

CONDITIONS, SPECIFICATIONS AND RELATED DOCUMENTS FOR

UNIT B/C OF THE
UNIVERSITY OF MINNESOTA
HEALTH SCIENCES EXPANSION
PROJECT NO. MINN. 18 (HP)

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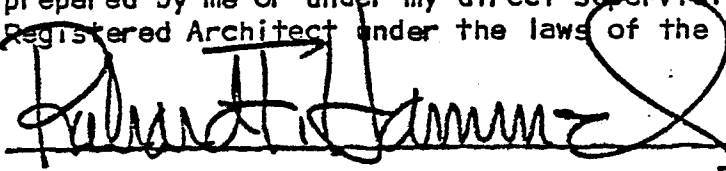
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As to Architectural Work:

I hereby certify that these plans, specifications or reports were prepared by me or under my direct supervision, and that I am a duly Registered Architect under the laws of the State of Minnesota.

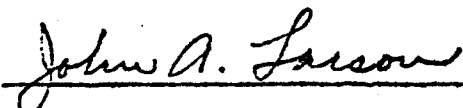


Date: September 2, 1975

Reg. No. 3667

As to Structural Engineering:

I hereby certify that these plans, specifications or reports were prepared by me or under my direct supervision, and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.



Date: September 2, 1975

Reg. No. 4625

TABLE OF CONTENTS

VOLUME ONE

ALL CONTRACTS

Pages

PROJECT IDENTIFICATION

Title Page

1 Page

Table of Contents

4 Pages

DIVISION A - BIDDING REQUIREMENTS

A1 Advertisement for Bids

A1-1 thru A1-2

A2 Instructions to Bidders

A2-1 thru A2-15

A3 Bid Form

A3-1 thru A3-9

A4 Bid Bond

A4-1

A5 Equal Opportunity and Affirmative Action Program Forms

A5-1 thru A5-5

DIVISION B - CONTRACT FORMS

B1 Agreement

4 Pages

B2 Contractor's Bond

2 Pages

DIVISION C - CONDITIONS OF THE CONTRACT

C1 General Conditions

C-1 thru C-54

C2 Wage Rate Determination

9 Pages

DIVISION 1 - GENERAL REQUIREMENTS

01010 Summary of Work and Special Requirements

01010-1 thru 01010-35

01100 Description of Alternates

01100-1 thru 01100-20

01150 Payment

01150-1 thru 01150-3

01200 Contract Time

01200-1 thru 01200-6

01250 Construction Schedule

01250-1 thru 01250-6

01300 Submittals

01300-1 thru 01300-5

01400 Testing and Inspection

01400-1 thru 01400-3

01500 Temporary Facilities

01500-1 thru 01500-25

01700 Project Close Out

01700-1 thru 01700-6

01800 Cash Allowances

01800-1 thru 01800-2

01910 Cutting, Removal and Patching

01910-1 thru 01910-5

01920 Test Borings

1 Page

Reports

65 Pages

VOLUME TWO

GENERAL CONSTRUCTION

DIVISION 2 - SITEWORK

02200 Earthwork

02200-1 thru 02200-10

02400 Protection, Excavation, Support Walls,
Underpinnings and Caissons

02400-1 thru 02400-5

02600 Bituminous Paving

02600-1 thru 02600-4

DIVISION 3 - CONCRETE

03100 Concrete Formwork

03100-1 thru 03100-6

03200 Concrete Reinforcement

03200-1 thru 03200-3

03300 Cast-in-Place Concrete

03300-1 thru 03300-19

03410 Architectural Precast Concrete

03410-1 thru 03410-12

03420 Structural Precast Concrete

03420-1 thru 03420-3

Pages

DIVISION 4 - MASONRY	
04100 Mortar	04100-1 thru 04100-3
04200 Unit Masonry	04200-1 thru 04200-11
04260 Brick Pavers	04260-1
DIVISION 5 - METALS	
05122 Structural Steel Erection	05122-1 thru 05122-5
05302 Metal Decking Erection	05302-1 thru 05302-3
05500 Metal Fabrications	05500-1 thru 05500-15
05750 Special Formed Metal	05750-1 thru 05750-6
DIVISION 6 - CARPENTRY	
06100 Carpentry	06100-1 thru 06100-11
06400 Custom Woodwork	06400-1 thru 06400-9
06412 Plastic Laminate Casework	06412-1 thru 06412-13
DIVISION 7 - THERMAL AND MOISTURE PROTECTION	
07110 Membrane Waterproofing	07110-1 thru 07110-10
07150 Dampproofing	07150-1 thru 07150-2
07210 Insulating Gradient Fill	07210-1 thru 07210-4
07220 Building Insulation	07220-1 thru 07220-6
07411 Preformed Metal Siding	07411-1 thru 07411-3
07510 Built-Up Bituminous Roofing	07510-1 thru 07510-13
07600 Sheet Metal Work	07600-1 thru 07600-9
07610 Sheet Metal Roofing	07610-1 thru 07610-3
07800 Roof Accessories	07800-1 thru 07800-2
07900 Gaskets, Caulking and Sealants	07900-1 thru 07900-8
DIVISION 8 - DOORS AND WINDOWS	
08110 Hollow Metal	08110-1 thru 08110-4
08113 Acoustical Hollow Metal	08113-1 thru 08113-3
08200 Wood Doors	08200-1 thru 08200-4
08330 Coiling Doors	08330-1 thru 08330-2
08331 Rolling Shutters	08331-1 thru 08331-2
08360 Sectional Overhead Doors	08360-1 thru 08360-3
08700 Finish Hardware	08700-1 thru 08700-11
08730 Weatherstripping and Soundstripping	08730-1 thru 08730-4
08800 Glass and Glazing	08800-1 thru 08800-5
08900 Curtainwall Systems	08900-1 thru 08900-20
DIVISION 9 - FINISHES	
09100 Lath, Plaster and Gypsum Drywall	09100-1 thru 09100-21
09300 Tile Work	09300-1 thru 09300-6
09500 Acoustical Treatment	09500-1 thru 09500-4
09510 Custom Acoustical Panels and Grid System	09510-1 thru 09510-5
09541 Metal Ceilings and Soffits	09541-1 thru 09541-4
09650 Resilient Flooring	09650-1 thru 09650-4
09750 Composition Seamless Flooring	09750-1 thru 09750-3
09760 Conductive Seamless Flooring	09760-1 thru 09760-6
09820 Elastomeric Coatings (S.G.-1)	09820-1 thru 09820-4
09830 Glazed Wall Coatings (S.G.-2)	09830-1 thru 09830-4
09841 Sprayed Fireproofing	09841-1 thru 09841-7
09900 Painting	09900-1 thru 09900-15

Pages

DIVISION 10 - SPECIALTIES

10100 Chalkboards and Tackboards	10100-1 thru 10100-3
10180 Toilet Compartments	10180-1 thru 10180-2
10200 Louvers and Vents	10200-1 thru 10200-3
10250 Firefighting Devices	10250-1
10270 Access Flooring	10270-1 thru 10270-3
10500 Lockers	10500-1 thru 10500-3
10501 Coin Operated Lockers	10501-1 thru 10501-3
10620 Folding Partitions	10620-1 thru 10620-5
10630 Operable Walls	10630-1 thru 10630-5
10800 Toilet and Bath Accessories	10800-1 thru 10800-4
10900 Wardrobe Accessories	10900-1 thru 10900-2

