

THE UNIVERSITY OF MICHIGAN

COLLEGE OF ENGINEERING

FACULTY REQUIREMENT

for

OFFICE AND LABORATORY BUILDING

NORTH CAMPUS

August, 1959

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FOREWORD

This report, a "Faculty Requirement" for an Office and Laboratory Building to be located on the North Campus for use by the College of Engineering, is the second document resulting from a year of continuous study by the North Campus Planning Committee of the College of Engineering. It is based upon the data and recommendations included in the "Space Study and Recommendations" issued in January, 1959. The detail, as will be found, has been developed for the specific purpose of providing the architects and engineers with the best possible guidance by a faculty who must continue to respond to their responsibilities in the development of educational and research programs.

The North Campus Planning Committee represents all departments of the College of Engineering. The recommendations of this Committee are based on a study of all departmental needs for space and space arrangement in which to carry out their responsibilities of teaching and research. The study included the relationship and communication requirements of the occupants of the structures covered by these specifications and their need for space in the College of Engineering Laboratories now located on the North Campus. Also included are studies of the relationship of offices, laboratories, and classrooms for maximum efficiency of student communications with the teacher, of the service relationship between the faculty and its needs for secretarial and student assistants, and of the flow of students in passing from classroom to classroom. Both building location and arrangement specifications are the results. Similar studies of utility needs, lighting, and heating have been completed and are included.

The work of the North Campus Planning Committee has been very thorough. This report is not intended to rule out suggestions for improvements which may develop in the work to be completed leading to construction. It must be recognized, however, that the effort put into this study exceeds that of the architectural study that would normally precede an engineering design, and therefore alternates from these requirements need to be considered by the Planning Committee. The North Campus Planning Committee is being maintained for the purpose of assisting the College representative to the architects and engineers.

Throughout the study leading to this report, the Committee has emphasized maximum flexibility so that the structure described by these specifications may provide for a rapidly changing technology.

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I. INTRODUCTION

A. Previous Planning

Every attempt has been made in determining the space requirements of the College of Engineering to produce realistic estimates. The following report is a delineation of the requirements of the College of Engineering as determined by the North Campus Planning Committee. The names of members of this committee will be found in the Appendix. The initial effort was to estimate the space that will be required by 1970. Only a brief summary of the several space studies will be included here.

The basis for all the subsequent work of the planning committee is a report¹ issued in 1956 by a committee headed by Professor S. S. Attwood, presently Dean of the College of Engineering. This report shows that by 1970 the College expects a total enrollment of 9,000 students. Of these 9,000 students, it is understood by the committee that 6,000 upperclassmen and graduates will be located on the North Campus. A summary of the 1970 space requirements is shown in Table I, page 3.

On March 1, 1957, a supplemental report² was issued which revised the space requirements of the College of Engineering and also the five-year building plan. It should be noted that neither of these reports were prepared by the present North Campus Planning Committee.

In January, 1959, a third space-study and recommendation report was prepared by Deans S. S. Attwood and G. V. Edmonson.³ A revision of the previous report² was necessary to account for the

Russell report⁴ and the changes which had taken place in the previously proposed building schedule. It became evident that it would be necessary to shift the office and small-laboratory building to first priority. Table III of reference III, reproduced on page 2 shows the space occupied. The laboratory space needs of the College is the only area where increases have occurred. The need of added laboratory space to satisfy the real needs for teaching and research are clearly demonstrated. Adequate laboratory space should be at least twice that shown in the table. Table IV from the same report, gives the minimum recommended space per student for these same categories.

The above recommendations are based on a study made by the present North Campus Planning Committee. In an extensive review⁵ of the total space requirements as set forth in the Attwood report, it was found that the original requirements were realistic, and it was necessary only to alter them to include several smaller departments which had not

TABLE III. SPACE OCCUPANCY COMPARISON

Space Occupancy	Michigan Council of State College Presidents Space Occupied in 1955*	1958 Occupancy by College of Engineering*
Classrooms	19.4	16.5
Design Rooms	14.9	12.4
Laboratories		
Large	Not Separable	Not Separable
Small		
	Total <u>38.0</u>	Total <u>48.7</u>
Offices		
Faculty		
Secretary and supporting files	Not Separable	Not Separable
Administrative		
	Total <u>317.0</u>	Total <u>286.0</u>

*Numbers indicate square feet per person.

TABLE I. 1970 SPACE REQUIREMENTS

SPACE	NET SQUARE FEET
<u>Laboratory and Office Building</u>	
Small laboratories	572,000
Faculty office Student assistants Not separable Secretarial	152,500
Lecture classrooms (48 seats)	54,000
Lecture classrooms (32 seats)	17,500
Drafting rooms	56,500
Special amphitheater type rooms (75 seats)	
Special amphitheater type rooms (100 seats)	10,000
Special amphitheater type rooms (150 seats)	<u> </u>
	138,000
Student organization offices	2,000
Student study and meeting rooms	3,000
Student study and meeting rooms	<u>7,000</u>
	12,000
Faculty conference rooms	5,400
Faculty lounge	<u>2,500</u>
	7,900
Deans' offices (including secretarial space)	5,000
College secretary and records (including vault)	5,000
Placement office and interview rooms	<u>4,000</u>
	14,000
Reproduction facilities (blueprint, Multilith, etc.)	1,500
Cafeteria and food service	<u>20,000</u>
Total (laboratory and classroom building)	917,900
<u>Necessary Adjacent Facilities (See Art. 1-3)</u>	
Library	70,000
Auditorium (1500 seats)	
Auditorium (500 seats)	46,000
Auditorium (300 seats)	<u> </u>
Total (adjacent facilities)	116,000
Grand Total (net square feet this project)	<u><u>1,033,900</u></u>
<u>Additional 1970 Net Space Requirements</u> (Not part of this project)	
Laboratory - Office	70,000
Large laboratories	158,000
	<u>228,000</u>
TOTAL	<u>1,261,900</u> ³

TABLE IV. RECOMMENDATION FOR MINIMUM NET SPACE OCCUPANCY

Space Occupancy	Recommendation, net sq. ft.*	Classrooms, Office, and Laboratory, % Area
Classrooms	13.6	9.5
Design Rooms	9.5	6.4
Laboratories		
Large	26.7	67.2
Small	<u>70.0</u>	
Total	96.7	
<hr/>		
Offices		
Faculty	130.0	
Secretary and supporting files	104.0	16.9
Administrative and student activities	<u>53.0</u>	
Total	287.0	

* Numbers indicate square feet per person.

