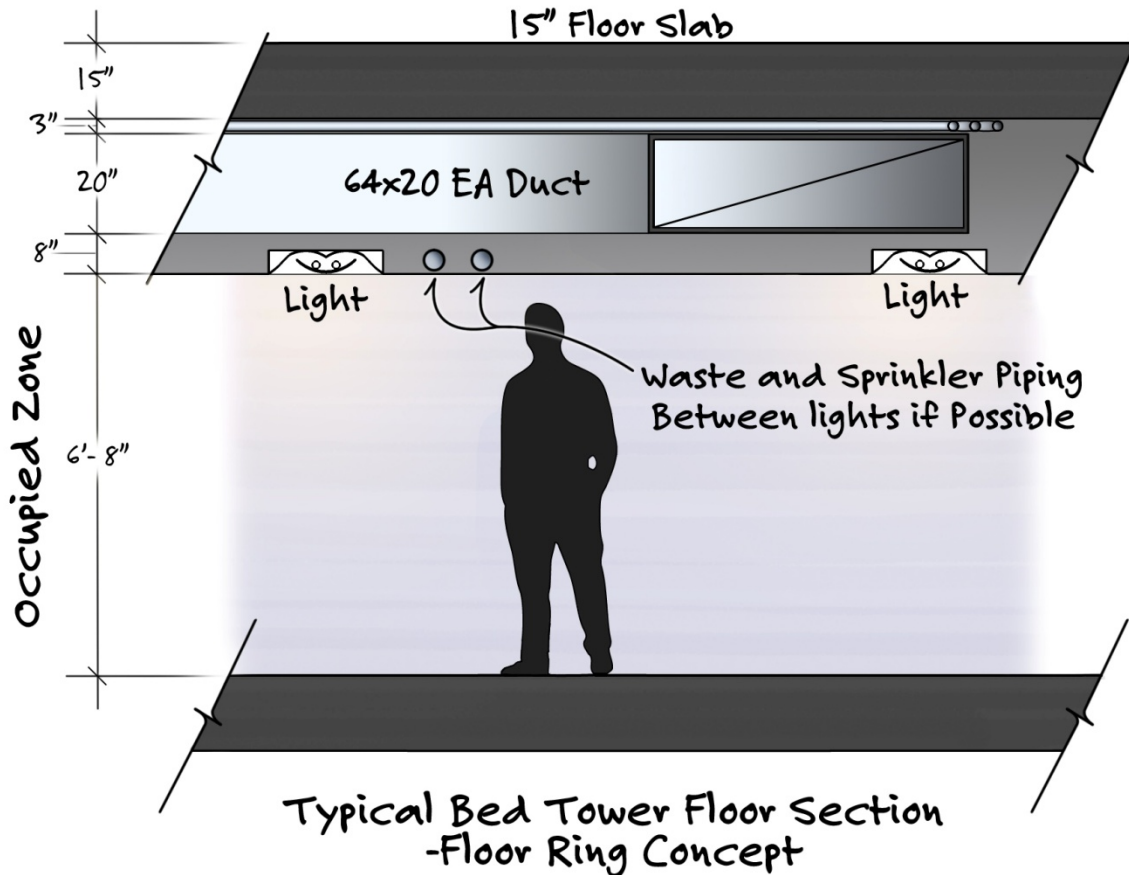
The study team has reviewed a number of potential design solutions. Northwestern University design standards normally require ventilation systems be designed to a "ring duct" standard for optimum laboratory function flexibility. Other options studied include the "short spoke" ductwork design concept and the interstitial design concept to maximize head room clearance for the current bed tower floors.

Floor Ring Concept: This distribution concept relies on distribution of ductwork, piping, conduit, laboratory gases and fire protection systems within the confines of the laboratory ceiling space. The duct routing strategy is based on having supply air sourced from two different directions such that portions of the distribution system can be "shut down," such as for system maintenance or space renovation, while still allowing remaining spaces to receive ventilation. This is important in a research environment. In this concept supply ductwork sizing can be reduced to 50% of the total volume since there are two ducts serving the gross laboratory space. In the sketches below, ductwork depths of 18 inches to 20 inches are required to maintain a reasonable duct aspect ratio. Reducing the aspect ratio further will incur significant costs and reduce system operating efficiency.

Bed Tower Lab Ventilation
 Floor Ring



Floor Ring Floor



Floor Ring "Bed Tower" Section

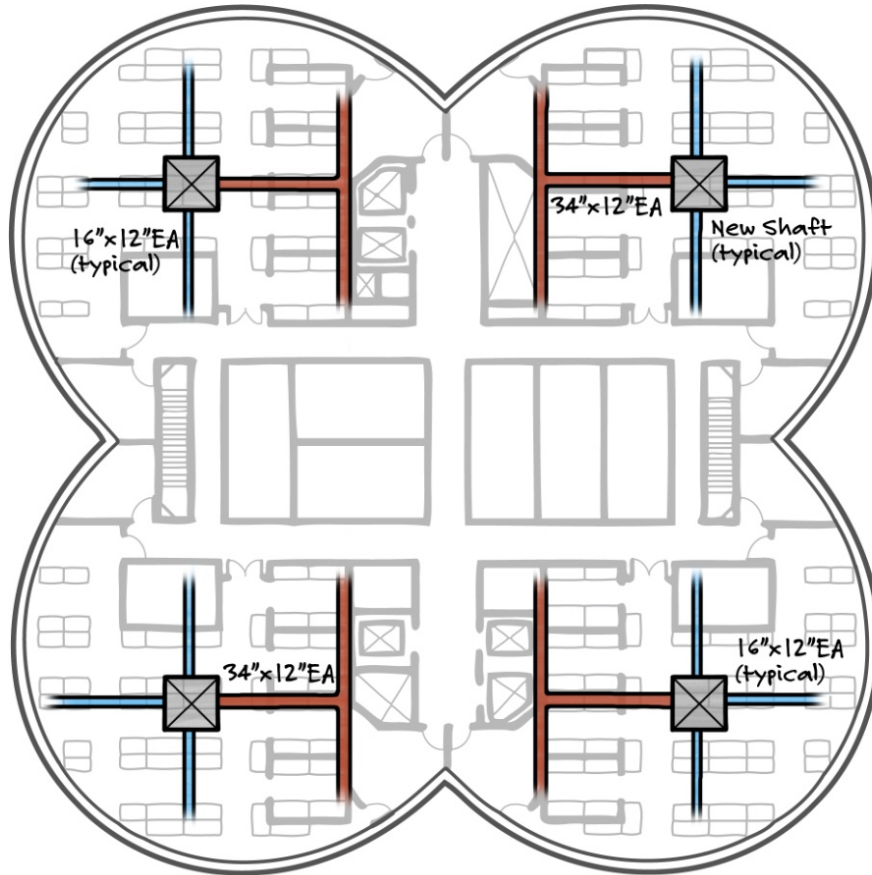
Using the Floor Ring distribution concept will require a minimum of 3 inches for electrical conduit and conduit support pathway. The ductwork zone is a minimum of 20 inches and the lighting zone consists of another 8 inches. This section makes an almost extraordinary assumption that sprinkler piping, waste piping, laboratory gases such as compressed air, vacuum and nitrogen, and hot and cold water will all be able to be installed between light fixtures. In reality this is a very unlikely scenario, but is assumed for purposes of this study. The resulting occupied zone is a mere six foot eight inches of head room.

Short Spoke Concept: This distribution concept again relies on distribution of ductwork, piping, conduit, laboratory gases and fire protection systems within the confines of the laboratory ceiling space. This concept does not incorporate the distribution redundancy of the ventilation system as the Floor Ring concept above, but was reviewed due to its relatively smaller ductwork and resulting higher head room. This concept assumes that major shaft space can be developed in the center of each of the laboratory modules (as indicated by the "four boxed X's" shown below. Both supply and exhaust ductwork would distribute vertically in this concept. As with the Floor Ring Concept shown above, this concept assumes that sprinkler piping, waste piping, laboratory gases such as compressed air, vacuum and nitrogen, and hot and cold water will all be able to be installed between light fixtures. Again, in reality this is a very unlikely scenario, but is assumed for purposes of this study. Another major assumption is new steel framing that will be required for each of these new shafts will NOT impinge on any of the horizontal distribution. Even with the above assumptions the resulting occupied zone is an only increases nominally

to seven foot four inches of head room. It is AEI's opinion that a fully designed and coordinated installation would result in head room considerably lower than shown in this section.