DIVISION 11 - EQUIPMENT

11180 Darkroom Equipment	11180-1 thru 11180-3
11320 Audio-Visual Aids	11320-1 thru 11320-4
11600 Laboratory Equipment	11600-1 thru 11600-18
11611 Metal Laboratory Casework	11611-1 thru 11611-32
11750 X-Ray Accessories	11750-1 thru 11750-2
11770 Sterilizers	11770-1 thru 11770-4
11861 Trash Chutes	11861-1 thru 11861-3

DIVISION 12 - FURNISHINGS

None

DIVISION 13 - SPECIAL CONSTRUCTION

13100 Audiometric Rooms	13100-1 thru 13100-9
13500 Integrated Ceilings	13500-1 thru 13500-13
13750 Radiation Protection	13750-1 thru 13750-4
13800 Sound Isolation	13800-1 thru 13800-4

VOLUME THREE

VERTICAL TRANSPORTATION

DIVISION 14 - CONVEYING SYSTEMS

14010 General Provisions - Vertical Transportation	14010-1 thru 14010-7
14210 Traction Elevators	14210-1 thru 14210-19
14220 Hydraulic Elevators	14220-1 thru 14220-11
14230 Elevator Cabs	14230-1 thru 14230-5
14240 Elevator Entrances	14240-1 thru 14240-3
14600 Escalators	14600-1 thru 14600-6

MECHANICAL CONSTRUCTION

DIVISION 15 - MECHANICAL

15010 General Provisions	15010-1 thru 15010-13
15100 Basic Materials and Methods	15100-1 thru 15100-7
15110 Pipe and Pipe Fittings	15110-1 thru 15110-6
15120 Valves	15120-1 thru 15120-6

DIVISION 15 - MECHANICAL (continued)

15130 Piping Specialties	15130-1 thru 15130-8
15140 Mechanical Supporting Devices	15140-1 thru 15140-4
15150 Vibration Isolation	15150-1 thru 15150-5
15160 Mechanical Systems Insulation	15160-1 thru 15160-8
15200 Water Service and Booster Pump System	15200-1 thru 15200-4
15220 Domestic and Laboratory Hot Water Systems	15220-1 thru 15220-4
15260 Soil and Waste System	15260-1 thru 15260-4
15270 Subdrainage	15270-1
15290 Roof and Area Drainage System	15290-1 thru 15290-2
15300 Plumbing Fixtures and Trim	15300-1 thru 15300-19
15310 Laboratory Fixtures and Trim	15310-1 thru 15310-25
15350 Gas Piping System	15350-1 thru 15350-2
15410 Compressed Air System	15410-1 thru 15410-3
15420 Laboratory and Clinical Vacuum System	15420-1 thru 15420-2
15430 Special Gases	15430-1 thru 15430-5
15460 Distilled Water System	15460-1 thru 15460-2
15470 Dental Oral Evacuation System	15470-1
15500 Fire Protection System	15500-1 thru 15500-7
- 15570 Fuel Handling System	15570-1 thru 15570-3
15600 Steam Heating System	15600-1 thru 15600-5
15650 Hot Water Heating System	15650-1 thru 15650-6
15710 Radiator Coolant System	15710-1 thru 15710-4
15800 Ventilation and Air Conditioning	15800-1 thru 15800-14
15830 Air Filtration Equipment	15830-1 thru 15830-3
15900 Air Conditioning Refrigeration	15900-1 thru 15900-19
15950 Mechanical Work for Fire Management and Environmental Control Systems	15950-1
15990 Chemical Treatment	15990-1 thru 15990-3

ELECTRICAL CONSTRUCTION

DIVISION 16 - ELECTRICAL

- 16010 General Provisions - Electrical	16010-1 thru 16010-8
16100 Electrical Basic Materials	16100-1 thru 16100-7
- 16110 Basic Systems and Methods	16110-1 thru 16110-6
16200 Electric Service System	16200-1 thru 16200-17
16210 Emergency Standby Systems	16210-1 thru 16210-5
16220 Service Grounding System	16220-1 thru 16220-2
- 16300 Electrical Distribution System	16300-1 thru 16300-7
- 16310 Electrical Secondary Devices	16310-1 thru 16310-5
- 16400 Lighting Fixtures	16400-1 thru 16400-12
16410 Lighting Control and Dimming Systems	16410-1 thru 16410-10
16500 Communications Systems	16500-1 thru 16500-7
16600 Special Systems	16600-1 thru 16600-12
16610 Lightning Protection	16610-1 thru 16610-3
16700 Electrical Power Equipment	16700-1 thru 16700-4
16800 Electric Heating Systems	16800-1 thru 16800-3
16900 Fire Management and Environmental Control Systems	16900-1 thru 16900-57

TABLE OF CONTENTS

SECTION 14010 GENERAL PROVISIONS - VERTICAL TRANSPORTATION

- 1.1 SCOPE
- 1.2 SCOPE OF WORK - VERTICAL TRANSPORTATION
- 1.3 RELATED WORK UNDER OTHER CONTRACTS
- 1.4 PERFORMANCE REQUIREMENTS
- 1.5 MAINTENANCE
- 1.6 FINISHES AND SAMPLES
- 1.7 QUALIFIED BIDDERS
- 1.8 INSPECTION AND ACCEPTANCE
- 1.9 SHOP DRAWINGS, WIRING DIAGRAMS AND PRINTED INSTRUCTIONS
- 1.10 GUARANTEE
- 1.11 PERMITS

SECTION 14210 TRACTION ELEVATORS

- 1.1 SCOPE
- 2.1 OPERATION
- 2.2 MACHINE ROOM EQUIPMENT
- 2.3 HOISTWAY EQUIPMENT
- 2.4 CAR EQUIPMENT
- 2.5 LANDING CONTROL STATIONS
- 2.6 SIGNALS

SECTION 14220 HYDRAULIC ELEVATOR

- 1.1 SCOPE
- 2.1 OPERATION
- 2.2 MACHINE ROOM EQUIPMENT
- 2.3 HOISTWAY EQUIPMENT
- 2.4 CAR EQUIPMENT
- 2.5 LANDING CONTROL STATIONS
- 2.6 SIGNALS

SECTION 14230 ELEVATOR CABS

- 1.1 SCOPE
- 2.1 ANCHORING CAB COMPONENTS
- 2.2 SHELL
- 2.3 CANOPY
- 2.4 WAINSCOT
- 2.5 ENTRANCE COLUMNS AND FRONT RETURN PANELS
- 2.6 TRANSOM AND SOFFIT
- 2.7 BASE
- 2.8 DOOR PANELS
- 2.9 CEILING
- 2.10 LIGHTING