TABLE VIII. 1970 NET SPACE REQUIREMENTS, NORTH CAMPUS

Requirements	Net Square Feet
Faculty offices, secretary, files service space	161,000
Small laboratories	645,100
Classrooms, design rooms, special lecture rooms, seminar rooms	138,000
Large laboratories (Aeronautical, Automotive, Fluids I & II)	158,000
Administration	14,000
Faculty conference, lounge	7,900
Student activities	<u>12,000</u>
	Sub-Total 1,125,900
Common Facilities - North Campus	
Library	70,000
Auditoriums	46,000
Cafeteria	<u>20,000</u>
	Sub-Total 136,000
	TOTAL <u>1,261,900</u>

been previously considered. Table VIII of the above report, reproduced on page 4, gives the estimated total of Engineering College space required on North Campus by 1970.

B. Building Studies and Requirements

1. General Requirements

The remainder of this report deals only with the office and small laboratory building. Since the present committee is made up of at least one member from each department, its second and third tasks were to determine how the space shall be arranged and to delineate the basic specifications for the building. The committee has agreed that the following general requirements shall be met by the proposed new office-laboratory building on the North Campus.

a. The space shall have maximum flexibility. The committee believes that departments must be held together within a given area and not be split among several locations or buildings. This means that the structure must be able to accommodate fluctuations in department size without requiring major relocation of personnel.

b. It is the unanimous decision of this committee that classrooms, offices, and small laboratories shall be intermixed in a planned distribution throughout the structure. When the three functions are separated, contact between faculty and students and between members of the faculty is seriously reduced.⁵

c. It is not intended that these specifications shall preclude suggestions by the design architects and engineers for their improvement. The committee however reserves the right to determine whether or not

suggestions by the architects and engineers shall be incorporated into these specifications.

d. It is the unanimous decision of this committee that the space shall be contained in one building which houses the several types of rooms in a planned arrangement. Since maximum utilization of this space throughout the year is necessary and since many of the rooms are interior, the building shall be air-conditioned. The purpose of this building, then, is to provide classrooms and office area adequate for the junior, senior, and graduate classes of the College of Engineering. Small laboratories are defined as those requiring ordinary ceiling heights and having ordinary structural requirements.

2. Location

The location of this building was studied in regard to the present layout of the North Campus and to the probable growth of that area. The building shall be centrally located with respect to the surrounding laboratory buildings used by the College of Engineering, and hence shall serve as a natural focal point for College activities.

The most suitable location is the area immediately west of the Phoenix and Automotive buildings. At the present time the eastern boundary of this area is uncertain because of a 500 foot clear radius around the reactor as required by AEC regulations. Several trial layouts of possible building plans showed that the most useful building would require that the 500 foot radius be reduced to 300 feet. Contingent upon obtaining AEC permission to reduce the 500 foot radius to 300 feet, the building shall occupy the area as shown on page 8 .

II. ARCHITECTURAL DETAILS

A. Proportions

The committee examined several plans for typical office laboratory buildings of three and four stories. In addition, a study was made of a taller building which showed that serious student flow problems exist when the number of stories exceeds four. After additional careful consideration of the factors of real estate, space and utility, the committee agreed that the structure shall be four stories in height and shall be in accordance with the layout shown on page 8 .