Short Spoke "Bed Tower" Floor Plan

Bed Tower Lab Ventilation
Short Spoke

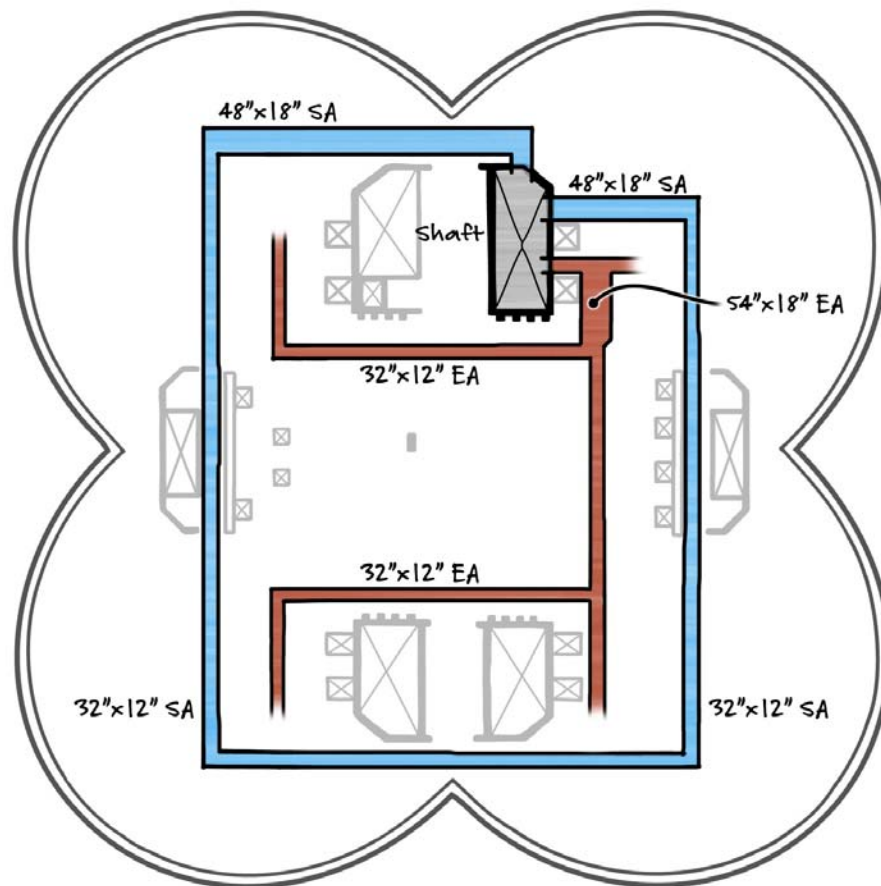


Short Spoke "Bed Tower" Section

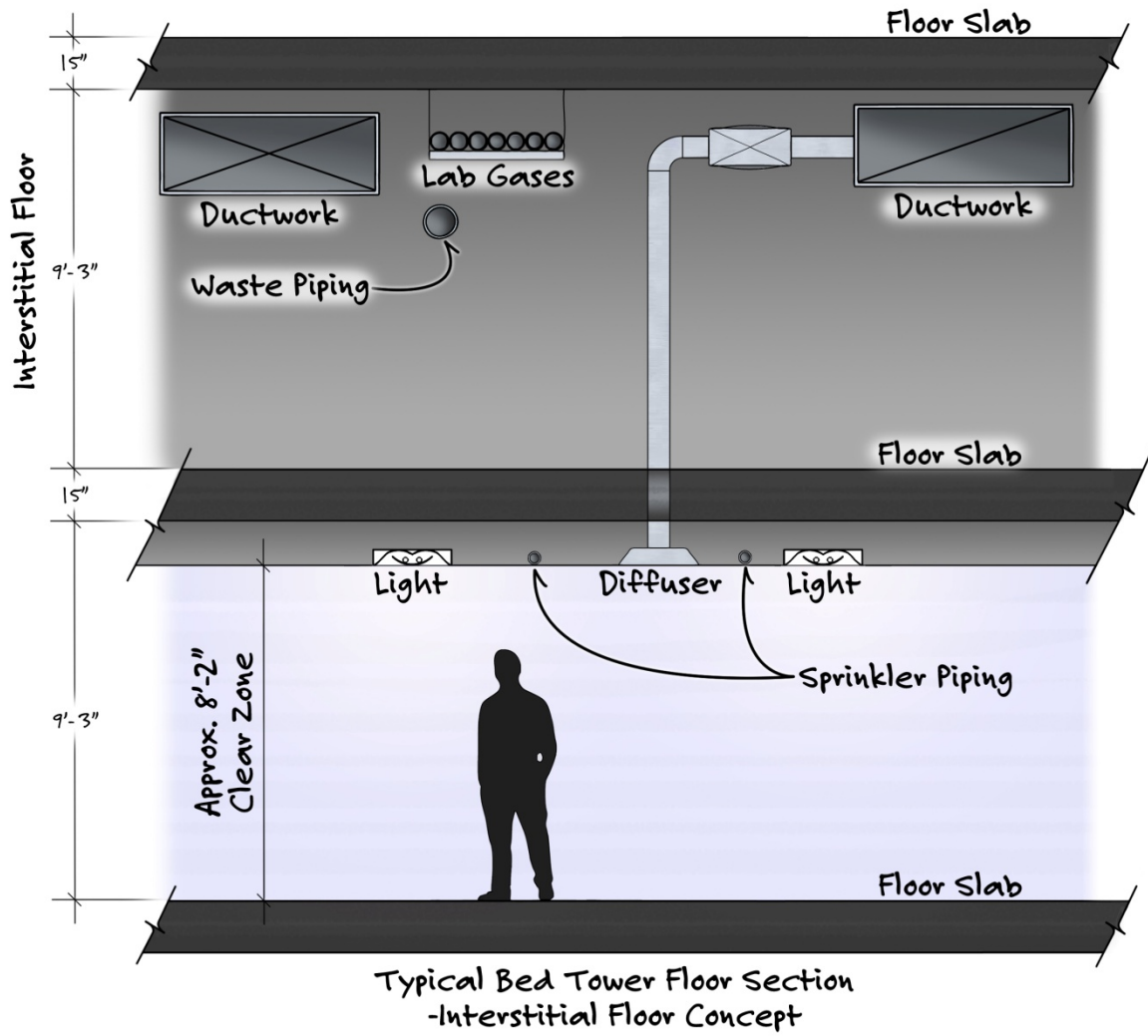
Interstitial Distribution Concept: The interstitial distribution systems concept shown below appears to maintain the greatest vertical head room possible. Due to the exceedingly low floor to floor height of the bed tower floors, these interstitial spaces would be required above each laboratory floor to house horizontal infrastructure distribution and terminal distribution devices. Floors 7, 9 and 11 would be dedicated to laboratory research spaces while floors 8, 10, and 12 would be dedicated to house mechanical, electrical, and piping distribution, valves, terminal units, controls, and other materials and devices. Additionally, the "interstitial floor" concept would also apply to the vivarium on the 2nd floor. Vivarium spaces should be designed to be maintained without access to animal holding and procedure

spaces. Current "Guide to Animal Care" Standards strongly recommend interstitial or similar designs be implemented to limit maintenance access to vivarium program spaces. The interstitial design concept would require smaller holes to be created in the structural floor slab to penetrate the slab and service Bed Tower laboratory spaces and the vivarium located in the building pedestal. This strategy would eliminate horizontally distributed ductwork on the Bed Tower floors, and significantly reduce the amount of horizontally distributed ductwork on the vivarium floor. Infrastructure required to be distributed horizontally on these floors would thus be limited to fire protection, branch electrical circuits, lighting systems and possibly laboratory gases. The low floor to floor height will certainly require lighting to be of the fully direct fixture type verse the preferred lighting strategy utilizing indirect fixtures, or combination direct indirect fixtures. Use of the preferred fixture types would require lighting fixtures to be suspended approximately 18 inches below the ceiling or floor slab resulting in head room of no greater than 7'-9" assuming the structure is used as the ceiling. Head room of approximately 8'-2" can likely be maintained through use of the fully direct lighting fixtures attached to existing structure (no ceiling), and again assuming space for fire protection system installation can be accommodated between light fixtures.

Bed Tower Lab Ventilation "Interstitial Concept" Ring Ductwork



Bed Tower Interstitial Plan



Bed Tower Interstitial Section Thru Two Floors

PROPOSED ELECTRICAL RECONFIGURATION

General

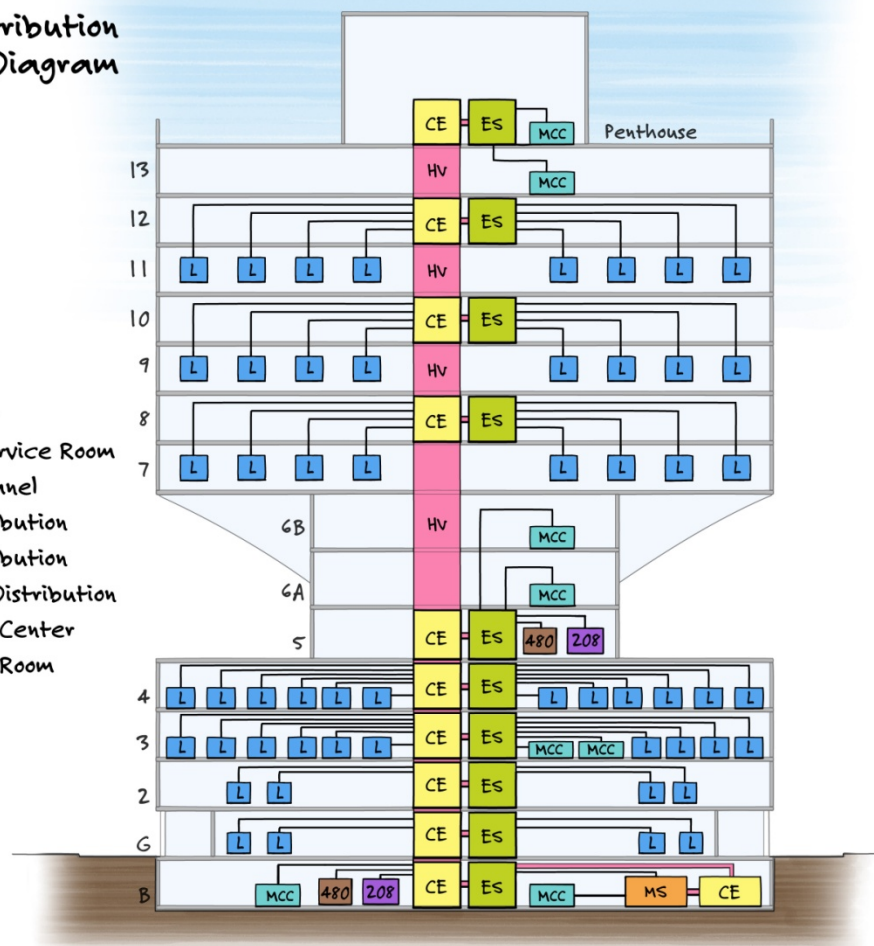
This section outlines a proposal for the replacement of the current hospital electrical system with a system designed to accommodate a state-of-the-art medical research facility. This outline will review the basic system parameters required in the renovated facility. It should be noted that there are a number of baseline assumptions established for the renovated facility, including:

- All existing equipment and systems will be demolished and removed.
- Replacement electrical systems will utilize state-of-the-art technology and equipment.
- All systems will be designed to satisfy City of Chicago Building Codes and Northwestern University Standards.
- Sustainability and LEED design principles will be essential aspects of the proposed design.
- Flexibility, reliability, and maintainability will be core objectives of the renovated systems.
- The proposed installation is depicted on the electrical distribution schematic diagram.

Electric Distribution Schematic Diagram

Legend

- CE Com Ed Vault
- ES Electrical Service Room
- L Laboratory Panel
- 208 208 volt Distribution
- 480 480 volt Distribution
- HV High Voltage Distribution
- MCC Motor Control Center
- MS Main Service Room



Utility Service

Incoming electrical service will enter the building through multiple, redundant 12.47kv ComEd service feeders. These feeders will supply a main ComEd utility vault located in the basement level. All medium voltage feeders will be routed in underground concrete encased ductbanks. Redundant service, fed via diverse routing paths will be incorporated where feasible. The building will be supplied from multiple ComEd substations as available. The construction of the main utility vault will be constructed to ComEd standards.

Main utility service switchgear and transformers will be furnished, installed, and maintained by ComEd, and located in a 3-hour, fire-rated main vault. All 12.47kv main switchgear, transformers, and cabling will be fully redundant, and shall be equipped with automatic transfer capability. Main vault service transformers shall supply secondary power at 480Y/277 volts, 3 phase, 4-wires to building service switchgear located in an adjacent switchgear room. Maximum service transformer rating shall be 2500KVA.

The basement through fourth floors shall be equipped with a series of vertically stacked ComEd utility vaults, facilitating the use of redundant 12.47kv distribution. These vaults shall be located in the building core, and sized to accommodate ComEd switch racks and dry type stepdown transformers.

The maximum transformer rating for these typical floor vaults will be 500kva. Secondary voltages supplied will be 480Y/277 volts, 3 phase, 4-wires and 208Y/120 volts, 3 phase, 4-wires. Secondary service feeders from ComEd transformers will supply building distribution panels located in adjacent electric service rooms on each floor.

Levels 5/6A/6B mechanical floors will house a ComEd vault sized to service the major mechanical loads on these levels. Transformers installed at these levels may exceed the 500kva limitation established for the typical floors. Capacity requirements in excess of 500kva will utilize (3) single-phase transformers connected in a three phase arrangement.

Levels 8, 10, and 12 shall be configured as mechanical interstitial floors, as described in the mechanical systems section. These floors will house ComEd vaults configured to deliver 480Y/277-volt, 3-phase, 4-wire service to mechanical equipment located on these floors, and 208Y/120-volt, 3-phase, 4-wire service to laboratories located at floors 7, 9, 11. All horizontal secondary distribution will distribute from a centrally located electrical room adjacent to these ComEd vaults. Horizontal distribution will occur at the interstitial levels, dropping down to the laboratories below.

A final ComEd vault will be located at the 13th Floor, serving the 13th Floor/Penthouse mechanical loads at 480Y/277-volts, 3-phase, 4-wires.