- 2.11 VENTILATION
- 2.12 HANDRAILS
- 2.13 PADS AND HOOKS
- 2.14 SOUND DEADENING

SECTION 14240 ENTRANCES

- 1.1 SCOPE
- 2.1 STRUCTURAL MEMBERS
- 2.2 SILLS
- 2.3 ENTRANCE FRAMES
- 2.4 DOOR PANELS
- 2.5 NONVISION WINGS
- 2.6 INSIDE THE HOISTWAY

SECTION 14600 ESCALATORS

- 1.1 SCOPE
- 2.1 OPERATION
- 2.2 MACHINE ROOM
- 2.3 WELLWAY
- 2.4 STEP ASSEMBLY
- 2.5 SAFETY DEVICES
- 2.6 HANDRAIL
- 2.7 BALUSTRADE
- 2.8 LANDINGS
- 2.9 CONTROL STATIONS
- 2.10 SHOP FABRICATION

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this Division. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

1.2 SCOPE OF WORK - VERTICAL TRANSPORTATION

A. Work of this Contract includes furnishing and installing a complete elevator and escalator plant as shown on drawings and specified. All work and material necessary to accomplish this installation in a complete and workmanlike manner, except that specifically excluded as "Related Work under Other Contracts", shall be provided.

B. The work shall be done in accordance with local codes which may govern the requirements of the installation and the latest edition of the American Standard Safety Code for Elevators (referred to as the "ANSI Code"), including revisions and authorized changes in effect on the date of these specifications. In case requirements differ between codes, the more stringent shall apply.

C. In all cases where a device or part of the equipment is referred to in the singular number, it is intended that such reference shall apply to as many devices as are required to complete the installation.

D. Refer to Section 01500 for requirements for temporary elevator service during construction.

1.3 RELATED WORK UNDER OTHER CONTRACTS

A. General Construction:

1. Elevator pits, including access doors and ladders, etc.
2. Hoistway structure and walls.
3. Support for machine and deadend beams.
4. Temporary protection of hoistway and escalator openings during construction.
5. Floor openings for escalators.
6. Machine room structure, floors, walls, openings, hatches, gratings, doors, etc.
7. Structural support for escalator trusses.
8. Permanent guard rails around floor openings near escalators.

9. Escalator exterior balustrade and truss finish.
 10. Sheet metal enclosure around trash chute.
 11. Masonry work including grouting under entrance sills, filling around entrance frames and installation of guide rail inserts (inserts furnished by Elevator Contractor).
- B. Mechanical Construction:
1. Heating and ventilating of machine rooms.
 2. Pit drainage.
- C. Electrical Construction:
1. Pit and machine room lighting and power.
 2. Normal 3-phase mainline power feeders to terminals on each controller unit, including protected disconnect switch.
 3. Normal single-phase power feeders to terminals on each controller unit including 20-amp circuit breaker for car lighting and blower.
 4. 30-amp single-phase power feeders to one elevator control panel in each machine room as designated by the Elevator Contractor. (This may later be changed to 3 phase by Elevator Contractor as this varies from Contractor to Contractor.)
 5. Emergency 3-phase elevator mainline power via normal feeders. Voltage characteristics to be same as normal mainline power.
 6. A pair of conductors to a control panel in each elevator machine room as designated by the Elevator Contractor to signal the presence of emergency power.
 7. 1-1/2" diameter conduit between elevator machine rooms for Elevator Contractor's interconnection of emergency power control circuits.
 8. Emergency single-phase power for elevator car lighting and blower via normal power feeders.
- D. Other Contractors or Vendors:
1. Install telephone unit in the elevator car and connect circuit to each elevator hatch junction box: by telephone company.

1.4 PERFORMANCE REQUIREMENTS

- A. Contract Speed: The contract speed shall be provided for up direction travel with full-capacity load. The speed in either direction under any loading condition

shall not vary more than 5% of the contract speed for traction elevators or 10% for hydraulic elevators at full load up and no load down.

B. Capacity: In accordance with the ANSI Code, the elevator shall be designed and adjusted to safely lower, stop and hold the car with a load of 125% of the rated capacity.

C. Door Times: The door opening time shall not be longer than shown by the following:

<u>ELEVATOR NUMBER</u>	<u>TIME (SECONDS)</u>
4 THROUGH 9	1.6
13	2.0

Door opening time shall be measured from the instant the doors start to open until 1" from the fully open position. When the car stops level with the floor, the doors shall not be open more than 3/4 of their fully open position. The door closing time shall not be less than 3.0 seconds nor less than is permitted by the ANSI Code (under Rule 112.4). A kinetic energy of not more than 7 ft. lbs. shall be required to stop the closing doors at any point in their travel.

D. Floor-to-Floor Time: The time for a traction or hydraulic elevator to travel from floor to floor under any loading condition shall not exceed 8.5 and 16.0 seconds, respectively, for a typical floor-to-floor distance. Floor-to-floor time shall be level and stopped at the next floor with the doors 3/4 open. The above time shall be obtainable with dependable, consistent operation without undue wear or stress on the equipment and without excessive maintenance. Furthermore, the elevator shall provide a comfortable ride with smooth acceleration and retardation and a soft stop.

E. Retention: The Owner reserves the right to withhold payment of the final retainage portion of the contract amount until such time as all performance requirements as specified herein are satisfactorily met.

1.5 MAINTENANCE

A. Included with New Equipment Contract: The Elevator Contractor shall furnish maintenance including 24-hour call back on all equipment described in Division 14 of these specifications for a period of 12 months commencing on date of final acceptance of the systems under Vertical Transportation Contract. The maintenance shall include weekly systematic examination, adjustment and lubrication of all equipment. The Elevator Contractor shall also repair or replace electrical and mechanical parts whenever required and shall use only genuine, standard parts produced by the manufacturer of the equipment installed. All maintenance work shall be performed by competent personnel under the supervision and in direct employ of the Elevator Contractor.

B. Contract: Bidders shall also quote the monthly cost of a 5-year maintenance agreement to commence on completion of the 12-month period above. This quotation shall be submitted on the Bidder's own executed standard maintenance form with the bid but separate therefrom. Under this agreement, the Elevator Contractor shall at

all times maintain the performance requirements specified and shall submit monthly reports of inspections and repairs made. Safety test reports shall be furnished with details of tests performed. If this contract is accepted, the contract price may be adjusted as of the date of acceptance and thereafter as provided in the contract.

C. Interim: Completed or uncompleted elevators shall not be used by trades other than the Elevator Contractor without written permission of the Owner and as provided in Article 4.3 of Section 01500. In the event this permission is given, the General Contractor shall assume full responsibility for protection of the passengers, equipment, cab and doors, and shall pay the Elevator Contractor his standard rates for servicing the elevator during the period of such temporary usage. The Elevator Contractor shall restore the elevators at the completion of the Project, as specified under Section 01500.

1.6 FINISHES AND SAMPLES

A. Field Painting: The following equipment shall be thoroughly cleaned of oil, grease, scale and other foreign matter, and given one coat of field-applied machinery enamel by the Elevator Contractor. Enamel color shall be Contractor's standard.

1. Hoistway: All equipment and metal work installed as a part of this work which is exposed in the hoistway (unless galvanized).