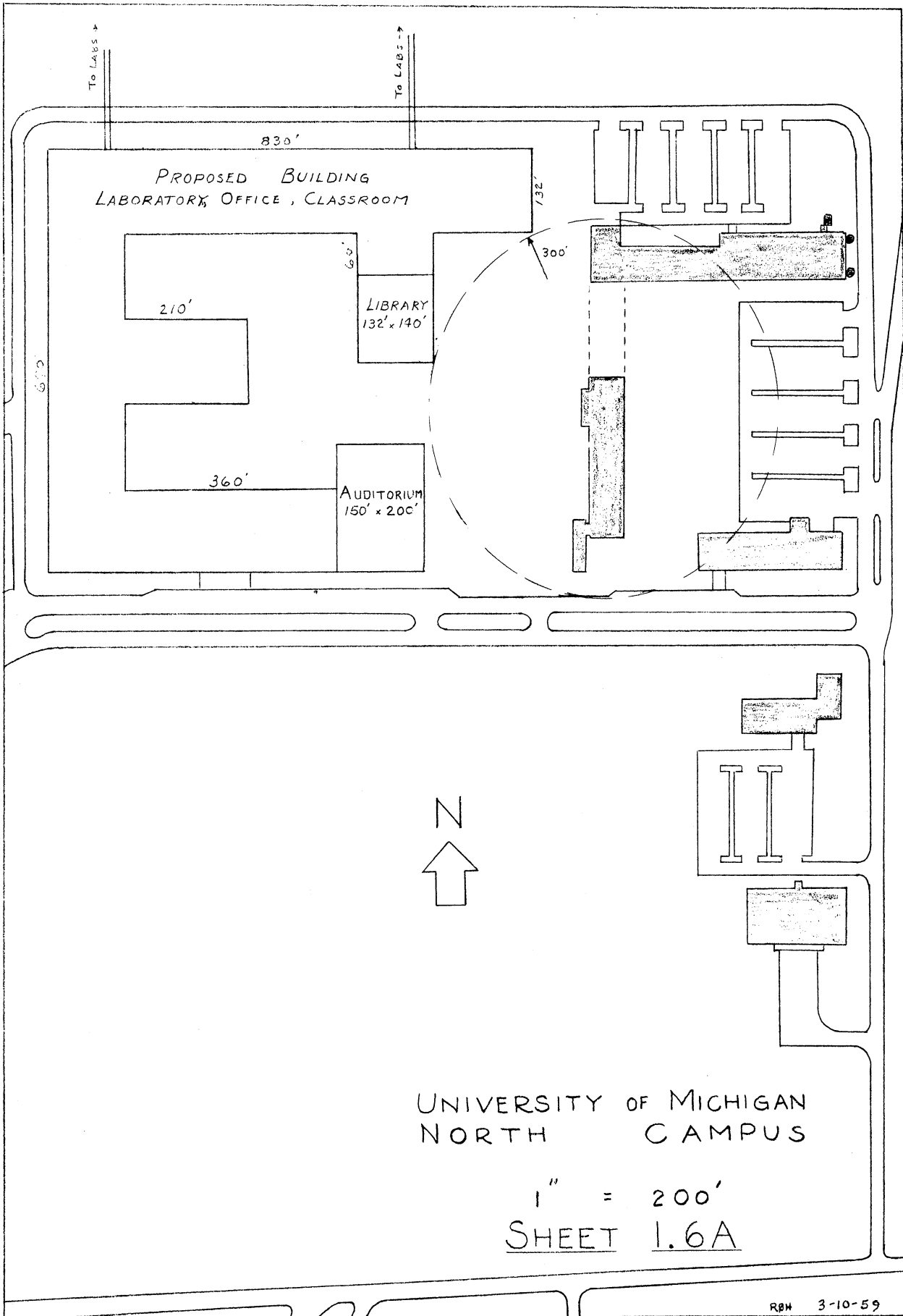
B. Supporting Facilities

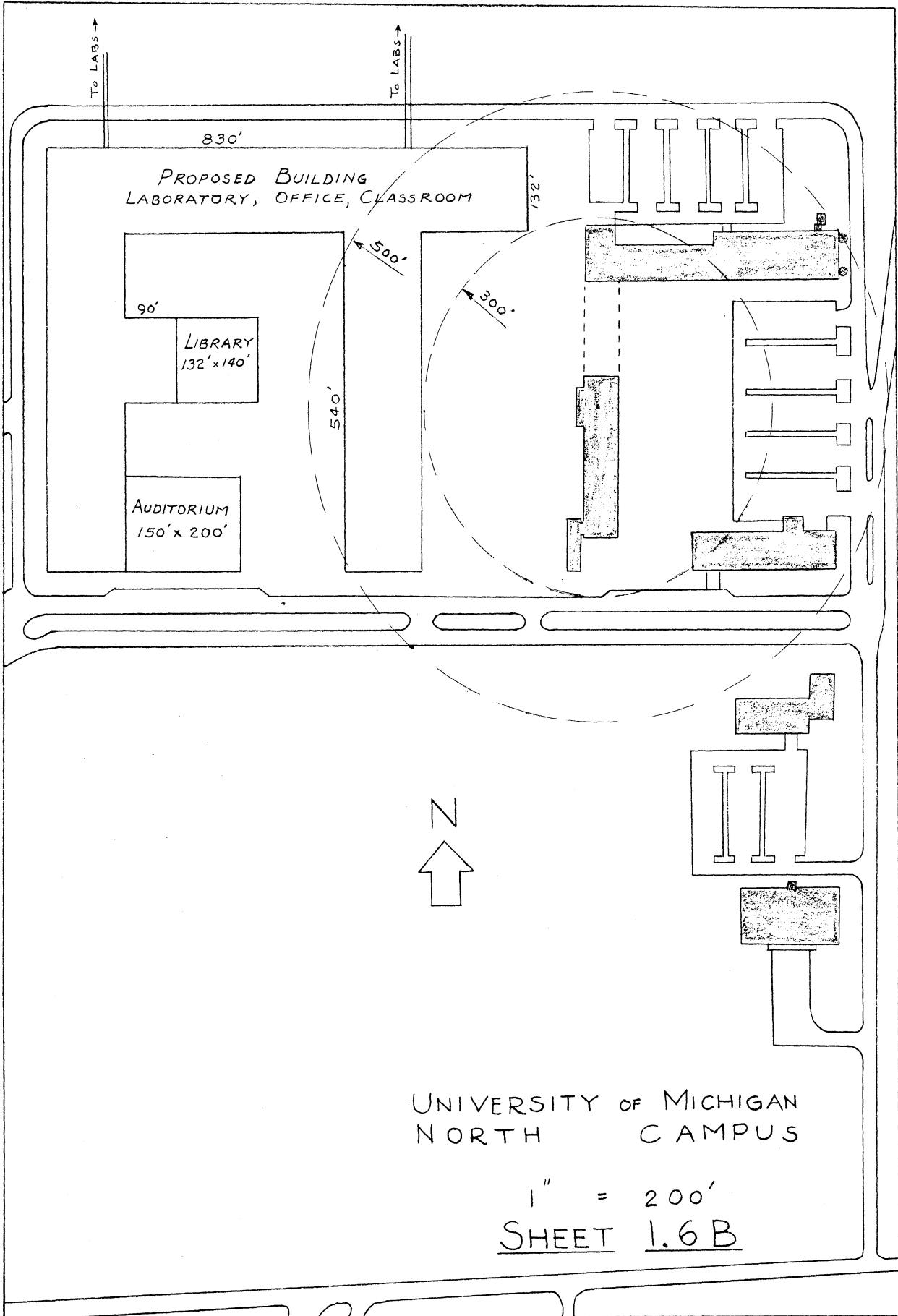
1. Adjacent and Common Facilities

This building shall be a self-contained unit of the College of Engineering due to its distance from the main campus. Thus, library, auditorium, and cafeteria facilities shall be provided. It is required that library space adequate for the anticipated enrollment be provided as a wing or adjunct of the building, that a cafeteria be incorporated into the building itself, and that an auditorium be constructed as a wing in such a way as to provide close and direct access to the street.