BUILDING DISTRIBUTION

The building distribution system will originate at (3) three, 3000Ampere, 480Y/277 volt, 3 phase, 4-wire, double-ended switchgear lineups located at the basement level. This equipment will be designed with 100% redundancy, including dual main breakers and a normally open tie breaker. Switchgear construction with drawout, microprocessor based solid state air circuit breakers will be the basis of design. This equipment will supply power to basement and vivarium mechanical equipment including chillers, fans, and pumps.

Horizontal 480Y/277-volt, 3-phase, 4-wire feeders from the basement service equipment will route to remote mechanical equipment rooms in the basement and vivarium. Motor control centers and distribution panels will supply power to mechanical equipment in these locations. Variable frequency drives will be installed as required for specified mechanical systems. All feeder and branch conductors will be copper, type THHN/THWN or XHHW insulation, installed in IMC and/or EMT conduit.

Basement through Fourth Floor power distribution shall originate at electric service rooms located adjacent to ComEd floor utility vaults. Secondary service on these floors will be supplied at 480Y/277 volts, 3 phase, 4-wires and 208Y/120 volts, 3 phase, 4-wires. Main service distribution panels will route 480 and/or 208 volt power to strategically located lighting, receptacle, mechanical, and laboratory panelboards.

Mechanical floors 5/6A/6B will be served from a ComEd utility vault located on those levels. Secondary service from this vault will supply (1) 3000 Ampere, 480Y/277 volt, 3 phase, 4-wire, double-ended switchgear lineup. This construction and configuration of this equipment will match the main service gear located in the basement. This lineup will supply power to mechanical equipment, including fans, pumps, compressors, and elevators.

Power distribution for Levels 7, 9, and 11 laboratory floors will originate in service distribution panels located on interstitial floors 8, 10, and 12. Horizontal feeders from these floor service panels will route to individual panelboards located in laboratory modules floors 7, 9, 11 via the interstitial floors. Laboratory panels will be readily accessible at each laboratory module to facilitate operation and any required modifications.

Power distribution to 13th Floor/Penthouse loads will originate at the main electrical service room at that level. Horizontal feeders will service distribution panels and/or motor control centers at 480Y/277-volts, 3-phase, 4-wires.

Emergency Services

Emergency power to the facility will originate at a central generator room located in the basement level. The main generator plant will consist of two (2) 1000KW/1250KVA, 480Y/277 volt, 3 phase, 4-wire, 60hz diesel engine generator sets. The installation shall include starting batteries, battery chargers, jacket heaters, day tanks, and required accessories. The installation shall be equipped with a 600KW load bank, to facilitate proper weekly load tests, as required by the City of Chicago.

The generator installation shall be configured for automatic paralleling and distribution to start, synchronize, and control the on-site generating plant. Outgoing emergency feeders shall originate at integral load breakers in the paralleling gear, and serve automatic transfer switches located throughout the building Exit and emergency lighting shall conform to the requirements of a City of Chicago System I. Automatic transfer switches and paralleling gear shall be housed in dedicated space apart from the main generators. The main fuel storage capacity shall enable a minimum 24-hour operation.

The building emergency system shall include the following loads:

- Exit and Emergency Lighting
- Fire Pump(s)
- Elevators
- Fire Alarm/Life Safety System
- Security System
- Building Automation System
- Telecom/Data Equipment
- Vivarium Space Conditioning
- Fume Hood Exhaust Systems
- Pumps designed to overcome gravity
- Essential Laboratory Equipment

The emergency system shall comply with all applicable City of Chicago requirements.

Lighting – Lamps and Luminaires

The lighting system envisioned for the project will utilize high efficiency T-5/T-8 fluorescent and LED lamp sources, designed to produce high quality, low brightness illumination in all occupied areas, while minimizing energy consumption and lamp replacement costs.

Luminaire selection will consider the high technology nature of the working laboratory spaces. In this context, strong consideration will be given to indirect illumination via T-5 and/or T-8 fluorescent lamps. Areas restricted by available floor heights will consider the use of recessed “indirect” fixtures.



Recessed Indirect Picture

Corridor and public spaces will utilize high efficiency fluorescent and/or LED sources. Back of house space will employ T-8 fluorescent industrial fixtures. Lamps will be high color rendering (CRI) to enhance the quality of illumination in all occupied spaces.

Lighting Controls

Lighting controls will utilize the latest technology to facilitate functionality and maximum operating efficiency. At a minimum, the lighting controls will satisfy the requirements of the Chicago Energy Code. It is anticipated that lighting control strategies will incorporate daylight harvesting in perimeter zones where available. The use of occupancy sensors will be universal throughout the facility. Master building lighting controls will facilitate full integration with mechanical systems for maximum operating economy.

Fire Alarm/Life Safety System

The building will be equipped with a City of Chicago high-rise compliant fire alarm/life safety system. The system shall be a distributed, microprocessor based analog addressable fire alarm system, providing fire detection and alarm notification throughout the building. The system shall include complete voice communication, including one-way public address, and two-way firemen's communications. A rescue assistance intercom will connect remote areas of refuge with the main Fire Command Center. Visual notification devices will be installed to satisfy the requirements of the Americans with Disabilities Act (ADA) and the Illinois Accessibility Code. All of the required fire alarm/life safety and control and annunciation equipment will be housed in a Fire Command Center located in the Main Lobby. The Fire Command Center will include but not be limited to the following equipment:

- Fire Alarm Control Panel
- Fire Alarm Annunciator Panel
- Voice Communications Panel
- Sprinkler System Supervisory Panel
- Elevator Control Panel
- Emergency Power Monitoring
- Fan Status Indicator Panel
- Fire Pump Status Panel
- Emergency Telephone for Fire Department Use

COST STUDY



NORTHWESTERN
UNIVERSITY



Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion
Chicago, IL
Job Number 11331-00
May 13, 2011 rev4 May 18, 2011

Summary of Cost Estimate Assumptions

This Estimate is not a guarantee of Final Bid Cost or of Final Project Cost.

This is an Opinion of Probable Cost of Architectural, Structural, Mechanical, Electrical, Piping, Fire Protection Systems for the proposed building.

The estimate is representative of average unit pricing and labor from historical job costs of similar type, cost and labor data from Mechanical Contractors Association of America (MCAA), Costworks 2011 1st Qtr. (Masterformat Div. 1 - 46) by R.S. Means Company Inc., National Mechanical Estimator by Ottaviano, National Electrical Contractors Association (NECA) and Sheet Metal Estimating by Herbert C. Wendes.

The subcontractor unit rates include the subcontractors overhead and profit, unless other wise stated.

The mark-ups included in the unit prices cover the cost of field overhead, home office overhead and profit, and range from 15% to 25% of the costs of a particular item.

Since we have no control over the cost of labor, material and equipment, or the contractor's method of carrying out the work and determining the price, or over competitive bidding or market conditions, this opinion of probable construction cost provided is made on the basis of experience and qualifications. This opinion represents our best judgment as professional construction consultants with the Construction Industry. However, we cannot and do not guarantee that proposals, bids or the construction cost will not vary from opinions of probable cost in this estimate.

General Assumptions:

"Allowances" are considered to be an allotted sum of money for a particular system or scope of work for which sufficient detail is not available to determine a definitive cost.

These cost allowances are included to project a final cost to include labor, material, equipment and any subcontractor costs.

The owner receives the savings for any amount under the allowance and is at risk for any amount over the allowance.

The estimate is in today's dollars, and has been adjusted to the local area.

This estimate does not include any fees or permits.

This estimate is intended to reflect construction costs only.

This estimate is intended to reflect normal construction schedules only.

Variations in material costs, labor efficiencies, wage rates, union practices, and bid climate will effect final costs.

Workers will report to the actual job site.

Materials delivered to the actual job site will need to be scheduled.

Additional Labor has been applied for existing construction and restricted access.

No premium or overtime has been included.

The Owner will be involved in the scheduling or phasing of all work that disrupts a utility or service.

Staging, phasing & mobilization/demobilization costs have been applied (for work required by all trades on all floors).

No commissioning or validation has been included.

Sales Tax is included in unit pricing.



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**Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion
Chicago, IL
Job Number 11331-00
May 13, 2011 rev4 May 18, 2011**

Summary of Cost Estimate Assumptions

General Construction Assumptions:

Renovation structure does NOT have sufficient capacity for the projected loads.
Costs have been included to modify structure.

Plumbing Assumptions:

Plumbing service does NOT have sufficient capacity for the projected loads.
Costs have been included for expanded service.

Fire Protection Assumptions:

Fire Protection service does NOT have sufficient capacity for the coverage.
Costs have been included for expanded service.

Mechanical Assumptions:

Mechanical service does NOT have sufficient capacity for the projected loads.
Costs have been included for expanded service.

Electrical Assumptions:

Electrical service does NOT have sufficient capacity for the projected loads.
Costs have been included for expanded service.



NORTHWESTERN
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Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion
 Chicago, IL
 Job Number 11331-00
 May 13, 2011 rev4 May 18, 2011

Space	Gross SF	Assignable SF
Existing Prentice Stone Area Breakdown		
PH - Mechanical	4,000	0
13th Floor - Mechanical	17,250	0
12th Floor - Interstitial	17,250	0
11th Floor - Lab	17,250	12,075
10th Floor - Interstitial	17,250	0
9th Floor - Lab	17,250	12,075
8th Floor - Interstitial	17,250	0
7th Floor -Lab	17,250	12,075
6B Floor - Mechanical	5,500	0
6A Floor - Mechanical	5,500	0
5th Floor - Mechanical (to be Removed)	5,500	0
4th Floor - Lab	34,900	24,430
3rd Floor - Interstitial & Lab	34,900	6,980
2nd Floor - Vivarium & Lab	34,900	20,940
Ground Floor - Collaborative	19,800	11,880
Basement Floor - Building Support, Core Lab & Mechanical	45,000	20,250
Existing Prentice Stone Area Total (Includes MEP / Elev Shafts, etc)	310,750	120,705