2. Machine Room: Machine, motor generator, controller, selector, duct and conduit (unless galvanized).

B. Baked Enamel:

1. Prime: All surfaces, receiving a baked enamel finish shall be thoroughly cleaned of oil, grease, scale and other foreign matter before any finish is applied. All material shall receive one coat of rust-resisting mineral paint, after which a filler coat shall be applied over all uneven surfaces. The filler coat shall be sanded and ground off level and smooth, and a final coat of mineral paint applied.

2. Final: In addition to the prime finish specified above, 3 additional coats of best-grade enamel, solid color as selected, shall be applied and baked.

C. Natural Metals: All natural metals shall be stretcher-leveled, resquared sheets. Sheets shall be .063" minimum for door facings and .074" minimum for entrance frames and front returns. The grain of belting shall run in the direction of the longest dimension. A satin finish shall be provided by first removing tool and die marks and then finishing with sanding belts. All surfaces shall be perfectly smooth and without waves. Stainless steel shall be ASTM A167, Type 302 or 304 with No. 4 satin finish.

D. Machined Surfaces: Machine-finished surfaces shall be protected against corrosion by a coat of grease or tallow or other effective means as soon as the machining is completed.

E. Samples: Samples of all finishes and materials shall be submitted for the Architect's approval in accordance with Section 01300.

1.7 QUALIFIED BIDDERS

A. The Elevator Contractor shall be one regularly engaged in the business of design, engineering, manufacturing, installation and servicing elevators of the type and character specified. In the interest of unified responsibility and to avoid the use of field assembled equipment of various manufacturers which has not been specifically designed and engineered to operate in conjunction with other related devices, the Bidder must be a bona fide manufacturer of the controller (except relays), selector, related control signal apparatus, governor, safety, door operator and signal fixtures. The hoisting machine motor and motor-generator set shall either be manufactured by the Elevator Contractor or shall be manufactured to the specifications of the Elevator Contractor and as governed by these specifications.

B. Elevators and Escalators: The elevators and escalators shall be manufactured and installed by Houghton Elevator Company, Otis Elevator Company, Westinghouse Elevator Company, or approved equal.

C. Entrances: The entrances shall be manufactured and installed by C. E. Architectural Products; Globe Van Doorn Corporation; Hauenstein & Burmeister, Inc.; Houghton Elevator Company; Otis Elevator Company; Westinghouse Elevator Company; or approved equal. Installation shall be by the Elevator Contractor.

D. Cabs: The cabs shall be manufactured by C. E. Architectural Products; Globe Van Doorn Corporation; Hauenstein & Burmeister, Inc.; Houghton Elevator Company, Otis Elevator Company, Westinghouse Elevator Company; or approved equal. Installation shall be by the Elevator Contractor.

1.8 INSPECTION AND ACCEPTANCE

A. Inspection: Upon completion of the equipment installation, a team of competent men with instruments shall be provided to assist the Owner and/or his representative in making the following tests and inspections:

1. Verification of completeness of installation.
2. Contract speed check and floor-to-floor time check for compliance with performance requirements of these specifications (test weights required for this purpose shall be furnished by the Contractor).
3. A complete check of performance, including:
 - a. Starting, accelerating, running.
 - b. Decelerating, leveling, stopping.
 - c. Door operation.
4. A full-load run test shall be conducted on all elevators. The elevator shall be run at full speed with a full load for one continuous hour. During the test the traction elevators shall stop at each floor in both directions of travel and

shall stand idle for 10 seconds before proceeding to the next floor. During the test the hydraulic elevator shall stand idle for 45 seconds before proceeding to the next floor.

5. A temperature-rise test shall be conducted on the traction elevators. The temperature rise of the hoisting motor, motor generator and exciter shall be determined during the full-load test run. Temperatures shall be measured by the use of thermometers inserted into the various windings, etc., and shielded by cotton waste. Under this conditions the temperature rise of the equipment shall not exceed 50 degrees centigrade above ambient temperature. Test shall be started only when all parts of equipment are within 5 degrees centigrade of the ambient temperature at time of starting test.

B. Final Acceptance: Final acceptance of the entire installation shall be made only after all equipment has satisfactorily passed the aforementioned inspection and tests and the electrical diagrams have been provided.

C. Temporary Acceptance: Refer to Article 4.3 of Section 01500. When each elevator has been installed to a stage near completion and declared ready for service before entire erection of all elevators has been completed, the Owner may accept the elevator for use and place it in regular service.

1.9 SHOP DRAWINGS, WIRING DIAGRAMS AND PRINTED INSTRUCTIONS

A. Shop Drawings: Before beginning fabrication and work, shop drawings showing the plan views of the pit, hoistway, machine room, elevation view of the hoistway, cab and entrance details and details of the signal shall be prepared and submitted for approval. Refer to the Section 01300 for number and manner of submittals. Shop drawings shall be submitted within 60 days of contract award.

B. Wiring Diagrams: A complete reproducible set of "As Installed" straight-line wiring diagrams showing the electrical connections of all equipment, in the hoistway, as well as the machine room, shall be furnished prior to final acceptance. Also, a complete set of diagrams shall be mounted on 1/8" masonite sheets and mounted in a wall-hung rack in each machine room. A legend sheet shall be furnished with each set of drawings containing the following information:

1. Name and symbol of each relay, switch or other electrical apparatus.
2. Location on drawings, drawing sheet number and area of switches and relays, etc., and location of all contacts.
3. Location of apparatus - whether on controller, selector, motor-generator starter, hoistway or elevator car.

C. Printed Instructions: The following printed information shall be furnished prior to final acceptance:

1. A set of neatly bound instructions explaining all operating features, including all apparatus in the car control panels.

2. A set of printed instructions and recommendations for maintenance of all elevator equipment.

3. A lubrication chart, indicating all lubrication points and type of lubrication recommended for all equipment.

4. A complete parts catalog for all replaceable parts.

1.10 GUARANTEE

A. The materials and workmanship of the apparatus installed shall comply in every respect with these specifications and all defects not due to ordinary wear and tear or improper use or care, which may develop within one year from date of final acceptance of the entire project shall be corrected to the satisfaction of the architect at no additional cost. Refer to the General Conditions.