2. Parking Facilities

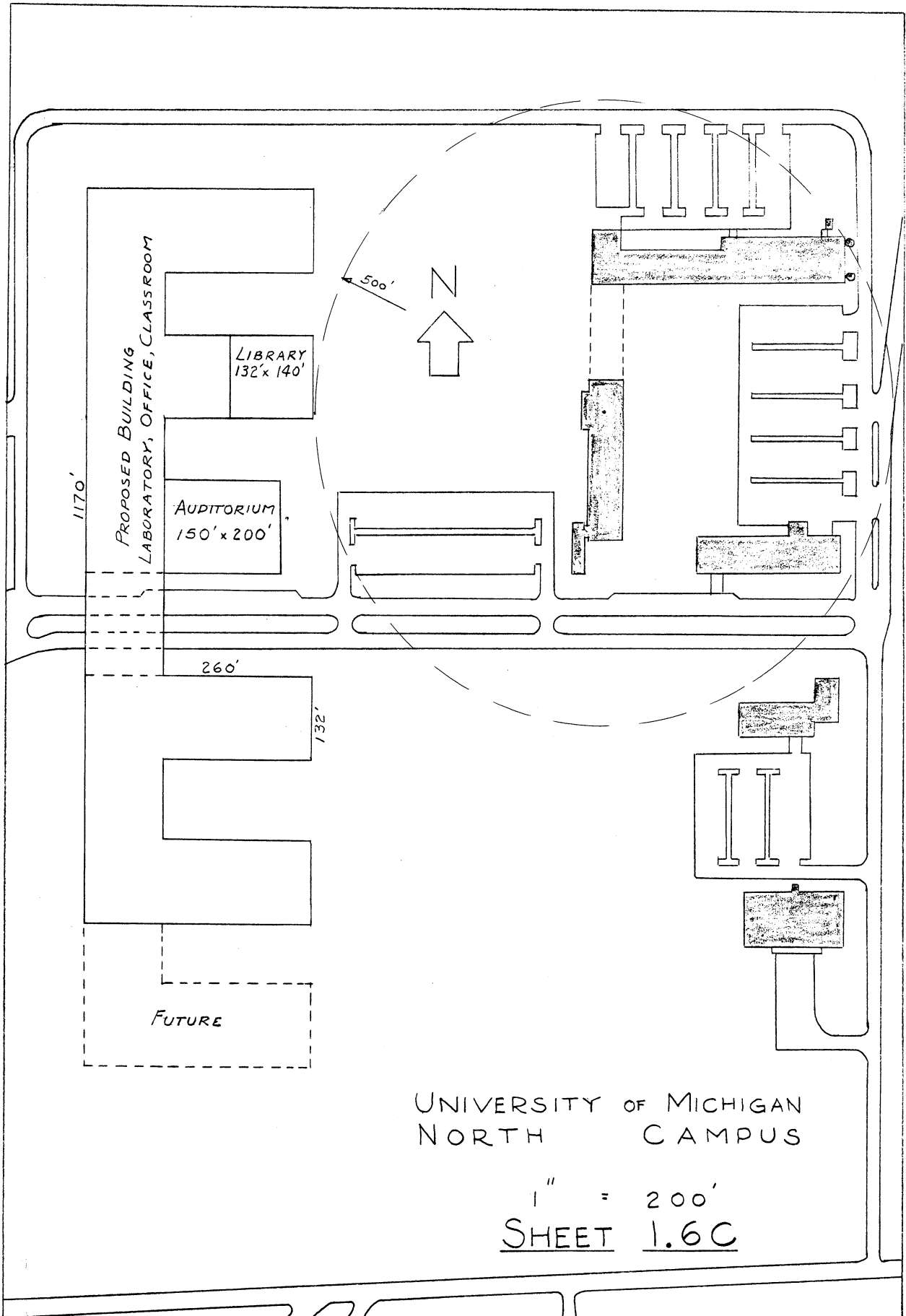
An integral part of any office-laboratory building must be adequate automobile access and parking areas. Parking shall be provided in the basement areas of this building in such a way that, under normal conditions, a staff member can leave his automobile approximately underneath his office