Bldg Efficiency 38.843%



**Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion**

Chicago, IL

Job Number 11331-00

May 13, 2011 rev4 May 18, 2011

<u>Trade</u>	<u>System</u>	<u>Subtotal Cost</u>	<u>Unit Cost</u>	<u>Quantity</u>	<u>Units</u>
Conversion Construction Cost					
SITE	Hardscape Repairs/Modifications	\$ 1,476,100	\$ 4.75	310,750	Square Feet
SITE	Landscape Modifications	\$ 310,800	\$ 1.00	310,750	Square Feet
GC	General Conditions (Applied to All Trades)	\$ 5,484,700	\$ 5,484,700.00	1	Lump Sum
GC	Demolition	\$ 1,087,600	\$ 3.50	310,750	Square Feet
GC	Foundation Modifications	\$ 2,874,400	\$ 9.25	310,750	Square Feet
GC	Vertical Structure Modifications	\$ 3,884,400	\$ 12.50	310,750	Square Feet
GC	Horizontal Structure Modifications	\$ 4,428,200	\$ 14.25	310,750	Square Feet
GC	Exterior Cladding Repair/Modifications	\$ 1,867,500	\$ 17.25	108,260	Square Feet
GC	Doors & Windows	\$ 1,631,400	\$ 5.25	310,750	Square Feet
GC	Roofing, Thermal & Moisture Protection	\$ 543,800	\$ 1.75	310,750	Square Feet
GC	Interior Partitions	\$ 1,476,100	\$ 4.75	310,750	Square Feet
GC	Floor, Wall & Ceiling Finishes	\$ 1,942,200	\$ 6.25	310,750	Square Feet
GC	Casework	\$ 4,661,300	\$ 15.00	310,750	Square Feet
GC	Equipment	\$ 3,107,500	\$ 10.00	310,750	Square Feet
GC	Specialties	\$ 699,200	\$ 2.25	310,750	Square Feet
GC	Stair Modifications	\$ 1,087,600	\$ 3.50	310,750	Square Feet
GC	Elevator Replacement	\$ 1,476,100	\$ 4.75	310,750	Square Feet
GC	Existing Building Conditions	\$ 3,729,000	\$ 12.00	310,750	Square Feet
GC	Crane & Rigging	\$ 233,100	\$ 0.75	310,750	Square Feet
FP	Demolition	\$ 310,800	\$ 1.00	310,750	Square Feet
FP	Fire Protection	\$ 1,553,800	\$ 5.00	310,750	Square Feet
MECH	Demolition	\$ 466,100	\$ 1.50	310,750	Square Feet
MECH	Steam & Condensate	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Heating Hot Water	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Chilled Water	\$ 2,175,300	\$ 7.00	310,750	Square Feet
MECH	Equipment (Lab, Vivarium, Interstitial & Common)	\$ 4,661,300	\$ 15.00	310,750	Square Feet
MECH	Supply Air (Lab, Vivarium, Interstitial & Common)	\$ 3,107,500	\$ 10.00	310,750	Square Feet
MECH	Return Air (Lab, Vivarium, Interstitial & Common)	\$ 3,107,500	\$ 10.00	310,750	Square Feet
MECH	General Exhaust (Lab, Vivarium, Interstitial & Common)	\$ 1,864,500	\$ 6.00	310,750	Square Feet
MECH	Fume Exhaust	\$ 1,553,800	\$ 5.00	310,750	Square Feet
MECH	Cold Rooms	\$ 372,900	\$ 1.20	310,750	Square Feet
MECH	Warm Rooms	\$ 372,900	\$ 1.20	310,750	Square Feet
MECH	HVAC Controls/BAS	\$ 3,107,500	\$ 10.00	310,750	Square Feet
MECH	Test & Balance	\$ 932,300	\$ 3.00	310,750	Square Feet
MECH	Insulation	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Existing Building Conditions	\$ 2,796,800	\$ 9.00	310,750	Square Feet
MECH	Crane & Rigging	\$ 155,400	\$ 0.50	310,750	Square Feet
ELEC	Demolition	\$ 621,500	\$ 2.00	310,750	Square Feet
ELEC	Main Service	\$ 1,243,000	\$ 4.00	310,750	Square Feet
ELEC	Distribution	\$ 932,300	\$ 3.00	310,750	Square Feet
ELEC	Life Safety	\$ 621,500	\$ 2.00	310,750	Square Feet
ELEC	Critical Power	\$ 776,900	\$ 2.50	310,750	Square Feet
ELEC	Electrical/lighting	\$ 3,729,000	\$ 12.00	310,750	Square Feet
ELEC	Electrical/Branch Power	\$ 1,864,500	\$ 6.00	310,750	Square Feet
ELEC	Motor Control	\$ 621,500	\$ 2.00	310,750	Square Feet
ELEC	Phone/data communications	\$ 1,243,000	\$ 4.00	310,750	Square Feet
ELEC	Security/fire cabling	\$ 1,087,600	\$ 3.50	310,750	Square Feet
ELEC	Security Access Control	\$ 932,300	\$ 3.00	310,750	Square Feet
ELEC	Security CCTV	\$ 466,100	\$ 1.50	310,750	Square Feet
ELEC	Existing Building Conditions	\$ 1,398,400	\$ 4.50	310,750	Square Feet



NORTHWESTERN
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**Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion**

Chicago, IL

Job Number 11331-00

May 13, 2011 rev4 May 18, 2011

<u>Trade</u>	<u>System</u>	<u>Subtotal Cost</u>	<u>Unit Cost</u>	<u>Quantity</u>	<u>Units</u>
<u>Conversion Construction Cost</u>					
PLMB	Demolition	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Sanitary Waste	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Lab Waste	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Domestic Hot/Cold Water	\$ 621,500	\$ 2.00	310,750	Square Feet
PLMB	Laboratory Hot/Cold Water	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	High Purity Water	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Animal Water	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Lab Compressed Air	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Lab Vacuum	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Natural Gas	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Carbon Dioxide	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Fixtures	\$ 621,500	\$ 2.00	310,750	Square Feet
PLMB	Core Drilling	\$ 155,400	\$ 0.50	310,750	Square Feet
PLMB	Insulation	\$ 621,500	\$ 2.00	310,750	Square Feet
PLMB	Test & Balance	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Existing Building Conditions	\$ 1,087,600	\$ 3.50	310,750	Square Feet
Subtotal Cost Site & Building		\$ 98,682,800	\$ 317.56		
<u>Contingency</u>					
	Construction Contingency	15% \$ 14,802,420	\$ 47.63		
Subtotal Cost Site/Building & Contingency		\$ 113,485,220	\$ 365.20		
<u>Escalation</u>					
	Escalation (@ 3% per year for two years to Midpoint of construction)	6% \$ 6,809,113	\$ 21.91		
Total Conversion Cost		\$ 120,294,333	\$ 387.11		



Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion
Chicago, IL
Job Number 11331-00
May 13, 2011 rev4 May 18, 2011

<u>Trade</u>	<u>System</u>	<u>Subtotal Cost</u>	<u>Unit Cost</u>	<u>Quantity</u>	<u>Units</u>
<u>New Building Construction Cost</u>					
SITE	Excavation & Earthwork	\$ 1,320,700	\$ 4.25	310,750	Square Feet
SITE	Hardscape	\$ 1,786,800	\$ 5.75	310,750	Square Feet
SITE	Landscape	\$ 466,100	\$ 1.50	310,750	Square Feet
GC	General Conditions (Applied to All Trades)	\$ 7,101,100	\$ 7,101,100.00	1	Lump Sum
GC	Foundation	\$ 9,322,500	\$ 30.00	310,750	Square Feet
GC	Vertical Structure	\$ 7,768,800	\$ 25.00	310,750	Square Feet
GC	Horizontal Structure	\$ 8,079,500	\$ 26.00	310,750	Square Feet
GC	Exterior Cladding	\$ 3,247,800	\$ 30.00	108,260	Square Feet
GC	Doors & Windows	\$ 3,107,500	\$ 10.00	310,750	Square Feet
GC	Roofing, Thermal & Moisture Protection	\$ 3,107,500	\$ 10.00	310,750	Square Feet
GC	Interior Partitions	\$ 9,322,500	\$ 30.00	310,750	Square Feet
GC	Floor, Wall & Ceiling Finishes	\$ 3,107,500	\$ 10.00	310,750	Square Feet
GC	Casework	\$ 6,991,900	\$ 22.50	310,750	Square Feet
GC	Equipment	\$ 5,438,100	\$ 17.50	310,750	Square Feet
GC	Specialties	\$ 3,107,500	\$ 10.00	310,750	Square Feet
GC	Stairs	\$ 1,553,800	\$ 5.00	310,750	Square Feet
GC	Elevators	\$ 1,243,000	\$ 4.00	310,750	Square Feet
FP	Fire Protection	\$ 1,553,800	\$ 5.00	310,750	Square Feet
MECH	Steam & Condensate	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Heating Hot Water	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Chilled Water	\$ 2,175,300	\$ 7.00	310,750	Square Feet
MECH	Equipment (Lab, Vivarium, Interstitial & Common)	\$ 6,215,000	\$ 20.00	310,750	Square Feet
MECH	Supply Air (Lab, Vivarium, Interstitial & Common)	\$ 4,661,300	\$ 15.00	310,750	Square Feet
MECH	Return Air (Lab, Vivarium, Interstitial & Common)	\$ 3,729,000	\$ 12.00	310,750	Square Feet
MECH	General Exhaust (Lab, Vivarium, Interstitial & Common)	\$ 2,486,000	\$ 8.00	310,750	Square Feet
MECH	Fume Exhaust	\$ 1,553,800	\$ 5.00	310,750	Square Feet
MECH	Cold Rooms	\$ 372,900	\$ 1.20	310,750	Square Feet
MECH	Warm Rooms	\$ 372,900	\$ 1.20	310,750	Square Feet
MECH	HVAC Controls/BAS	\$ 3,729,000	\$ 12.00	310,750	Square Feet
MECH	Test & Balance	\$ 932,300	\$ 3.00	310,750	Square Feet
MECH	Insulation	\$ 1,243,000	\$ 4.00	310,750	Square Feet
MECH	Crane & Rigging	\$ 77,700	\$ 0.25	310,750	Square Feet
ELEC	Main Service	\$ 1,243,000	\$ 4.00	310,750	Square Feet
ELEC	Distribution	\$ 466,100	\$ 1.50	310,750	Square Feet
ELEC	Life Safety	\$ 621,500	\$ 2.00	310,750	Square Feet
ELEC	Critical Power	\$ 776,900	\$ 2.50	310,750	Square Feet
ELEC	Electrical/lighting	\$ 3,729,000	\$ 12.00	310,750	Square Feet
ELEC	Electrical/Branch Power	\$ 1,243,000	\$ 4.00	310,750	Square Feet
ELEC	Motor Control	\$ 388,400	\$ 1.25	310,750	Square Feet
ELEC	Phone/data communications	\$ 932,300	\$ 3.00	310,750	Square Feet
ELEC	Security/fire cabling	\$ 776,900	\$ 2.50	310,750	Square Feet
ELEC	Security Access Control	\$ 621,500	\$ 2.00	310,750	Square Feet
ELEC	Security CCTV	\$ 466,100	\$ 1.50	310,750	Square Feet
PLMB	Sanitary Waste	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Lab Waste	\$ 1,243,000	\$ 4.00	310,750	Square Feet
PLMB	Domestic Hot/Cold Water	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Laboratory Hot/Cold Water	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	High Purity Water	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Animal Water	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Lab Compressed Air	\$ 932,300	\$ 3.00	310,750	Square Feet



NORTHWESTERN
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Northwestern Memorial Hospital
Prentice Stone Women's Hospital Conversion
 Chicago, IL
 Job Number 11331-00
 May 13, 2011 rev4 May 18, 2011

<u>Trade</u>	<u>System</u>	<u>Subtotal Cost</u>	<u>Unit Cost</u>	<u>Quantity</u>	<u>Units</u>
<u>New Building Construction Cost</u>					
PLMB	Lab Vacuum	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Natural Gas	\$ 932,300	\$ 3.00	310,750	Square Feet
PLMB	Carbon Dioxide	\$ 310,800	\$ 1.00	310,750	Square Feet
PLMB	Fixtures	\$ 621,500	\$ 2.00	310,750	Square Feet
PLMB	Core Drilling	\$ 155,400	\$ 0.50	310,750	Square Feet
PLMB	Insulation	\$ 621,500	\$ 2.00	310,750	Square Feet
PLMB	Test & Balance	\$ 310,800	\$ 1.00	310,750	Square Feet
Subtotal Cost Site & Building		\$ 129,025,200	\$ 415.21		
<u>Contingency</u>					
	Construction Contingency	15% \$ 19,353,780	\$ 62.28		
Subtotal Cost Site/Building & Contingency		\$ 148,378,980	\$ 477.49		
<u>Escalation</u>					
	Escalation (@ 3% per year for two years to Midpoint of construction)	6% \$ 8,902,739	\$ 28.65		
Total New Building Construction Cost		\$ 157,281,719	\$ 506.14		

APPENDIX



ROLF JENSEN & ASSOCIATES, INC.
FIRE PROTECTION CONSULTANTS

600 West Fulton Street
Suite 500
Chicago, IL 60661 USA
www.rjainc.com
+1 312-879-7200
Fax: +1 312-879-7210

May 17, 2011

VIA ELECTRONIC MAIL: Robert.Lubalin@Jacobs.com

Mr. Robert Lubalin
Jacobs Consultancy, Inc.
303 South Broadway, Suite G20
Tarrytown, New York 10591

**ADAPTIVE REUSE OF THE FORMER PRENTICE WOMEN'S HOSPITAL
333 EAST SUPERIOR STREET – CHICAGO, ILLINOIS**

Dear Mr. Lubalin:

Rolf Jensen & Associates, Inc. (RJA) was asked to provide code consulting services related to an adaptive reuse study being conducted on the former Northwestern Memorial Prentice Women's Hospital at 333 East Superior Street.