1.11 PERMITS

A. The Elevator Contractor shall obtain and pay for necessary municipal or state inspections and permits and make such tests as are called for by the regulations of such authorities. These tests shall be made in the presence of the authorized representatives of such authorities.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Related Work Specified Elsewhere:

- | | | |
|----|---------------------|---------------|
| 1. | General Provisions: | Section 14010 |
| 2. | Elevator Cabs: | Section 14230 |
| 3. | Elevator Entrances: | Section 14240 |

C. Equipment Summary:

- | | | |
|----|-------------------------|---|
| 1. | Group and Number: | West: No. 4, 5 and 6
East: No. 7, 8 and 9 |
| 2. | Duty: | No. 4 and 5: 4000# at 700 f.p.m.
No. 6: 6000# at 700 f.p.m.
No. 7, 8 and 9: 4000# at 500 f.p.m. |
| 3. | Landings and Entrances: | No. 4 and 5: B, 1 through 9 and
11 through 15
No. 6: B, 1 through 15
No. 7, 8 and 9: 1 through 9 |
| 4. | Travel: | No. 4, 5 and 6: 214'-8"
No. 7, 8 and 9: 109'-4" |
| 5. | Supervisory Control: | Group automatic |
| 6. | Motor Control: | Variable voltage with automatic leveling |
| 7. | Entrance Size: | No. 4, 5, 7, 8 and 9: 4'-0" wide x
7'-0" high
No. 6: 4'-4" wide x 7'-0" high |
| 8. | Entrance Type: | Single speed, center opening |
| 9. | Door Operator: | High speed, heavy duty with DC motor |

- | | | |
|-----|---------------------------------|--|
| 10. | Door Protection: | Safe edges and double light rays with timing feature |
| 11. | Signals: | Hall lanterns, car position indicator, lobby control and indicator panel, illuminating pushbuttons |
| 12. | Communications: | Telephone system |
| 13. | Machine: | Overhead gearless traction |
| 14. | Equipment for Future Elevators: | Machine beams, 6-car group supervisory control circuitry, complete lobby control panel circuitry |
| 15. | Power Characteristics: | 480 volts AC, 3 phase |
| 16. | Additional Features: | Hoistway access switches
Load weighing device
2 car control stations
Operation on emergency power
Fireman's return and operation
Independent service
Buffer ladders and platforms
Motor generator shutdown switch
Anti-nuisance feature
Separate riser of pushbuttons on Elevator No. 6
Braille on car control stations
Handicapped accommodations
Nickel-silver car sill
Car and counterweight roller guides
Rope compensation on No. 4, 5 and 6
Emergency exit contacts
12-month full maintenance
Platform isolation
Rail backing (as required)
Car top station
Emergency service On No. 6 |

PART 2: PRODUCTS AND INSTALLATION

2.1 OPERATION

A. General: The elevators shall operate as individual groups as indicated in the Equipment Summary. Hall buttons shall be located at each floor, with buttons in each car corresponding to the floors served. Elevators shall be operable without an attendant and shall automatically start in response to calls registered by momentary pressure on the car or hall buttons. The elevator cars shall slow down and stop automatically at the landing corresponding to the call registered on the hall or car button. The stops shall be made in the order in which they are approached

by the elevator for each direction of travel, irrespective of the order in which they were registered. Only one car, traveling in the corresponding direction, shall stop in response to a hall button call. Simultaneous to the initiation of the slow down of a car for a hall call, the call shall be automatically canceled and shall remain so and the hall button corresponding to the elevator's direction of travel shall remain ineffective until the car leaves the floor. The calls registered on the car buttons shall cancel in the same manner as the hall buttons.

B. Operational Control: Each group of elevators shall be provided with an automatic 6-car group supervisory control system, operating to meet changing traffic conditions on demand response. The system shall include provision for handling traffic which is predominately in the up direction, predominately in the down direction, 2-way direction with periods in which traffic may be heavier in either direction, and intermittent or very light. As these traffic demands vary, the supervisory system shall automatically and continually provide any necessary changes in the mode of operation to provide the most effective means of handling the existing traffic condition. Acceptable systems shall be Houghton 10921C with Accu-flite, Otis VIP 260CL with ZIP and Westinghouse Mark IV with DMR. (Reprogrammable computer control is acceptable from any Bidder.)

C. Independent Service: It shall be possible to remove each elevator from service individually and operate it as a single elevator with an attendant, independently of the dispatching signals and landing buttons. When operated on independent service, the hall lanterns at typical floors for this elevator only shall not function.

D. Emergency Service (Elevator No. 6 Only): A spring-return keyed switch shall be located in each of the separate riser hall pushbutton fixtures to call the elevator. Actuating the key switch at any floor shall trigger a low-volume, single-stroke gong and illuminate a red signal light in the car operating panels indicating to riding passengers that the car is required for emergency service. Existing car calls shall be canceled and the elevator shall express to the floor where the key has been momentarily actuated. After the elevator arrives, the doors shall open and remain open until the car is placed on emergency service by means of a 2-position key-operated switch in the car operating panel. If this action is not taken within approximately 60 seconds (time to be adjustable), the doors shall close and the car shall return to normal service. When on emergency service, actuation of the desired floor button shall immediately cause the elevator doors to close and the car shall express directly to the selected floor, by-passing all hall calls. The elevator shall be returned to normal service when the emergency key is removed from the switch in the car operating panel. The emergency service feature shall automatically override and take preference over the independent service feature.

E. Independent Freight Service (Elevator No. 6 Only): The elevator shall be arranged to operate from a separate riser of hall buttons located in the hoistway entrance frame at all floors. When placed on independent freight service, this elevator shall be removed from the dispatching system and shall not respond to the normal hall buttons. It shall operate as a selective-collective elevator, without an attendant, and shall respond to the separate riser of hall buttons and car buttons only. The normal signals shall continue to function when this elevator is on special freight operation. Selection of group or freight operation shall be accomplished automatically by means of timers and manually by means of a key-operated switch at

a selected location. Timers shall be provided to automatically cause this elevator to operate with the group during the morning, noon and evening traffic peaks during the normal work week. During periods other than these 3 traffic peaks, the elevator shall automatically be switched to independent freight service by means of timers. It shall also be possible by means of a key-operated switch to manually override the timers and place the elevator on either group of freight operation.

F. Motor Control: The motor control on all elevators shall be generator field control type; suitable for the operation specified and capable of providing smooth, comfortable acceleration, retardation and dynamic braking, limiting the difference in speed between full load and no load to not more than 5% of the contract speed. Solid-state power conversion units shall not be used.

G. Motor-Generator Timing: An automatic timing device shall be provided which will shutdown each motor-generator set in the order in which the car becomes idle. This device shall be adjustable to keep the motor-generator set running up to 3 minutes after the last call.

H. Automatic Leveling: An automatic 2-way leveling device shall be provided, designed to govern the leveling of the car to within 3/8" above or below the landing sill. The leveling operation shall be effective to avoid overtravel, as well as undertravel, of the car and maintain the leveling accuracy regardless of the load in the car, direction of travel, rope slippage or stretch in ropes.

I. Load Weighing: A means shall be provided for weighing the load in the elevator car. This device shall be designed into the control system to provide dispatching in advance of normal dispatch intervals and provide landing call by-pass when the elevator is filled to approximately 80% of full-capacity load. The setting shall be manually adjustable.

J. Door Operation: Doors shall open automatically when a car arrives at a terminal to permit egress of passengers whether or not the terminal floor call has been registered in the car. When another car is at the terminal and is loading for departure or upon expiration of a timed interval, the doors shall close and remain closed until this car is scheduled for loading. If no other car is at the terminal, an arriving car shall have its doors open until the car is dispatched or expiration of a timed interval with no demand.

K. Emergency Features:

1. Out-of-service Adjustment: In the event an elevator becomes shutdown or delayed for a predetermined interval of time, it shall automatically be taken out of the dispatching system and shall not cause delays in the dispatching of the other cars. The circuits shall also be designed to enable normal answering of all landing calls by other elevators in the group, regardless of where the "Out-of-Service" elevator is parked.