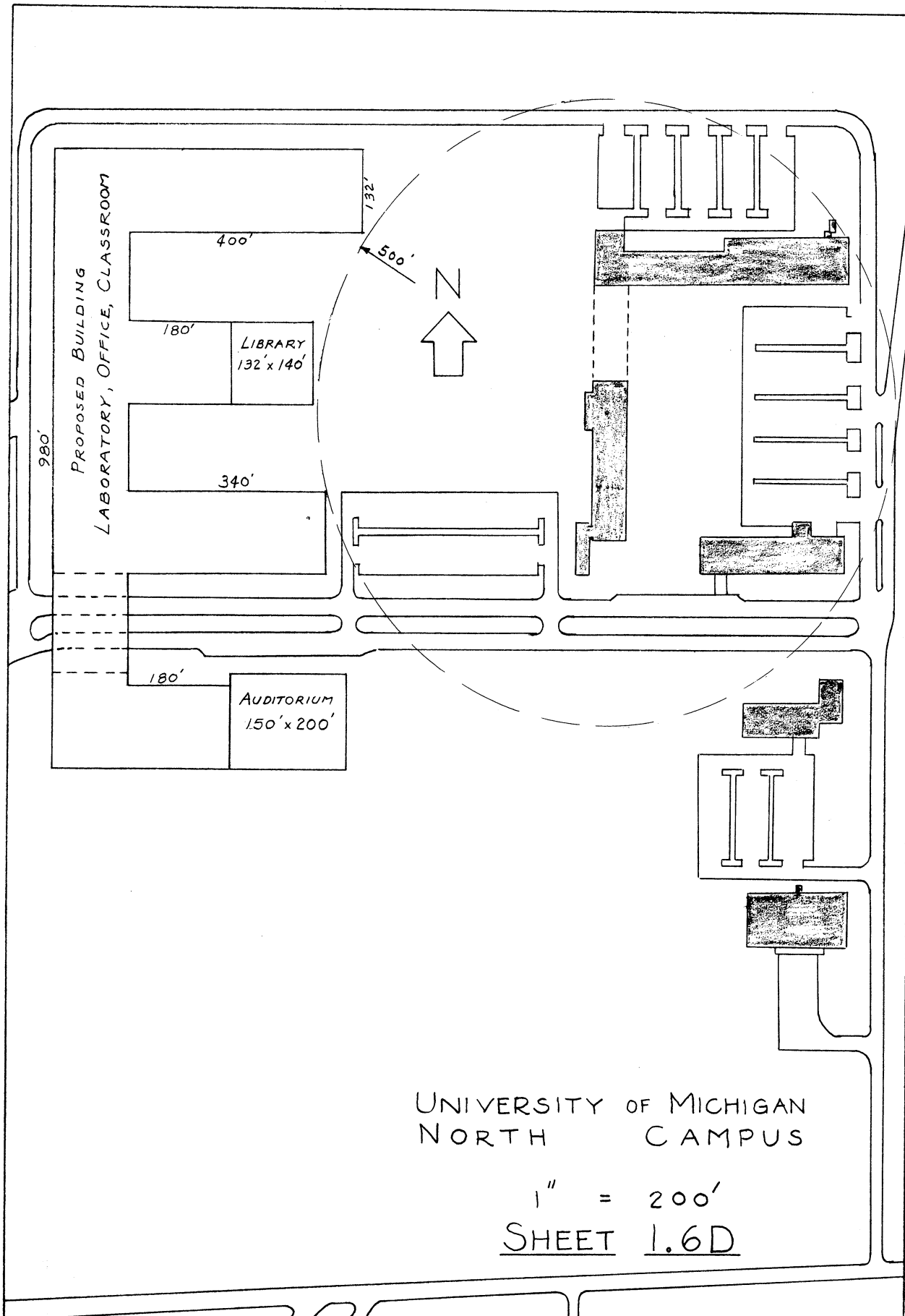




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1" = 200'
SHEET 1.6 B





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1" = 200'
SHEET 1.6D

area. Approximately 20 parking spaces are required per planning unit.
(See Section C).

3. Closed Walkways

Since this building will be a considerable distance from the neighboring buildings, and since parking facilities will become less than adequate as the area becomes more crowded, it is required that closed passageways be provided between the proposed building and the Phoenix Memorial Laboratory, the Automotive Laboratory, and the Fluids Engineering Laboratory. Additional passageways will be required for communication when other laboratory buildings are completed.

C. Building Details

1. General Space Requirements

To insure complete flexibility for the use of space to satisfy the requirement outlined in Paragraph I-B-1a, the structure excluding the library and auditoriums has been broken up into 42 typical planning units. Of these, 39 shall contain a mixture of offices, laboratories, and classrooms, and 3 shall contain administrative and cafeteria areas.

The planning unit (see drawing OL-101-2D) shall be 190 feet in length. This length shall be divided into 19 modules of 10 feet each. The width shall be 132 feet center to center of exterior columns. The height of a planning unit is one story.

2. Specific Space Requirements

a. Corridors - Each typical planning unit shall contain two longitudinal corridors with a minimum clear width of 6 feet with opposing doors open and a minimum width of 8 feet from wall surface to wall surface.

There shall be at least one cross corridor of similar dimension for each unit.

b. Offices - Each typical planning unit except the administrative and cafeteria areas shall contain 16 offices, in groups of eight. Each office shall have a minimum usable area of 130 square feet.

Offices shall be exterior to the corridors and separated from the corridors by a buffer zone which is to be used for secretarial activities. A minimum number of entrances from the corridor to the secretarial zone shall be provided to minimize noise coming to the office area. The secretarial zone serving each group of eight offices shall contain provisions for two secretaries and eight student assistants.

A room containing a sink and storage cupboards shall be included within the secretarial zone. It is anticipated that this room will be used for duplicating equipment, assemblage of duplicated material, and storage of duplicating and office supplies, as well as providing a private wash area for those working with duplicating copy.

c. Conferences rooms - (see also Section h) Each typical planning unit except the administrative and cafeteria areas shall contain one conference room suitable for a group of from 10 to 15 persons. This room shall have access directly from the corridor.

d. Classrooms -

(1) Lecture-type. Lecture-type classrooms are to be exterior to the corridors and shall have a 23-foot clear width. The preferred length is 29 feet-6 inches for a room to seat approximately 48 students, and 19-feet-6 inches for a room to seat approximately 32 students. Lecture-type

classrooms of each size shall be distributed among the 39 typical planning units in approximately equal number.

(2) Drafting-room type. Drafting rooms may be placed between the corridors and may have variable length dimensions. Preferred lengths are 29 feet-6 inches, 39 feet-6 inches, and/or 49 feet-6 inches. Drafting rooms shall be distributed among the 39 typical planning units approximately uniformly by area.

e. Special amphitheater-type rooms - Special amphitheater-type rooms of the number and capacity shown in Table I are to be provided. These rooms shall be distributed throughout the building.

f. Student organization offices - Student organization offices shall be provided as indicated in Table I. It is preferred that two or three such offices be grouped adjacent to the student study and meeting rooms.

g. Student study and meeting rooms - Student study and meeting rooms are to provide space where students can congregate during the day and where they can study. They shall be of varying size and distributed throughout the building. Such rooms will be used for meetings by student organizations in the evenings and for student conferences and similar activities, which do not require amphitheater-type facilities.

h. Faculty conference rooms (see also para. c) - In addition to the conference rooms mentioned in Section C, there shall be 10 faculty conference rooms to accommodate larger groups of faculty. The use of such rooms would be for holding large seminars, departmental meetings, and similar activities. They may be of varying size but shall accommodate 20 to 50 persons.

i. Faculty lounge - A faculty lounge shall be provided within the building to serve as a place of relaxation for the faculty and also as a reception room.

j. Service shafts - Vertical utility shafts shall be provided for services along the interior walls of the longitudinal corridors as shown on drawing OL-101-2D. These service shafts shall be provided at approximately 20 foot intervals or every other module.

Service shafts shall originate from the tops of two longitudinal utility tunnels in the basement area (see drawing OL-101-3D). They will be opened through the roof as desired to accommodate exhaust hoods and other ventilating equipment.

Horizontal distribution of utilities shall be made in the space between the suspended ceiling and the structural floor and/or on top of the structural floor slabs.

k. Storage space -

(1) Each classroom, laboratory, or conference room shall have provision for a wardrobe closet to accommodate at least one half the occupancy, except that such a closet in a conference room shall accommodate the full occupancy.

(2) Each drawing room shall have provision for storing student drawings between classes.

(3) Locker space shall be provided on each side of the cross corridor between longitudinal corridors. As many lockers as reasonably permissible shall be provided. Each locker shall accommodate a coat, hat, overshoes, and shall have at least one shelf for book storage.