Jacobs Consultancy (Client) has been retained by Northwestern Memorial Hospital (NMH) to investigate adaptive reuse of the existing building, with the intended transition from a healthcare occupancy to a laboratory occupancy. RJA has been asked to assist the Client by providing fire protection and life safety code consulting related to this potential change in occupancy. Our evaluation was limited to review of the Landmarks Illinois laboratory plans and plans developed by Jacobs Consultancy. These proposed plans were reviewed to the egress requirements of the 2011 edition of the Chicago Building Code (CBC). The plans were not reviewed to other applicable sections of the CBC unless these code sections related to egress. These other applicable sections include, but are not limited to, construction type, occupancy separations, storage and use of combustible and flammable liquids, and accessibility.

BASE BUILDING INFORMATION

The 13-story Bertrand Goldberg designed building was completed in 1974. The ground floor includes approximately 18,000 usable square feet with approximately 32,000 usable square feet on each of the 2nd, 3rd, and 4th floors. Currently, mechanical areas are on the 5th, 6th A and B levels. The 7th through 13th floors, in quatrefoil shape, each provide approximately 15,500 square feet of usable space. Until 2007, the building housed the Prentice Women's Hospital with exam rooms, offices, a labor and delivery unit, and patient rooms.



The building currently contains three stairways. Two stairways serve all floors (basement through the penthouse) and one stairway serves the basement through 4th floor. All three stairways discharge inside of the building on the ground floor, which is permitted by the CBC. Two of the three stairways discharge into a corridor and then to outside. One stairway discharges to a corridor which leads to an elevator lobby, then outside. Each existing stairway has an approximately 46 inch clear width, based on original building drawings. This clear width is equivalent to two units of exit width per the CBC.

Reusing the existing building as a laboratory space is one of the proposed new uses for the building. Laboratories are considered business occupancy (Group E) in the CBC. Based on the extent of proposed renovations, the building would need to comply with the CBC requirements for new construction. We understand that the building is proposed to be fully sprinkler protected in accordance with the CBC.

CBC EGRESS REQUIREMENTS

The following is a summary of some of the egress requirements applicable to the proposed reuse of the building. The requirements cited below are based on the building being provided with sprinkler protection throughout in accordance with the CBC. The CBC code sections are also noted.

- Travel Distance [10(13-160-140), 10(13-160-150)]
 - Business - 225 ft maximum travel distance
 - Assembly – 150 ft maximum travel distance
- Dead End Corridor 10(13-160-160) (50% of max travel)
 - Business - 112.5 ft
 - Assembly – 75 ft maximum dead end corridor
- 44 inch minimum corridor width [10(13-160-200), 10(13-160-220)]
- 44 inch minimum stairway clear width [10(13-160-200)]
- Within stairways, a minimum of 7-foot headroom is required [10(13-160-350)]
- Calculation of exit capacity [10(13-160-210)]
 - Doors, Corridors, Horizontal Exits – 90 people per unit of exit width
 - Doors, Corridors, Horizontal Exits in Assembly Units – 135 people per unit of exit width [3(13-84-180)(b)]
 - Stairs – 60 people per unit of exit width
 - Stairs in Assembly Units – 90 people per unit of exit width [3(13-84-180)(b)]
- Occupant load factors [3(13-56-310), 3(13-56-320)]
 - Business – 100 square feet per person
 - Storage – 300 square feet per person
 - Conference rooms, Classrooms, and Exhibit areas – 20 square feet per person
 - Table and Chairs – 15 square feet per person
 - Retail

- First Floor or Basement – 30 square feet per person
- Other Floors – 60 square feet per person

REVIEW OF THE LANDMARK ILLINOIS REUSE STUDY

RJA has reviewed a conceptual laboratory use plans illustrated on pages 8, 12, and 13 in the Landmarks Illinois report, dated April 2011. The following is a summary of the occupant load calculations, exit capacity, exit paths, and travel distances. The approximated floor areas noted below were based on the graphical scale of the drawings and therefore floor areas and corresponding occupant loads are approximate.

- Occupant load on typical floors based on approximate gross areas*
 - Floor 1 (Ground) – ~500 people
 - Retail - ~177 people (5,300 sqft)
 - Lounge/Recreation – 303 people (4,500 sqft)
 - Office and Storage – 20 people (2,000 sqft)
 - Floor 2 – ~833 people
 - Classrooms, conference rooms, and cafeteria - ~733 people (11,500 sqft)
 - Laboratory and offices - ~100 people (10,000 sqft)
 - Floor 3 - ~726 people
 - Classrooms and conference rooms - ~600 people (12,000 sqft)
 - Retail - ~25 people (1,500 sqft)
 - Laboratory and offices - ~101 people (10,000 sqft)
 - Floor 4 - ~726 people
 - Classrooms and conference rooms - ~600 people (12,000 sqft)
 - Retail - ~25 people (1,500 sqft)
 - Laboratory and offices - ~101 people (10,000 sqft)
 - Floors 7 through 13 - ~232 people**
 - Collaborative space - ~124 people (2,500 sqft)
 - Laboratory and offices – ~108 people (10,800 sqft)

*Gross floor areas noted do not include restrooms and shafts

**Number of calculated occupants noted is per each floor

- Exit capacity
 - Floor 1 – There are approximately six exits shown at the ground floor. The number of exits and exit capacity of Floor 1(Ground) appears to be adequate based on the calculated number of occupants.
 - Floor 2
 - The two existing stairways appear to be two units of exit width each and the two new stairs appear to be 1.5 units of exit width each. With a total of seven units of exit width, and using the assembly factor of 90 people per unit of exit width, the total exit capacity is 630 people. The number of exits appears adequate, but the exit capacity of Floor 2

- does not appear to be adequate based on the calculated number of occupants.
 - Even with using the assembly factor for stairways, the exit capacity is exceeded by the calculated number of occupants. An additional 2.5 units of exit width (56 inches clear width) would be required to accommodate the occupants on this floor.
 - In order to use assembly factor for stairways, the entire floor would need to be considered assembly use. This would require meeting the requirements for assembly use which includes, but is not limited to,:
 - Limiting travel distance on this floor to 150 feet
 - Providing fire rated separation of assembly spaces (classrooms and cafeteria)
 - Providing fire rated corridors
- Floors 3 and 4
 - The capacity of exits on Floors 3 and 4 appears identical to that on Floor 2 if the entire floor is treated as an assembly. As with Floor 2, the number of exits appears to be adequate but the exit capacity of Floors 3 and 4 does not appear to be adequate based on the calculated number of occupants.
 - To accommodate the occupants on Floors 3 and 4, the new stairways would need to be increased by 1.5 units of exit width (34 inches of clear width). These floors also require use of the stairway assembly factor and would therefore need to meet all the requirements for assembly uses.
- Floors 7 through 13
 - The two existing stairways appear to be two units of exit width each, having a total capacity of 240 occupants per floor. The number of exits and exit capacity for each of Floors 7 through 13 appears to be adequate based on the calculated number of occupants. However, the calculated number of occupants is very close to the maximum exit capacity. Additional assembly use space in the tower floors should be limited.
- Exit paths and travel distances
 - The maximum travel distances and maximum dead end corridor distances on the Ground Floor, Floor 2, and Floors 7 through 13 appear to comply with the CBC.
 - On Floors 3 and 4, dead end corridors and travel distances are in excess of the maximum allowed due to the location of existing stairways within laboratory space.
 - The plans to locate the two existing stairways within laboratory space on Floors 2, 3, 4, and Floors 7 through 13 also creates an additional issue. An occupant's path to an exit should not require passage from a lower hazard area to a high hazard area. A laboratory space would be considered a higher hazard as compared with office, classroom, or meeting spaces.

- On Floors 2, 3, and 4, access to the existing stairways is required to allow occupants to exit without passing into a laboratory space and provide adequate exit capacity on these floors.
 - On Floors 7 through 13, occupants in the collaborative space and elevator lobby must be provided access to two exits without passing through a laboratory space. Since each exit stairway has two entrances, a corridor arrangement could be developed to reclaim lab space in diagonally opposing laboratories and meet this requirement.
- Minimum ceiling height
 - The CBC requires an 84 inch minimum headroom in exit enclosures [10(13-160-350)]. The CBC does not address minimum ceiling height in corridors or other building locations.

REVIEW OF PROPOSAL B

RJA has also reviewed conceptual laboratory use plans illustrated developed by Jacobs Consultancy, named Proposal B. The plans have many similarities to the Landmarks Illinois plans with some exceptions. Notably, Proposal B uses alternating floors in the tower as laboratory space, with other floors as interstitial mechanical space. The following is a summary of the occupant load calculations, exit capacity, exit paths, and travel distances for Proposal B. For ease of comparison with the Landmarks Illinois plan, the floor numbers shown below will match the Landmarks plan and will not match those shown in Proposal B. As an example, Proposal B names the first floor above the ground “1st Floor” while the Landmarks Illinois document names the first floor above ground “2nd Floor”. The approximated floor areas noted below were based on the graphical scale of the drawings and therefore floor areas and corresponding occupant loads are approximate.

- Occupant load on typical floors based on gross areas*
 - Floor 1 (Ground) – ~249 people
 - Exhibit and Meeting - ~170 people (3,400 sqft)
 - Laboratory– 58 people (5,800 sqft)
 - Office – 21 people (2,100 sqft)
 - Floor 2 – ~290 people
 - Meeting Rooms - ~32 people (640 sqft)
 - Laboratory and offices - ~65 people (6,500 sqft)
 - Vivarium - ~193 people (19,300 sqft)
 - Floor 3 - ~162 people
 - Meeting Rooms - ~32 people (640 sqft)
 - Laboratory and offices - ~65 people (6,500 sqft)
 - Mechanical (Interstitial) - ~65 people (19,500 sqft)
 - Floor 4 - ~329 people
 - Conference rooms - ~110 people (2,200 sqft)
 - Laboratory and offices - ~219 people (21,900 sqft)
 - Floors 6, 8, and 10 - ~128 people**

- Conference room - ~13 (260 sqft)
- Laboratory and offices – ~115 people (11,500 sqft)

*Gross floor areas noted do not include restrooms and shafts

**Number of calculated occupants noted is per each floor

- Exit capacity
 - Floor 1 – There are approximately three exits shown at the ground floor. The number of exits and exit capacity of Floor 1 (Ground) appears to be adequate based on the calculated number of occupants.
 - Floor 2
 - The three existing stairways appear to be two units of exit width each. With a total of six units of exit width, and using the use factor of 60 people per unit of exit width, the total exit capacity is 360 people. The number of exits and exit capacity of Floor 2 appear to be adequate based on the calculated number of occupants.
 - The assembly use factor is not required to be used on this floor in the proposed configuration.
 - Floors 3 and 4
 - The capacity of exits on Floors 3 and 4 appears to be identical to that on Floor 2. The number of exits and exit capacity of Floors 3 and 4 appear to be adequate based on the calculated number of occupants.
 - Floors 6, 8, and 10
 - The two existing stairways appear to be two units of exit width each, having a total capacity of 240 occupants per floor. The number of exits and exit capacity for each of Floors 6, 8 and 10 appears to be adequate based on the calculated number of occupants.
- Exit paths and travel distances
 - The maximum travel distances and maximum dead end corridor distances on all Proposal B floors appear to comply with the CBC.