2. Auxiliary Hall Call Operation: In the event of hall button failure, a light shall illuminate in the lobby control panel. A switch shall be provided in that panel to actuate a system of automatic stops so that all floors will be served by the elevator.

3. Auxiliary Dispatchings: If for any reason the elevator dispatching system should fail to operate, provisions shall be made for auxiliary dispatching until normal automatic dispatching is restored.

4. Successive Starting: In the event of power interruption, motor-generator sets in the same group shall not start up simultaneously when power is restored.

5. Emergency Lighting: Emergency power for the car lights and blower shall be provided via the normal power conductors. Emergency car lights and blower shall function in the event of a normal power failure.

6. Emergency Power Transfer: In the event of normal power failure, the elevators shall be arranged to automatically return on emergency power to a preprogrammed floor, one car at a time. Operational features such as Independent Service shall be overridden allowing the elevator return. After all cars have been returned to this floor, a preselected elevator shall remain on emergency power. Emergency power shall be supplied through the normal machine room feeders. Provide selection switches so that the return operation can be interrupted and one car designated to run in case of an emergency situation. A pair of wires carrying emergency power shall be supplied to the controller designated by the Elevator Contractor in each machine room to supply a signal indicating power failure and activation of emergency operation. All other controls and provision for operation of each elevator on the emergency power supply shall be provided and installed by the Elevator Contractor.

7. Fireman's Return and Operation: Emergency return and operation in accordance with Rule 211 of the ANSI Code shall be provided. Controls, keys and instructions shall be located in the lobby floor control panel. Smoke sensors shall not be required.

L. Anti-Nuisance Feature: Controls shall be provided to recognize a condition where an abnormal number of calls are registered without the appropriate number of passengers requiring service. When this condition is "recognized", registered calls shall be canceled.

M. Disconnected Floors: The elevator circuitry shall be temporarily modified to prevent normal elevator service to the specific floors indicated on the drawings. This feature shall be overridden by Independent Service and Fireman's Operation to provide elevator service to these floors only on these modes of operation.

2.2 MACHINE ROOM EQUIPMENT

A. General: All equipment specified hereafter, except the governor-tension sheaves, shall be located in the machine spaces as indicated in the drawings. Alternate arrangements must be approved by the Architect. The machine, controller, selector, motor generator, starter, governor, mainline and auxiliary switches shall be provided with identifying decal or painted numerals.

B. Gearless Machine:

1. General: The machine shall consist of a motor, a drive sheave and a brake, all grouped on a single bedplate. Rotating parts shall be securely mounted in proper alignment on a forged-steel shaft. The shaft shall rotate on ball or roller bearings. Bearings shall be provided with automatic, self-lubrication from oil reservoirs. Oil gage and drain cocks shall be provided.

2. Bedplate: The bedplate shall be heavy structural steel shapes welded together. Plane or mill seal surfaces for parts secured to bedplate. Use cap screws or tap bolts to secure parts to bedplate where practical. Use of brackets or other extensions, bolted to bedplate shall not be permitted. The bedplate shall be isolated from the machine rooms to minimize the transmission of sound and vibration into the building structure.

3. Motor: The motor shall be direct-current, shunt-wound, slow-speed type, designed to develop required high-starting torque with low-starting current. The field coils shall be form or spool wound with windings in both the armature and fields arranged to permit reasonably easy renewal. The armature shall be electrically balanced and the sheave and brake drum shall be mechanically balanced. The commutator and brushes shall have sufficient area to prevent sparking or overheating under full load and shall have an individual-tension adjustment with means to adjust and lock brush holder as a unit. The motor shall run in either direction under full load without excessive heating or sparking and with one brush setting for loads and speeds within the specified duty range. The actual motor speed with any load from empty car to full-rated capacity shall not vary more than 5% from normal-rated speed. The motor coils shall be impregnated and baked to prevent moisture absorption. Insulation resistance between conductors and frame of motor shall be not less than one megohm. Dielectric shall successfully pass breakdown test of 1500 volts alternating current applied for not less than one minute.

4. Sheave: The driving sheave shall be hard cast iron or semi-steel, suitably grooved to produce proper traction, and shall be thick enough to provide for future wear in grooves. The diameter of the driving sheave shall not be less than 52 times the diameter of the hoist ropes. The drive sheave grooves and flanges shall be smooth turned and shall run true. The sheave shall be free from cracks, sand holes or other imperfections that would injure the ropes. The drive sheave and brake drum shall be keyed and secured to the rotating element. The secondary sheave shall be mounted to the machine beams in proper alignment with driving sheave.

5. Brake: An electromechanical brake shall be provided which shall consist of a brake drum cast integrally with the traction sheave, 2 brake shoes, 2 heavy springs to actuate the brake and an electromagnet to release brake. The brake shoes and springs shall be of sufficient size and strength to stop and hold a downward traveling car carrying 125% of its rated load. The brake drum wearing surface and edges shall be smooth turned. The brake shoe lining shall be fireproof-friction material and shall be shaped so that the drum will run free with a minimum clearance. Helical springs shall operate in compression to apply the brake when the electromagnet is deenergized. The electromagnet shall be deenergized by open safety devices, power failure, failure of any unit to function for safe operation of car, and upon normal stopping of car.

C. Motor-Generator Set:

1. General: A motor-generator set shall be provided. The motor-generator set shall run at 1200 or 1800 r.p.m. with an AC induction motor, suitable for the power supply characteristics, all in accordance with AIEE Standards for 70 degrees continuous operation. Both motor and generator shall be compactly mounted on a single-forged steel shaft which turns on sleeve, ball or roller type bearings. The entire rotating element shall be statically and dynamically balanced. Selenium dry-plate rectifiers or an exciter shall be provided to supply the direct-current power for operation of controller, brake, etc.

2. Bedplate: All units of the set shall be mounted on a single bedplate or on a unit frame with supporting feet. The entire unit shall be mounted on rubber, or equal, isolation pads to minimize the transmission of sound and vibration into the building structure.

3. Commutation: The set shall be designed for maximum efficiency and minimum noise and vibration. The commutation must be sparkless when running full speed with full load. No more than pin-point sparking shall be visible when accelerating and decelerating.

D. Selector: The floor selector shall be solid state or moving crosshead type. It shall simulate movement of the elevator, either by direct connection to the elevator car or by electrical coupling. The mechanical features and electrical circuits shall be designed to permit accurate control and rapid acceleration and retardation without passenger discomfort, and shall also provide electrical contact for operation of signal equipment. All relays, switches, contacts, mounting panels, terminal boards, etc., shall conform to the specifications for the Controller. The design of the selector shall provide easy access to mechanical parts and electrical equipment for adjustment or renewal.

E. Controller:

1. Frame: All controller switches, relays and other items of control equipment shall be mounted on panels made of moisture-resisting, noncombustible material. The panels shall be securely mounted on substantial, self-supporting steel frames with suitable fastenings. A vibration-absorbing mounting shall be provided for the steel frame to minimize the transmission of sound and vibration into the building structure.