(4) Where wardrobes are not needed along corridor walls, such space may be utilized for display cases opening onto corridors, and into classrooms or laboratories, and for utility cabinets, fire cabinets, and so forth, or the space may be made a part of the usable room space.

l. Rest rooms - Rest rooms for both men and women shall be provided in each planning unit to accommodate the occupancy of that unit. Separate rest rooms are to be provided for faculty personnel.

m. Chalkboards shall be installed on all accessible wall space in classrooms. One four foot long chalkboard shall be installed in each office. Twenty lineal feet of chalkboard shall be installed in each laboratory. One eighth foot long chalkboard shall be installed in each conference room.

III. STRUCTURAL REQUIREMENTS

A. Materials

The framing material shall be either structural steel or concrete. Concrete may be either poured in place, precast, prestressed, or a combination thereof. The use of lightweight concretes, structural and nonstructural, shall be considered.

B. Structural Frame

The plan of the structural frame shall accommodate the typical planning units described in Section II with provision for service shafts as shown in drawings OL-101-2D and OL-101-3D. Lateral distribution of services from the service shafts shall be accomplished generally above suspended ceilings and/or on top of the structural floor slabs. The story height shall provide for a minimum clear ceiling height of 8 feet-6 inches.

C. Ceilings

Suspended ceilings shall be used and shall be made of durable, light-colored acoustical material.

D. Floors

All floors shall be designed for a live load of 175 lb. per square foot.

If services are carried on top of the structural slab they shall be embedded in a concrete fill having a plastic weight of not more than 90 pounds per cubic foot and a minimum compressive strength of 900 pounds per square inch.

Floor finish in corridors shall be a hard-surfaced floor material selected especially for durability and ease of maintenance.

Floor finish in offices and classrooms shall be asphalt tile or a material with similar characteristics.

Floor finish in laboratory areas shall be a grease-resistant material.

All floor finishes in corridors and interior rooms shall be relatively light in color.

E. Walls

1. Exterior

Selection of wall material and construction shall be made on the basis of weather tightness, weather resistance, and insulating value in addition to appearance. Since the building is to be air-conditioned the insulating value of the walls is especially important. Exterior walls shall have an overall heat-transfer coefficient (U) consistent with the heating and cooling system described in Section IV-B-1. The amount of glass area in exterior walls shall be limited to 20 to 25% of the wall area.

A local maximum U value of 0.4 Btu/hr/sq.ft/°F is required for exterior walls, roof, and floor above the basement parking area. No portion of the above construction including windows, doors, window and door frames, etc., shall have a direct uninsulated path for heat conduction.

2. Interior

Movable partitions in the office areas are desired. Such partitions shall reduce the transmission of air-borne sound sufficiently to insure quiet offices. Transmission of sound between offices via the

ceiling and service space shall likewise be limited (see Section F).

Walls separating office areas from classrooms or laboratories and walls separating laboratories from other rooms shall be permanent walls of full story height.

F. Sound Control

Effective sound control is required throughout the building. Walls, ceilings, and floors shall be constructed so that the background noise level shall be approximately that represented by a noise criterion curve of 25.⁶ The sound attenuation through walls, ceilings, and floors separating office areas from laboratories and classrooms shall be a minimum of 45 decibels, and through the walls and over the ceilings in the office areas, a minimum of 40 decibels. Particular attention shall be paid to details of the walls, ceilings, and floors to prevent sound "leaks."

G. Doors

Corridor doors shall be recessed as shown on drawing OL-101-2D and shall project into the corridor a maximum of 12 inches (see Section II-C-2a).

Sliding doors may be used in the office areas to save space.

H. Windows

Locked sash shall be used, movable only for cleaning. (See Section E-1 for glass area requirements.)

Exterior sun-control devices shall be used to control direct sunlight on windows on the south and west sides for the building.

I. Stairways

Three stairways shall provide accesses to the roof and shall be properly enclosed for regular usage.

J. Roof

The roof shall have the same floor loading as the floors.

K. Approval

Final approval of structural requirements rests with the North Campus Planning Committee.

IV. UTILITIES

Distribution of utilities shall be from primary supply loops located in a utilities tunnel beneath the first floor level. Distribution to the various floors and rooms shall be through vertical utilities shafts and the clearance space above the dropped-ceilings. The general arrangement and sizes are indicated in drawings OL-101-2D and OL-101-3D. The arrangement and installation shall provide maximum flexibility for expansion, modifications, connections and maintenance.

A. Electrical

1. Power Circuits

a. The primary distribution loop shall be located in the utilities tunnel and shall be 4800 volts, 3-phase, 60 cycles. The loop shall be insulated for 13,200 volts to permit future changeover to this higher voltage.

b. All fixed installations of large electric motors, such as in the air-conditioning and heating system, shall be supplied with electric power directly from the substations at 440 volts, 3-phase, 60 cycles.

c. Step-down transformers (total number required not specified) shall be used to provide a secondary distribution system in the utilities tunnel. This shall be 208 volts, 3-phase, 60 cycles, 4-wire plus ground. This secondary distribution shall be bus ducts with plug-in type fused outlet boxes at each utilities-shaft. The bus ducts shall be insulated for 600 volts to permit future changeover to this higher voltage.

d. Distribution of electrical power to the various floor levels shall be through the vertical utilities-shafts and shall be 208 volts, 3 phase, 60 cycles, 4-wire plus ground. Bus ducts insulated for 600 volts shall be used.

e. Each interior laboratory or drawing room shall be provided with 3-prong, parallel-spade, polarized wall receptacles for 120 volts, single phase, 60 cycles with ground in the form of plug-mold or equivalent. The plug-mold shall run the entire length of all walls, excluding the corridor side wall, at a height which shall provide convenient access at workbench level. Outlet spacing shall be 3 feet. Power to the plug mold in each room shall be supplied from a distribution box with overload relays located at the utilities shaft in the same room. Locations for spare overload relays in the distribution boxes shall be provided. Loads shall be evenly distributed among the 3 phases. At least one duplex 3-prong wall receptable shall be located at each sink and display cabinet.

f. Capacity requirement for the plug-mold for the laboratories and drawing rooms shall be 29 watts/ft² at the utilities-shaft with a voltage variation not to exceed 114 to 120 volts at the convenience outlets.