Please contact the undersigned with questions.

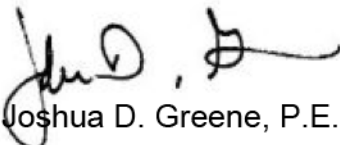
Sincerely,

ROLF JENSEN & ASSOCIATES, INC.

Prepared by:


John H. Mammoser, P.E. (IL)

Reviewed by:


Joshua D. Greene, P.E. (IL)

JHM/JDG: tj



NIH Porter Neuroscience Research Center
Bethesda, MD



New York University, Smilow Research
Center
New York, NY



University of Massachusetts, Aaron Lazare
Medical Research Building
Worcester, MA

Robert Lubalin

- **Centers for Disease Control and Prevention, Infectious Disease Laboratory - Building 17**, Atlanta, GA. 300,000 GSF / 180,000 NSF biomedical research building.
 - **Emory University, Winship Cancer Research Institute**, Atlanta, GA. 240,000 GSF/145,000 NSF biomedical research facility.
 - **Harvard Institutes of Medicine, Renovation of Boston English High School**, Boston, MA. 17,000 NSF biomedical research facility.
 - **National Institutes of Health, John Edward Porter Neuroscience Research Center**, Bethesda, MD. 619,000 GSF / 316,000 NSF neuroscience, biomedical research building.
 - **National Institutes of Health, The Louis Stokes Laboratories - Building 50**, Bethesda, MD. 257,000 GSF/151,000 NSF biomedical research facility.
 - **New York University School of Medicine, Joan and Joel Smilow Research Center**, New York, NY. 230,000 GSF / 120,000 NSF biomedical research facility.
 - **Rockefeller University, Collaborative Research Center**, New York, NY. 250,000 GSF / 130,000 NSF biomedical research facility.
 - **The Ohio State University, Biomedical Research Tower**, Columbus, OH. 400,000 GSF / 264,000 NSF biomedical research facility.
 - **The Van Andel Institute, Phase 1**, Grand Rapids, MI. 400,000 GSF / 264,000 NSF biomedical research facility.
 - **University of Maryland, MBI Medical Biotechnology Center**, Baltimore, MD. 206,222 GSF biomedical research facility.
 - **University of Massachusetts School of Medicine, Aaron Lazare Medical Research Building**, Worcester, MA. 340,000 GSF / 229,000 NSF biomedical research facility.
 - **University of Massachusetts School of Medicine, Albert Sherman Center**, Worcester, MA. 532,484 GSF / 392,268 NSF biomedical research building.
 - **University of Cincinnati, Center for Academic and Research Excellence (CARE)/ Crawley Building**, Cincinnati, OH. 240,000 GSF / 144,000 NSF biomedical research facilities.
 - **University of South Carolina, Discovery 1 Biomedical Research Building**, Columbia, SC. 112,600 GSF / 72,000 NSF biomedical research building.
 - **University of California, Seismic Replacement Research Bldg. 2 / J. Vernon Luck Sr., M.D. Research Laboratories**, Los Angeles, CA. 225,000 GSF / 128,000 NSF biomedical research building.
-



Columbia University, Mind, Brain and Behavior Building
New York, NY



Memorial-Sloan Kettering Cancer Center, Zuckerman Research Center
New York, NY



Mount Sinai School of Medicine, Center for Science & Medicine
New York, NY

Josh Meyer.

- **Children’s Hospital of Philadelphia, South Campus Research Facility**, Philadelphia, PA. 738,000 GSF / 435,000 NSF biomedical research facility
- **Columbia University, Mind, Brain and Behavior Building**, New York, NY. 432,730 GSF / 237,170 NSF biomedical research facility and 38,070 NSF) multi-level vivarium facilities.
- **Dana-Farber Cancer Institution, Longwood Center Tenant Fit-Out**, Boston, MA. 150,000 GSF biomedical research building.
- **Emory University, Health Science Research Building**, Atlanta, GA. 204,155 GSF / 119,428 NSF biomedical research building.
- **Memorial Sloan-Kettering Cancer Center, Mortimer B. Zuckerman Research Center**, New York, NY. 693,000 GSF / 374,000 NSF biomedical research facility.
- **Mount Sinai School of Medicine, Center for Science and Medicine**, New York, NY. 423,093 GSF/ 239,434 NSF biomedical research facility.
- **Oregon Health & Science University, Biomedical Research Building**, Portland, OR. 270,719 GSF / 140,000 NSF biomedical research building.
- **The Johns Hopkins School of Medicine, Broadway Research Building**, Baltimore, MD. 363,000 GSF / 190,000 NSF biomedical research building.
- **University of California, Los Angeles, Seismic Replacement Research Building 1**, Los Angeles, CA. 133,333 GSF / 78,000 NSF biomedical research facility.
- **University of California, San Francisco, Helen Diller Family Cancer Research Building**, San Francisco, CA. 163,865 GSF biomedical research facility.
- **University of Colorado Health Sciences Center, Research Complex 1 & Research Complex 2**, Denver CO. 600,640 GSF / 385,237 NSF biomedical research facility.
- **University of Michigan Medical School, Biomedical Science Research Building**, Ann Arbor, MI. 492,000 GSF / 279,000 NSF biomedical research facility.
- **University of Minnesota, Biomedical Discovery District Phase 2**, Minneapolis, MN. 263,000 GSF / 145,800 NSF biomedical research facility.
- **University of Pennsylvania Health System, Translational Research Building**, Philadelphia, PA. 445,000 GSF / 293,500 NSF biomedical research facility.



University of Pittsburgh, Biological Science Tower3, Pittsburgh, PA



Weill Cornell Medical College, Medical Research Building New York, NY

- **University of Pittsburgh, Biological Science Tower 3**, Philadelphia, PA. 330,000 GSF / 212,000 NSF biomedical research facilities.
- **University of Michigan Medical School, Biomedical Science Research Building**, Ann Arbor, MI. 492,000 GSF / 279,000 NSF biomedical research facility.
- **University of Pittsburgh Medical Center (UPMC), Pittsburgh Children’s Hospital Research Building**, Pittsburgh, PA. 230,000 GSF / 117,930 NSF biomedical research facility.
- **University of Rochester Medical Center, Arthur Kornberg Medical Research Building**, Rochester, NY. 290,000 GSF/196,000 NSF biomedical research facility.
- **University of Wisconsin, Wisconsin Institutes of Medical Research**, Madison, WI. 445,000 GSF / 267,000 NSF biomedical research facility.
- **Washington University, McDonnell Pediatrics Research Building**, St. Louis, MO. 226,000 GSF/154,000 NSF biomedical research facility.
- **Weill Cornell Medical College, Medical Research Building**, New York, NY. 500,000 GSF / 261,762 NSF biomedical research facility.

Representative Research Facility Experience



Northwestern University,
Molecular Therapeutics and
Diagnostics Building
Evanston, IL



The University of Chicago
Gwen and Jules Knapp Center for
Biomedical Discovery
Chicago, IL



Penn State University,
Millennium Science Complex
State College, PA

- **Northwestern University, Richard and Barbara Silverman Hall for Molecular Therapeutics and Diagnostics**, Evanston, IL. Structural design of a LEED Silver, 175,000-square-foot facility, composed of two four-story concrete laboratory buildings with one basement level, linked by a two-story-high structural steel office-wing bridge. The facility features an imaging center; core facilities for therapeutics, diagnostics and proteomics; state-of-the-art wet and dry research laboratories; conference space; and offices for faculty and staff.
- **The University of Chicago, Gwen and Jules Knapp Center for Biomedical Discovery**, Chicago, IL. Structural engineering of an award-winning 330,000-square-foot, 10-story concrete building that includes laboratory, laboratory support and office space. The building accommodates the wet laboratory programs of the departments of medicine and pediatrics, and cancer research.
- **Yale University, Biology Building**, New Haven, CT. Structural design of a LEED Gold, six-story, 295,690-square-foot building that consolidates the university's molecular, cellular, and developmental biology research functions. The below-grade area accommodates a two-level vivarium with interstitial service and mechanical area, and has strict vibration criteria set for laboratory levels.
- **Yale University, Malone Engineering Center**, New Haven, CT. Structural design of a LEED Gold, five-level flat-plate concrete building that houses biomedical, chemical and mechanical engineering programs.
- **Cornell University Physical Sciences**, Ithaca, NY. Structural design of a six-story 197,000-gross-square-foot state-of-the-art facility that houses laboratories and offices and provides research and instructional spaces for the departments of chemistry and chemical biology, physics, and engineering physics.
- **Penn State University, Millennium Science Complex**, State College, PA. Structural design for a four-story, 266,150-square-foot facility to house life and materials science programs. The building will include a structurally isolated quiet space with low acoustic and electromagnetic noise, suitable for future generations of instruments.
- **Rutgers University, Barlett Hall**, New Brunswick, NJ. Structural design for an expansion to develop a new biomedical research complex that houses endocrine research laboratories in one central facility. The extension includes eight laboratories, offices, and equipment rooms.
- **University of Oregon, Science Center**, Eugene, OR. Structural engineering services for four new buildings and renovated spaces among existing campus buildings. The science programs housed in this new complex include the Institute of Molecular Biology, computer and information science, geology, and physics. The project included a major addition and renovation to the science library.
- **Stanford University, School of Medicine, Richard M. Lucas Center for Magnetic Resonance Spectroscopy and Imaging Expansion**,

Representative Research Facility Experience

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University of Pennsylvania Health System,
Fisher Translational Research Center
Philadelphia, PA



Virginia Tech, Institute for Critical
Technologies and Applied Sciences,
Blacksburg, VA



Massachusetts Institute of Technology
Lincoln Laboratory
Lexington, MA

Stanford, CA. Structural design of an award-winning, two-story, 26,000-square-foot subterranean medical research laboratory. The building houses Tesla magnetic resonance and cyclotron imagers, a hot laboratory, and offices. Supporting laboratories and office spaces are provided for medical research staff. It is constructed with 35-foot-tall retaining walls supported installed with permanent tie-back anchors.