2. Switch and Relay Design: Switches and relays shall be of the direct-current, magnet-operated type with contacts of design and material to insure maximum conductivity, long life and reliable operation without overheating or excessive wear. A wiping action between contacts shall be used to prevent sticking due to fusion. Switches carrying highly inductive currents shall be provided with arc-deflectors or suppressors.

3. Component Mounting: All switches and relays shall be mounted on the front of panels together with any small electronic components. Large capacity resistors shall be mounted on the rear or top of panels. All components shall be readily accessible and easily renewable.

4. Protective Devices: Equipment shall be provided to protect the driving motor of the generator against phase reversal, overload and single phasing in all 3 phases of the "Delta" connection. The generator shall be protected against overload.

5. Time Delay Relay Design: Where time delay relays are employed in the circuits, they shall be of an accepted design that is reliable and consistent, such as condenser or electronic timing circuits.

6. Wiring: Wiring on the controller, whether factory or field wired, shall be done in a neat, workmanlike manner with all connections made to studs and/or terminals by means of grommets, solderless lugs or similar connections.

7. Terminal Blocks: Terminal blocks with identified studs shall be provided on the controller for connection of controller board circuitry with external wiring.

8. Marking: Identifying symbols or letters shall be permanently marked on or adjacent to each device on the controller and the marking shall be identical with markings used on the wiring diagrams. In addition to the identifying marks, the ampere rating shall be marked adjacent to each fuse holders.

9. Cabinet Design: A metal cabinet, with hinged doors at front and back with adequate ventilation to dissipate heat, shall completely enclose the controller.

F. Governor and Tension Sheave:

1. General: The governor shall be centrifugally operated and shall conform to the ANSI Code. It shall be mounted over the hoistway and be connected to the car safety tripping mechanism by means of a wire rope. The governor rope shall pass over the governor sheave and the weighted tension sheave in the pit.

2. Tension Sheave: The tension sheave in the pit shall be mounted in a weighted steel frame securely fastened to the main car or counterweight guide rails and provided with guides or pivot points to enable free vertical movement.

3. Jaw Design: The governor jaws shall grip the cable in a minimum time after the governor reaches its tripping speed and shall be held in engagement with the cable by springs and the tension of the governor cable. The governor jaws shall be designed so that the governor cable may slide through them after the safety has set, without damage to the cable.

4. Adjustment: The governor shall be accurately adjusted to operate within limits specified by the ANSI Code. All adjustable parts shall be sealed.

5. Switches: The operation of the governor on overspeed shall open a switch disconnecting the power from the elevator before the safety mechanism has tripped. A 2nd switch shall be provided to reduce the speed of the elevator prior to the operation of the disconnect switch.

6. Marking Plate: A metal marking plate shall be securely fastened to the governor and marked with governor tripping speed and rope size and construction.

G. Machine Beams: Provide the structural steel beams required for support of all elevator machine, secondary and 2:1 sheaves, deadend hitches, etc. The elevator shop drawings shall show size and location of any beam pockets required for support of these beams. Also, bearing plates, anchors, shelf angles, blocking, etc., shall be provided to securely support beams and equipment. This equipment shall also be provided for all future elevators.

H. Templates, Forms, Sleeves and Guards: All templates, forms and sleeves for providing necessary opening in the concrete slab over the hoistway shall be provided as part of this work. Sleeves for conduit and other small holes shall project 2" above the concrete slab and 2" steel angle guards shall be provided around the cable or duct slots.

2.3 HOISTWAY EQUIPMENT

A. Secondary, Compensation and 2:1 Sheaves:

1. General: The secondary, compensation and car and counterweight 2:1 sheaves shall be of hard cast iron, cast steel or semi steel of approved composition with accurately machined grooves.

2. Mounting: The secondary sheave shall be securely mounted on the underside of the machine beams and in proper alignment with the driving sheave. The compensation sheave shall be mounted in a steel frame, provided with slide-type shoes to ride on steel guides securely mounted to the pit floor. An electrical contact shall be mounted on the compensation sheave frame and shall be electrically connected into the control circuits to prevent operation of the elevator when the sheave approaches the upper or lower limit of travel. The car and counterweight 2:1 sheaves shall be securely mounted between the car and counterweight crosshead structural members.

3. Lubrication and Bearings: The sheaves shall have provision for self-lubrication from an integral oil or grease reservoir and shall have drain cocks or plugs. The sheave bearings shall be of the roller type.

4. Guards: A sturdily constructed metal sheave and drip pan mounted beneath all sheaves shall be designed to withstand shock and prevent ropes from leaving their proper grooves, and shall collect lubricant drippings. The compensation and 2:1 sheaves shall be protected to keep objects from falling between the ropes and sheave grooves.

B. Guide Rails and Brackets:

1. General: T-section guide rails shall be provided with a weight per foot as determined by the ANSI Code.

2. Fastenings: All guide rails shall be fastened to substantial steel brackets by heavy rail clips. Rails shall extend from the pit floor to the

underside of the overhead slab. They shall be erected plumb and parallel and shall not deviate more than 1/8". Guide rails shall be fastened to structural forms on the pit floor. Where guide rail brackets are fastened to concrete beams or walls, suitable inserts, together with all information relative to their location, shall be furnished as part of this work.

3. Joints: All guide rails shall have accurately machined tongue and groove joints and shall be machined on the back surfaces to take the machined, steel-joining plates.

4. Shimming: All shimming used to mount guide rails or brackets shall be of metal and shall not depend on friction alone to retain its location.

5. Backing: Only those supports so indicated on the drawings shall be furnished as work in other sections. Structural steel guide rail backing or framing shall be furnished and installed to stiffen rails whenever necessary. Intermediate tie brackets shall be provided for counterweight rails as required by the ANSI Code.

6. Drawing Information: Guide rail loads upon safety application, bracket spacing schedule and rail backing location shall be shown on the shop drawings.

C. Oil Buffers:

1. General: Oil buffers shall be located in the pits under the car and counterweight, together with all necessary blocking and supports. The buffers shall be anchored to structural forms on the pit floor and shall be arranged to avoid puncturing of pit waterproofing.

2. Design: The buffers shall be of the spring-return type except the counterweight buffer shall be of the gravity-return type, if fastened to the counterweight. Permanent means shall be provided for each inspection of the oil level in the buffers.

3. Marking Plate: Buffer marking plates required by the ANSI Code shall be of corrosion-resistant metal and shall indicate the buffer stroke.

4. Drawing Information: Buffer load reactions and buffer stroke shall be indicated in the shop drawings.

5. Inspection Ladders: Buffer inspection ladders with an attached platform shall be provided as a part of this section. The ladder shall be fabricated from steel tubing and shall be securely held in place when in use. The ladders shall meet the requirements of the inspecting authority.

D. Counterweight and Roller Guides:

1. General: The counterweight shall weigh the same as the complete elevator car plus approximately 40% of the specified capacity load. It shall consist of a structural steel frame and cast iron or steel plate filler weights all held securely in alignment with tie rods passing through holes in the weights and frame members. Rods shall be equipped with locknuts secured by cotter pins at each end.