g. Power at 208 volts, 3-phase, 4-wire plus ground shall be made available at the utilities-shaft for each laboratory and drawing room. Maximum capacity from this source shall be 100 amperes per room with a maximum voltage drop of 5 percent. This power shall be made available by means of a distribution box with overload relays and easily accessible connectors or lugs.

h. Electrical power shall be supplied to the center of bus-duct sections where possible, to provide good load distribution.

i. Electrical power to wall receptacles in the classroom and office space shall be provided and controlled from electrical closets in the corridors. Distribution from the electrical closets to the various rooms shall be located in the space above the dropped ceilings. Easily removable panels in the dropped ceilings shall be provided for easy access to this space for maintenance and modifications of the utilities distribution systems.

j. Wall receptacles in the classrooms and offices shall be 3-prong, parallel-spade, polarized receptacles for 120 volts, single phase, 60 cycles with grounded connection. Locations are shown in drawing 0L-101-2D.

k. Capacity requirements for the wall receptacles in both the classrooms and offices shall be 12 watts/ft².

l. All bus ducts shall be labeled at intervals with voltage "warning" and current capacity.

2. Lighting Circuits

a. Provide 100 foot-candles of light at desk height in all laboratory, classroom and office areas. Light shall be uniformly distributed with minimum glare.

b. Light fixtures for all areas shall not interfere with utilities distribution throughout the building.

c. Fluorescent fixtures are desired.

d. All lighting fixtures of a given type shall operate at a common voltage, either 208 or 120 volts.

e. Power shall be supplied from the bus ducts in the vertical utilities-shafts and overload relays in the electrical closets.

3. Special

a. All electrical power needs other than 60-cycle power shall be obtained from proper equipment, such as motor-generator sets, rectifiers, etc., located in spaces provided for this purpose in the utilities tunnel. These spaces shall be provided at regular intervals to permit short distribution lines to all floors.

4. General

a. All electrical installations shall be made according to the National Electric Code.

B. Mechanical

1. Heating, Ventilating, and Air-Conditioning

a. Provide a heating, ventilating, and air-conditioning system to provide maximum comfort under all weather conditions likely to be encountered.

b. A heat-pump type of system shall be investigated with sufficient supplementary heating capacity to provide adequate heating during periods when the building is unoccupied, such as at night or over extended vacation periods.

c. The building construction shall be such as to provide the most economical compromise between heat loss during heating, heat gain

during cooling, and initial cost. Outer wall heat transfer characteristics are specified in Section III-E-1.

d. Zoning of the building for different heating and/or cooling loads shall be considered.

e. Sound-level intensities generated by the heating, ventilating, and air-conditioning systems in the laboratory, office and classroom areas shall be consistent with the requirements in Section III-F.

f. Space shall be provided in all utilities-shafts for exhaust ducts of approximately 10-inch diameter. Provisions shall be made at the roof for easy future installation of these ducts. A typical complete installation shall be designed and the installation completed at a location to be selected at the time of construction.

2. Domestic Water

a. A main loop of domestic cold water shall be located in the utilities-tunnel, provided with a tee and shut-off valve at each utilities-shaft. The size shall be consistent with the pipe size provided in the utilities-shaft.

b. Distribution in the utilities-shaft shall be by 2 1/2 inch pipe to the first and second floors and by 2-inch pipe to the third and fourth floors.

c. Provide plugged-tees at each floor and locate just below the structural floor and roof.

d. Provide all laboratories with semi-permanent laboratory-type sinks, located close to the utilities shaft. Each sink shall be supplied with both hot and cold water by means of 3/4-inch pipes, reduced to 1/2-inch pipes for direct lines to the sink.

e. Distribution of domestic hot water is to be provided and shall be similar to the cold water distribution.

3. Sanitary Drains

a. A main sanitary drain loop shall be located in the utilities tunnel. Connections to the various floor levels shall be made through the utilities-shafts.

4. Storm Drains

a. A main storm-drain loop shall be located in the utilities tunnel. Connections to the various floor levels shall be made through the utilities shafts.

b. Supply unused capped Y-sections at each floor level in the storm-drains pipe. Locate just below the structural floor level.

c. At least 2 stand-pipe drains, 3-inch diameter, shall be located in each interior laboratory and drawing room. These shall be located at each inside corner along the center wall. Additional drains shall be provided as needed for rooms greater than 30 feet in width. Recommended locations are shown in drawing OL-101-2D. Allow sufficient workroom between drains and walls. All stand-pipe drains shall be properly connected to the storm drain and capped.

d. Provide one floor opening in each interior laboratory and drawing room for future installation of flush-type floor drain. Opening shall be covered with semi-permanent type cap. Sloped floors to the drain shall not be required.

5. Steam

a. Provide a low-pressure steam loop in the utilities tunnel. Details will depend upon final choice of heating system provided for the building.

b. Provide plugged tees at each utilities shaft.

6. Compressed Air

a. A main loop of compressed air, at 120 psig and 1000 cfm, shall be located in the utilities tunnel. Provisions shall be made for future expansion to a capacity of 2000 cfm. Tee connections with shut-off valves shall be provided at each utilities shaft.

b. Distribution to the upper floors will be through 2-inch pipes, located in the utilities shafts.

c. Provide a 3/4 inch pipe distribution to each laboratory and drawing room and terminate with plugged tees at bench level at sink.

7. Natural Gas

a. A main loop of natural gas at low pressure shall be located in the utilities-tunnel. Tee connections with shut-off valves shall be provided at each utilities shaft.

b. Distribution to the upper floors shall be through 1 1/2-inch pipes located in the utilities shafts.

c. Provide a 3/4 inch pipe distribution to each laboratory and drawing room and terminate with plugged tees at bench level at sink.

8. Piping-General

a. Provide plugged tees at all pipe connections where expansion of service may be likely.

b. All pipes subject to condensation and excessive heat loss shall be adequately covered.

c. All utility pipes shall be painted with code colors for identification purposes.