- **University of Pennsylvania Health System, Fisher Translational Research Center**, Philadelphia, PA. Structural design for two buildings including a five-story clinical building and a seven-level research facility. Two floors of the research building are dedicated to vivarium use, while the upper levels house laboratory space. A 33-foot-high mechanical plant floor separates the two sections of the building and supports a shift in column-module size that maximizes the efficiency of the laboratory areas.
- **University of Pennsylvania, Ruth and Raymond Perelman Center for Advanced Medicine**, Philadelphia, PA. Structural design of a new three-story, 600,000-square-foot facility. The building houses a cancer treatment center and clinical research program.
- **Virginia Tech, Institute for Critical Technologies and Applied Sciences**, Blacksburg, VA. Structural design of a four-level, 100,000-square-foot research facility to house flexible laboratory, utility, office, and teaching areas. The building serves researchers in bioengineering, biomaterials, nanotechnology, communications technology, and sensor technology. The building was designed to foster collaboration by providing contiguous workspace for researchers from different disciplines. A critical component is a structural system with sufficient vibration damping characteristics to meet the demands of sensitive research equipment.
- **Vanderbilt University Medical Center Addition and Research Laboratory**, Nashville, TN. Structural engineering services for the addition of a rehabilitation center, a cancer center, and 535,000-square-foot ambulatory care center to an existing 12-story medical center. Project scope included a nine-story, 175,000-square-foot medical research laboratory that houses up to 250 pathologists, laboratory technicians, house staff members, and office personnel. The medical center can now perform more than 560 different tests and intensive research.
- **The University of Chicago, William Eckhardt Research Center**, Chicago, IL. Structural engineering services for a 260,000-square-foot laboratory building. The project provides new space to support research in the departments of astronomy and astrophysics; physics; and computer science; and four interdisciplinary institutes, the James Franck Institute; the Enrico Fermi Institute; and the Kavli Institute in Cosmological Physics and Computation. The scope includes a new molecular engineering department with a cleanroom.
- **Harvard University, Undergraduate School of Science**, Cambridge, MA. Structural design of nine floors for physics and chemistry laboratories, dining facilities and auditoriums plus a six-story wing of classrooms and administrative offices.
- **Harvard University, Mallinckrodt Laboratory Renovation**, Cambridge, MA. Structural engineering services for complete replacement of

Representative Research Facility Experience

Page 3 of 3



National Institutes of Health,
The John Edward Porter Neuroscience
Research Center
Bethesda, MD



Howard Hughes Medical Institute,
Janelia Farm Research Campus
Ashburn, VA



Photo courtesy Rafael Viñoly Architects
Van Andel Institute Cancer Research Facility
Phase II
Grand Rapids, MI

mechanical and electrical systems, as well as the modernization of the laboratories and creation of new office spaces.

- **University of Pennsylvania Health System, Roberts Proton Therapy Center**, Philadelphia, PA. Structural design for a 120,000-square-foot building designed for innovative radiation therapy. The four-level facility houses a 220-ton particle accelerator and three 40-foot treatment gantries. The structure uses thick reinforced concrete slabs and walls to provide radiation shielding and also to support a 13-story research tower that is to be constructed above
- **Massachusetts Institute of Technology, Lincoln Laboratory Master Plan Expansion Program**, Lexington, MA. Structural engineering services for a new, five-level, 525,000 SF laboratory building; site development; chiller plant expansion; and upgrade and capacity enlargement of the steam generation boiler plant.
- **National Institutes of Health, The John Edward Porter National Neuroscience Research Center**, Bethesda, MD. Structural design of a 560,000-square-foot laboratory building that houses scientists from all clinical departments of neurology, psychiatry, neuro-surgery, medicine and anesthesiology. The building facilitates parallel research and includes 210,000 square feet of bench laboratory, laboratory support space, laboratory office space, a vivarium, a 400-seat auditorium, meeting rooms, a cafeteria, and a supply store.
- **Howard Hughes Medical Institute, Janelia Farm Research Campus**, Ashburn, VA. Structural design of a new 750,000-square-foot biomedical facility for research focused on neuronal networking and imaging that houses a staff of 200 to 300 scientists. The campus includes laboratories, a vivarium, meeting rooms, and education and support spaces.
- **Van Andel Institute Cancer Research Facility Phase II**, Grand Rapids, MI. Structural design of a 250,000-square-foot expansion that accommodates more than 50 laboratories in an open layout. Each floor includes autoclave rooms, environmental rooms, microscopy and tissue culture spaces, and unallocated research space. The facility includes a cafeteria, conference center, demonstration laboratory and a library.
- **U.S. Department of Energy, Argonne National Laboratory, Advanced Protein Crystallization Facility**, Argonne, IL. Structural engineering services for a 28,955-assignable-square-foot advanced biological research facility.
- **U.S. Department of Energy, University of California, Berkeley, Lawrence Berkeley National Laboratory, Computational Research and Theory Facility (CRTF)**, Berkeley, CA. Structural design of 180,000-square-foot facility with 60,000 square feet of long span computer laboratories, 90,000 square feet of offices and conference facilities, and a central plant. Design challenges included a 70-foot-high retaining wall system, 100-foot spans and heavily perforated diaphragms below computer floors.

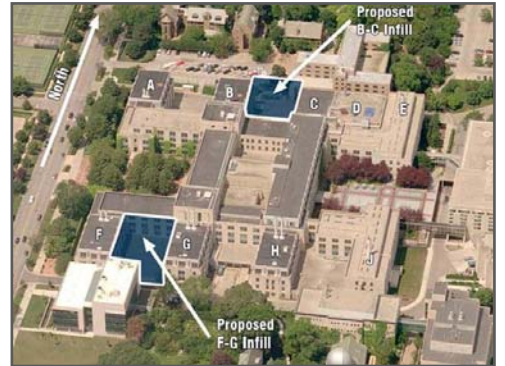
SCIENCE + TECHNOLOGY EXPERIENCE

Affiliated Engineers, Inc.

Northwestern University Technological Institute B-C and F-G Wings Infill

Evanston, Illinois

AEI provided MEP/T/I&C, lighting, and sustainable design services for this 100,000 square foot infill project. The 50,000 square foot B-C infill's first two stories house the relocated Integrated Molecular Structure Education and Research Center; three upper stories of mixed-use labs support the Engineering Life Science's research. The 50,000 square foot F-G infill includes a 6,000 square foot H5 Class 100 electronics clean room requiring a high air change rate, constant 45 per cent relative humidity year round using campus utilities, and individual room temperature control. To meet these challenges, AEI provided an additional full interstitial mechanical floor dedicated to support of this clean room. The remaining three floors are dedicated to dry laboratories used primarily by the Department of Earth and Planetary Science. The project is registered for LEED Silver certification.



Northwestern University Silverman Hall for Molecular Therapeutics and Diagnostics

Evanston, Illinois

This 147,000 square foot facility brings together researchers and staff in 17 research groups from the physical sciences, engineering, and life sciences to address fundamental questions in biomedical research and to develop new medicines and diagnostics. In addition to wet and dry labs, cutting edge instrumentation for imaging, proteomics and genomics, synthesis, computational bioinformatics, robotic screening, and drug discovery is housed in shared facilities to encourage multidisciplinary collaboration.

AEI provided MEP/FP/IT/I&C, lighting, and sustainability design services for this facility. AEI's sustainable design elements included water use reduction, optimized and minimum energy performance, CFC reduction, ozone depletion and work on minimum indoor air quality performance. Other sustainable design features are carbon dioxide monitoring, increased ventilation effectiveness, thermal comfort, and water efficiency performance.



Northwestern received a LEED Gold rating for this facility.

The University of Chicago

Gwen and Jules Knapp Center for Biomedical Discovery

Chicago, Illinois

This 330,760 sf, 10-story, state-of-the-art translational research facility houses the Departments of Medicine and Pediatrics, as well as the Cancer Research Center. AEI participated in the programming, concept development, and MEP/Lighting design services for the facility. The programming and concept development effort included creation of the space program, the building concept, and evaluation of three potential building sites. Key areas in the building include laboratories for protein and peptide structure, flow cytometry, mass spectrometry, nucleic acid research, DNA sequencing and genomics and microscopy research. Researchers have access to linear equipment rooms; computational lab space; environmental and procedure rooms; and a full-floor, 30,000 square foot vivarium. The facility also contains auditorium space, meeting rooms, laboratory and support space.



The University of Chicago

William Eckhardt Research Center

Chicago, Illinois

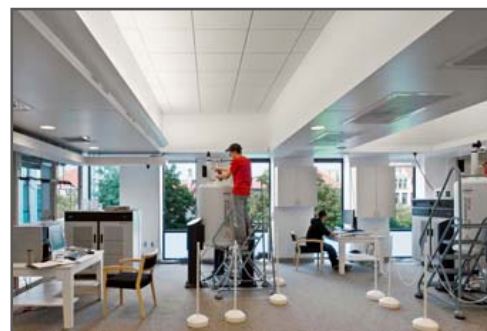
The 265,000 square foot William Eckhardt Research Center will host a broad spectrum of 21st-century science, from investigation of the deepest cosmic mysteries to manipulations of matter on the scale of atoms and molecules, and houses offices, conference rooms, and laboratories for the Division of Physical Sciences units, including the Astronomy and Astrophysics Department, the Kavli Institute for Cosmological Studies, and the Enrico Fermi Institute. The building will also house the University's new program in Molecular Engineering providing a clean room and specialized laboratory and imaging facilities. Precision will characterize the science that goes on within the Eckhardt Center; thus, demanding tight controls of the mechanical systems supporting the building. The two basement levels will contain specially designed, vibration-dampening space for clean rooms and molecular imaging. AEI was selected to design MEP/Controls systems, as well as implement sustainability initiatives related to the LEED Gold certification goal.

The University of Chicago

Searle Chemistry Laboratory Renovation

Chicago, Illinois

The substantial renovation of the 90,236 square foot Searle building accommodates the expansion of the Department of Chemistry from 21 to 25 faculty members, and provides space for synthetic chemistry laboratories and two large suites for instrumentation (NMR spectroscopy and mass spectrometry), all while fostering cross-disciplinary human interaction. In addition, the building provides a temporary home for the Computation Institute while its new facilities are designed and constructed. AEI provided M/E/AV design services for the project which achieved LEED Gold EB certification.



**City University of New York
Advanced Science Research Center**

New York, New York

AEI completed the development of a master plan for the entire South Campus of CCNY, including all existing buildings and the three new buildings proposed for the science complex (CCNY Science, ASRC I and ASRC II). The severely constricted site consists of 760,000 square feet of space. AEI was also retained to provide MEP design services for Phase I, including the design of thermal and electrical utilities serving the new science complex. The two, 200,000 square foot buildings house and facilitate high-end research by CUNY faculty in five key and emerging scientific disciplines: photonics, nanotechnology, water and environmental sensing, structural biology and neuroscience. The buildings will house a laboratory and vivarium, along with meeting, conference, and break rooms.



**Stony Brook University
Advanced Energy Research and Technology Center (AERTC)**

Stony Brook, New York

The 50,000 square foot AERTC is a cooperative effort between Stony Brook University and participating institutions, industrial partners, and federal laboratories to provide space for research on various types of alternative fuels and fuel sources. Due to the types of research conducted in this facility, the client desired this building to be a symbol of energy conservation and set a goal of a LEED Platinum rating. AEI's MEP design includes many energy efficient and conserving systems including: chilled beams, heat wheels, solar thermal systems, photovoltaics, low flow fume hoods, and daylighting.



**Memorial Sloan-Kettering Cancer Center
Mortimer B. Zuckerman Research Center**

New York, New York

Situated on a tight urban space, this 23-story, 692,000 square foot facility provides maximum flexibility and efficiency in a new state-of-the-art laboratory environment. Realizing a need for more research space and with a plan in place to add 50 new researchers over the next 5-10 years, the new facility supports immunology, computational biology, molecular pharmacology and chemistry, cancer biology and genetics, human oncology, pathogenesis, high-throughput screening, molecular cytology, molecular cytogenetics, and nuclear magnetic resonance. Conference and break rooms on every floor promote researcher interaction. AEI provided engineering systems planning and design to support this new facility. Incorporating features of sustainable design, the facility includes an energy recovery system, an onsite recycling program, digital control of the ventilation systems, daylighting and no CFC refrigerants. The masonry and glass building was treated with a special silk-screen process called fritting that controls light that enters the building, as well as the amount of light it emits.