C. Utilities Shafts

a. Utilities shafts for distribution of utilities to upper floor levels from the utilities tunnel shall be provided as indicated on drawing 0L-101-2D.

b. Horizontal sections of unistrut shall be provided at approximately 4-foot intervals. These shall be anchored to the wall of the shaft and shall be strong enough to provide support for the piping and bus ducts in the utilities shaft.

c. Barriers shall be provided at each floor level in each shaft to reduce fire hazards and noise transmission.

d. The top of the shaft shall be so constructed as to permit its entire use for a high-capacity exhaust duct. Provisions shall be made for protection from the weather, excessive wind noise, and excessive heat loss.

e. Adequate access panels or doors shall be provided at floor and ceiling levels to provide convenient access and working room to the utilities shafts.

D. Telephones

a. Minimum size conduit for telephone outlets shall be $3/4$ inch.

E. Hall Clocks

a. Two hall clocks shall be provided in each planning unit; one clock centered in each of the two main corridors.

F. Drinking Water

a. Provide conveniently located drinking fountains. These shall be of the mechanical refrigeration type of drinking water cooler.

G. Elevators and Load Areas

a. Provide 1-freight elevator to service each building area described by a 200 foot radius circle whose center is at the elevator location. The capacity of each elevator shall be 20,000 pounds, its speed shall be 200 feet per minute and its platform shall have a minimum size of 10' x 12'. The lower opening shall be at the level of the underground parking area; the upper opening shall be located at the level of the building roof.

b. Provide a loading area adjacent to the elevator opening at the level of the underground parking area. Provide a load lift for each elevator.

c. Provide 1-passenger elevator to service each building area described by a 200 foot radius circle whose center is at the elevator location. The capacity of each elevator shall be 5000 lbs., its speed shall be 250-300 feet per minute, and shall accommodate a maximum of 25 people. The lower opening shall be at the level of the underground parking; the upper opening shall be at the level of the top floor of the building.

V. OCCUPANCY COSTS

This section is included in the Faculty Requirement to show the need for funds in addition to those required for the actual construction of the office-laboratory building. Funds of this nature must be considered as an integral part of the total requirement for the building. This section will serve as a guide for occupancy planning. Occupancy costs are divided into four categories; namely, moving, new purchases, installations, and painting.

A. Moving Expenses

1. Furniture and furnishings.
2. Equipment and Apparatus
 - a. Mechanical disconnections
 - b. Electrical disconnections

This section includes not only the physical relocation of existing items but will also involve costs in making the items available for the moving crew. These costs, on many occasions, may actually exceed the moving cost. Laboratory equipment may require special crating or the use of special handling equipment such as cranes and hoists.

B. New Purchases

1. Office Furniture

Each office shall be provided with the following:

1 double pedestal desk	1 waste basket
1 table 30 x 60	2 side chairs
1 swivel chair	2 file cabinets (4 drawer)
1 combination wardrobe	2 bookcase (tall)

2. Laboratory Furniture

Such items as laboratory stools, special bench tops and fume hoods are typical examples.

3. Furnishings

Items such as special floor coverings, black-out window curtains, and additional chalkboards are included under this heading.

4. Partitions

Folding partitions, room dividers, permanent and temporary walls required in addition to the partitions installed under the general construction contract are represented by this heading.

5. Equipment and Apparatus

6. Instruments

New purchases involve hidden costs such as shipping charges, insurance, service contracts, consultation fees and the like. In many cases, the actual cost may be double the anticipated purchase price. The purchase of special laboratory items often requires the preparation of specifications and drawings. These services add a considerable sum to the purchase price.

C. Installations

Design and engineering time for the preparation of installation drawings may represent a major portion of the installation costs and should be considered in addition to the direct costs of labor and materials.

1. Furniture and Furnishings

Placement and leveling of laboratory benches, laying of special floor coverings, and the installation of black-out curtains at the time of occupancy are represented by this heading.

2. Equipment and Apparatus

a. Mechanical trades - All plumbing and shop work is included in this section. Labor and materials, for new installations and for the modification of existing equipment, should be considered.

b. Electrical trades - This item includes all electrical work necessary for the connection of new and existing equipment. Rewiring and/or rebuilding of electrical motors for the new location is often required. These costs can represent a major portion of the work.

c. Architectural trades - This section includes the installation of special windows, shade screening and the like, not installed by the general contractor at the time of construction.

D. Painting

All installations of new and existing equipment should be painted to afford a uniform color scheme. This section includes the painting of all laboratory apparatus, equipment, piping, special enclosures and electrical conduit installed at the time of occupancy.

REFERENCES

1. S. S. Attwood et al., Report of the North Campus Planning Committee, College of Engineering, Requirements for Classroom, Office, and Small Laboratory Buildings, no date.
2. S. S. Attwood et al., North Campus Engineering Space Requirements, March 1, 1957.
3. S. S. Attwood and G. V. Edmonson, The University of Michigan College of Engineering, Report of Space Study and Recommendations, January 23, 1959.
4. Russell Report.
5. Report of Space Arrangement Study Committee, A Subcommittee of the North Campus Planning Committee, Requirements for New Engineering Office and Small Laboratory Building.
6. Beranek, L. L., "Revised Criteria for Noise in Buildings," Noise Control, January, 1957; and "Design for Hearing," Progressive Architecture, May, 1959.

APPENDIX

MEMBERS OF THE NORTH CAMPUS PLANNING COMMITTEE

The North Campus Planning Committee is a faculty group appointed by Dean S. S. Attwood. The following is a list of the Committee and their department affiliation.

S. S. Attwood	Engineering Administration
G. V. Edmonson	Engineering Administration
S. K. Clark	Engineering Mechanics
R. A. Flinn	Metallurgical Engineering
W. H. Graves	Mechanical Engineering
R. B. Harris	Civil Engineering
R. C. Hawkes	Engineering Administration
L. N. Holland	Electrical Engineering
C. Johnson	Industrial Engineering
W. Kerr	Nuclear and Electrical Engineering
C. M. Land	Willow Run Laboratories
L. M. Legatski	Civil Engineering
J. E. Lesch	U.M.R.I.
H. P. Liepman	Aeronautical Engineering
P. Melgaard	Student Member
W. Mirsky	Mechanical Engineering
W. C. Nelson	Aeronautical Engineering
M. H. Nichols	Aeronautical Engineering
M. J. Sinnott	Metallurgical Engineering
J. Tarboux	Electrical Engineering
G. J. Van Wylen	Mechanical Engineering
G. L. West, Jr.	Naval Architecture and Marine Engineering

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