University of Minnesota
Physics and Nanotechnology Building

Minneapolis, Minnesota

AEI was selected to provide sustainable MEP pre-design and design services for this 154,237 square foot building housing the physics research program and the Center for Nanostructure Applications. The laboratory space is flexible, with adequate utilities, environmental controls, and modern safety provisions to accommodate the needs of evolving research programs. Some of the rooms are equipped with special environmental controls, clean and standby power, electromagnetic shielding, and vibration isolation. A helium liquefier and recovery system serves labs equipped with helium recovery capability. Multiple meeting rooms are equipped with modern A/V and teleconferencing (audio and IP-based video), and wired and wireless connectivity for laptops.

University of Minnesota
McGuire Translational Research Facility

Minneapolis, Minnesota

A collaborative environment was the goal of this facility which houses 33 new researchers and could potentially generate more the \$17 million of additional federal and private research dollars for the University. Researchers from The Stem Cell Institute, the College of Pharmacy's Orphan Drug Center, and the new Center for Infectious Disease and Microbiology Translation Research call the TRF home. Emerging and catastrophic diseases are studied in the new 96,300 square foot facility, including Alzheimer's, AIDS, Parkinson's, diabetes, cancer, epilepsy, and malaria. The School of Pharmacy utilizes part of the top floor to investigate drugs for orphan diseases; a substantial portion of two floors are dedicated to stem cell research. Support spaces include a 9,500 square foot vivarium, frog colony, culture hoods, tissue culture and incubators, procedural suites, and office space. AEI provided MEP/FP/lighting design services.



University of Minnesota
Winston and Maxine Wallin Medical Biosciences Building

Minneapolis, Minnesota

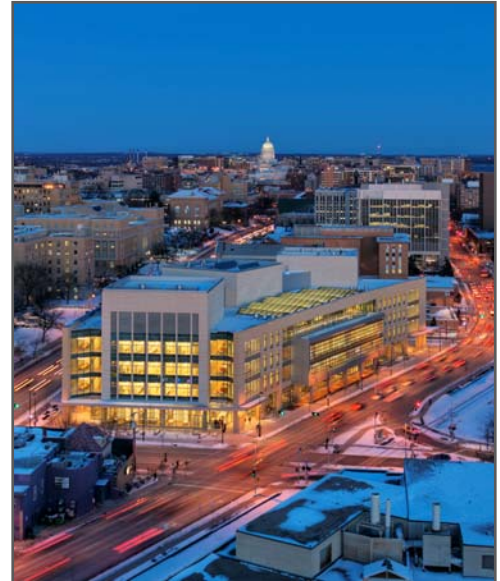
At 114,723 square feet, this clinical research facility (a 'sister' to the above mentioned TRF) provides space for infectious disease, immunology, neuroscience, and cancer research, and accommodates 36 lead researchers and their support staffs. Support space includes two vivaria – one ABSL-3 and one BSL-2, conference rooms, and offices. AEI designed MEP/FP systems for this building which is home to world-leading research programs in Alzheimer's disease, ataxia, and other neurodegenerative and neuromuscular diseases such as muscular dystrophy, Parkinson's disease, and ALS (Lou Gehrig's disease).



**University of Wisconsin
Wisconsin Institutes for Discovery**

Madison, Wisconsin

The 300,000 square foot Wisconsin Institutes for Discovery (WID) was created to address critical challenges in the life sciences, beginning with translational and multidisciplinary research, and resulting in products, companies, and jobs that address real human and market needs. WID houses a private research institute, Morgridge Institute for Research, and the public Wisconsin Institute for Discovery. Together these institutes allow access to funding and talent from both the public and private sectors, which is a critical paradigm for accelerating scientific innovation. The two institutes pursue research in: regenerative biology, virology, medical devices, pharmaceutical informatics, core computational technology, education, epigenetics, virtual living environments, tissue engineering, optimization, and systems biology. AEI provided conceptual planning and programming and the M/E/Controls/sustainable/lighting design. Registered for LEED Gold.



**University of Wisconsin
Engineering Centers**

Madison, Wisconsin

AEI provided programming, planning and MEP/IT/Lighting design services for this 204,000 square foot, state-of-the-art teaching/learning environment that supports the College of Engineering's vision for the integration of education and research. The building allows students to learn in an innovative environment that incorporates different engineering disciplines into one space and allows students to begin to utilize hands-on skills beginning in their freshman year. This facility houses space for both student centers and research centers, including nano material, nano fabrication, plasma manufacturing, common labs, biomedical research, Class 10, 100, 1,000 and 10,000 clean rooms, trace centers and an automotive and engine dyno room. The building has a 10,000 square foot semiconductor clean room area, with a space classification of Class 10 for highly toxic gases.



**University of Wisconsin
Biochemistry Building II**

Madison, Wisconsin

The 275,200 square foot Biochemistry II Building includes laboratories for 20 research groups; animal quarters; four tiered lecture halls with seating for 400, 180, 130 and 75; three 36-seat classroom-style meeting rooms; three biochemistry instruction laboratories; administrative space, and a variety of specialized equipment and support facilities. The facility also accommodates offices for the national NMR structural database which is accessed by researchers throughout the world.



University of Kansas

Measurement, Materials, and Sustainable Environment Center

Lawrence, Kansas

KU is constructing a three-story, 47,000 square foot engineering building devoted exclusively to green technologies research. This facility houses research activities from the earliest phases of innovation to their maturity, which enables market sectors to deploy sustainable technologies that have been tested, measured, and verified. AEI contributed MEP programming and design, which provides advanced energy monitoring and control capabilities for the building management system. AEI's previous experience in test cell/servo-hydraulics and electromagnetic interference, anechoic, reverberation, and phase change material rooms all contributed expertise to this project's programming. AEI is designing the facility to the equivalent of LEED Silver certification.



University of Nevada-Las Vegas

Science, Engineering and Technology Building

Las Vegas, Nevada

UNLV has built a new academic research complex that provides an interactive environment for collaborative research in both science and engineering. AEI provided MEP/lighting design and commissioning services for this state-of-the-art, multifunctional lab building and an associated central plant building. The 196,000 square foot facility features five themed research labs: Information, Data and Communications Technology; Arid Lands Environmental Science, Policy and Engineering; Energy and Material Science and Engineering, Entertainment; and Convention Technology and Engineering; and Shared Ground Floor Theme Lab



North Carolina State University

Engineering Buildings I, II & III

Raleigh, North Carolina

AEI was selected to provide master planning and MEP design services for three new engineering facilities. Engineering Building I at 157,000 square feet includes the chemical and materials engineering departments. Support areas include large and small seminar rooms, lab support, offices and a central atrium. This mixed-use facility, where hazardous production laboratories make up 15 of the 45 laboratories, required an MEP system that incorporates flexibility to allow for future change and redundancy to ensure human safety and to protect research integrity. Engineering Building II is 210,000 square feet and includes electrical and computer engineering. The design accommodates computer and robotic lab. Additional building spaces include large teaching auditoriums, various sized meeting and instructional spaces, graduate student labs and faculty offices. Engineering Building III provides 100,000 square feet of space for mechanical and aerospace engineering and biomedical engineering.



Purdue University
Bindley Bioscience Center

West Lafayette, Indiana

The 50,000 square foot biomedical engineering building is the functional anchor of the University's new Discovery Park. The building is in close proximity to key biology, bioprocessing, and veterinary medical capabilities as well as planned nanotechnology and biosciences research facilities. Students learn engineering science, analysis and design solely in the context of biology, physiology, genomics, proteomics, bioinformatics, instrumentation development and medicine. Researchers engage in interdisciplinary, cutting-edge research in fields such as intelligent biomaterials, genomics, proteomics, cellular engineering, tissue and biomedical engineering. AEI designed the MEP systems.



University of California
Hearst Memorial Mining Building

Berkeley, California

AEI was the MEP Engineer for the renovation of this 140,000 square foot historic minerals science and metallurgy facility. The challenge was to update the facility to modern research standards while preserving the building's original integrity. The building supports the nano-sciences and a nano-engineering center with facilities that include 9,000 square feet of Class 100,000 clean rooms, laboratories with chemical vapor deposition, metal organic chemical vapor deposition, and vapor phase epitaxy equipment. The facility also includes electromagnetic, physical and chemical properties laboratories and facilities for electron microscopy, gas chromatography, and mass spectroscopy. The systems that support these spaces include acid waste neutralization, pure water, and process cooling. All the systems are designed to cross seismic isolation joints with movement of 30 inches in all directions in the ground plane.



The Ohio State University
Chemical and Biomolecular Engineering and Chemistry Building
Columbus, Ohio

The 225,000 square foot research/teaching facility provides a new home for the Chemical and Biomolecular Engineering research and undergraduate program, as well as substantially upgraded research laboratories capable of supporting synthetic, process, physical, nano-scale, and computational chemistry and chemical engineering. In addition to the research and research support space, the building supports administrative, core laboratory, instructional, and common building support functions.

The project is in the early stages of programming. This exercise will be guided by four main goals: optimize shared interdisciplinary space, promoting collaboration; sustainable practices; flexible design with modularity; and efficient space utilization.

In addition to MEP design services, AEI is providing its Précis (Preliminary Consult in Sustainability) services, engaging in a design charrette showcasing potentially appropriate MEP systems solutions to meet or exceed sustainability goals. OSU is expecting the building to achieve LEED Silver certification at a minimum.

**US Department of Energy
Energy Systems Integration Facility (ESIF)**

Golden, Colorado

The U.S. Department of Energy's new ESIF, located at the National Renewable Energy Laboratory in Golden, is to be the Golden Field Office of Energy Efficiency and Renewable Energy's signature building for energy technology integration research and engineering. It is a high visibility project of national scope. The ESIF will support research, engineering, design, testing, and analysis of components and systems to enable economic, reliable integration of renewable electricity generation, fuel production, storage, and building efficiency technologies with the U.S. fuels and electricity delivery infrastructure. The 175,000 square foot ESIF will provide laboratory and research capabilities for a broad range of renewable energy generation. The facility will be designed to achieve LEED Gold certification.



**National Institutes of Health
Porter Neuroscience Research Center, Phase II**

Bethesda, Maryland

Within a single complex meant to promote world-class biomedical research, the Porter Neuroscience Research Center unites molecular and systems sciences with the disciplines of neurology, psychiatry, neurosurgery, and the allied sciences. Diversity in function and form will support the changing needs of its scientists and researchers, as well as the research approach – from animal models to cell culture and computer science.

Commissioned to complete the 305,000 square foot second phase, AEI's engineering design supports the goal of a flexible, reliable, sustainable, and highly collaborative research environment through use of redundant, interconnected utility service, multiple manifolded air handling systems and network transformers, and utility distribution through an interstitial. NIH is seeking certification by the two leading green building industry third party assessors -- US Green Building Council and Green Globes – of achievement in sustainability and energy conservation design.



**Department of Homeland Security
National Biodefense Analysis and Countermeasures Center (NBACC)**

Fort Detrick, Maryland

Created by the U.S. Department of Homeland Security in the months following the 2001 anthrax attacks, the NBACC is a government laboratory quantitatively assessing the risks posed by biological threats and attributing their use in bioterrorism or biocrime events. The 160,000 square foot facility's research guides the development of such countermeasures as detectors, drugs, vaccines, and decontamination technologies. Classified as a Sensitive Compartmented Information Facility, NBACC achieved the highest international standard of testing and calibration by which a lab can be assessed, ISO 17025, and as such is