2. Roller Guides: The counterweight frame shall be provided with 4 sets of roller guides to provide smooth, quiet travel. The guide shoes shall consist of at least 3 rollers of a durable, resilient, oil-resistant material, mounted on a substantial metal base. The design of the roller guides shall be such that all rollers shall have continuous contact with the corresponding guide rail surface under all conditions of loading.

E. Hoisting, Compensation and Governor Ropes:

1. Hoisting Ropes: Hoisting ropes shall be proper size and number to insure good wearing qualities. As a minimum, the number of ropes shall comply with the factor of safety requirements of the ANSI Code, Rule 212.3.

2. Governor Rope: The governor rope shall be of construction and composition required for the governor furnished. Under normal operation of the elevator, the governor rope shall run free and clear of governor jaws, rope guards and other stationary parts.

3. Compensation Ropes: The weight of the hoistway cables and the unbalanced portion of the traveling cable weight shall be compensated by means of ropes if necessary for proper performance. The ropes shall be fastened at one end to the counterweight and at the other end to a hitch plate on the bottom of the elevator car and shall pass under a weighted-tension sheave in the pit.

4. Shackles: Adjustable rope shackles with individual tapered, babbitted sockets shall be provided for each end of the ropes.

F. Normal and Final Terminal Stopping Devices:

1. Normal Device Operation: Normal terminal stopping devices shall be provided, consisting of electrical contacts located on top of the elevator car which are operated by cams mounted at the top and bottom of the hoistway or shall consist of electrical contacts located at the top and bottom of the hoistway and operated by a cam or cams located on top of the elevator car. This device shall automatically bring the elevator to a stop at the top and bottom terminal landings with any load up to and including 125% of the contract capacity from any speed attained in normal operation. This device shall operate independently of any other operating devices and shall continue to function until the final limit switch operates.

2. Final Device Operation: Final limit switches located at the top and bottom of the hoistway shall be arranged to automatically stop the car and counterweight within the predetermined overtravel limits, independently of all other operating devices.

3. Rollers: Switches shall be equipped with engaging arms provided with rubber-tired rollers for engagement with cams.

G. Electrical Wiring:

1. General: All wiring between the machine room, hoistway junction box, car junction box, landings, pit and other associated equipment shall be furnished and

installed as part of this work. Wiring shall be copper, properly insulated, and have a flame-retarding and moisture-resisting outer cover. It shall be run in galvanized or painted metallic conduit or duct, using strain boxes as required. All material used and method of installation shall conform to the National Electrical Code.

2. Conduit and Duct: In accordance with Section 0130 and Article 1.9 of Section 1401, Contractor shall submit for approval shop drawings of electrical metallic tubing or metal wireways prior to installation. If metallic tubing is used, extra care shall be used to insure satisfactory mechanical installation. Except for the DC Loop, each conduit run or duct run shall contain 10% spare wires and in any event not less than one spare wire. Except as follows, conductors shall be run in rigid steel conduit, electrical metallic tubing or metal wireways, 1/2" and larger:

a. Traveling cable to elevator cars.

b. Connections not exceeding 36" in length between risers and limit switches, interlocks, pushbutton boxes, door operator motors and similar devices may be run in flexible metal conduit.

c. Flexible hard service cord, Type S0, between fixed car wiring and car door switches.

3. Traveling Cables: The car operating panel, position indicator and other electrical equipment in the car shall be connected with the controller by means of flexible cable run from the bottom of the car to an outlet in the hoistway. Cables shall have a flame-retarding and moisture-resisting outer cover, shall have steel-supporting fillers and shall be suspended directly by them to relieve the conductors of strain. Each traveling cable shall contain 10% spare wires and in any event not less than one spare wire.

4. Terminal Connections: Terminal connections for all conductors shall be made on terminal blocks or studs having identifying numbers. All conductor connections shall be made with terminal eyelets of the solderless type.

5. Communications: Provide a minimum of 4 sets of insulated communication wires in the traveling cables, extending from the hoistway junction box to the car junction box, communication cabinet, etc.

H. Entrance Equipment:

1. Hangers and Tracks:

a. Hangers: Each door panel shall be equipped with sheave-type, 2-point suspension hangers with provisions for vertical and lateral adjustments. The hangers shall consist of a malleable iron or steel bracket, approximately 1/4" thick, equipped with 2 sheaves, provided with ball-type bearings, properly sealed to retain grease lubrication.

b. Upthrust Rollers: Rollers, provided with ball type bearings, sealed to retain grease lubrication, shall be provided on the hanger bracket to

take the upthrust of doors. An eccentric shaft mounting shall permit fine upthrust roller adjustments.

c. Tracks: Tracks for hangers shall be of basic open-hearth steel, approximately 190 Brinell hardness, not less than 2" x 2" x 1/2" thick, and be cold drawn to a smooth finish. The upper edge of the track shall have a contour to match that of the main sheave. Alternately, tracks may be formed, cold-drawn steel with smooth track finish. Track shall be fastened to the header at frequent intervals to insure permanent track alignment and be removable for repair or replacement.

d. Interlocks: Hoistway doors shall be equipped with an electromechanical interlock, designed to prevent the starting of the car until the doors are closed and locked. Engaging components of the mechanical-locking device shall be free of noises.

e. Closers: A mechanical door-closing device shall be provided for each entrance to assure automatic closing of the hoistway doors and prevent the hoistway doors from standing open when the car is not at the landing. Weighted closers shall not run in frames attached to door panels.

1. Pit Stop Switch: An emergency stop switch shall be provided adjacent to the access in each elevator pit and shall function similar to the switch in the elevator car. It shall conform to the requirements of the ANSI Code, Rule 210.2.g.

2.4 CAR EQUIPMENT

A. Car Frame and Safety:

1. Frame: The car frame shall consist of steel channels securely fastened together, reinforced and braced to provide a rigid structure for mounting the platform and car enclosure. The car frame height shall be sufficient to enable installation of the specified car enclosure.

2. Safety: A flexible guide clamp type car safety shall be securely mounted integrally with the plank channels and shall be provided with linkage and lever arms for connection with the governor rope. The safety shall be designed so that in the event of excessive descending speed, the tripping of the governor shall cause the safety jaws to grip the guide rails and bring the car to a gradual stop in accordance with the requirements of the ANSI Code. The safety shall be reset by lifting the elevator car.

3. Safety Contact: An electrical contact, connected electrically in the safety circuit and mechanically to the safety device, shall be arranged to shut off the power to the elevator motor upon engagement of the safety jaws.

B. Guides: The car frame shall be provided with 4 sets of roller guides to provide smooth, quiet elevator travel through the hoistway. The roller guides shall consist of at least 3 rollers, of a durable, resilient, oil-resistant material, mounted on a substantial metal base. Each roller shall rotate on precision-grade ball bearings. The entire elevator car shall be properly balanced to equalize pressures on all guide rollers. All rollers shall have continuous contact with

the corresponding guide rail surface under all conditions of loading. The maximum speed of rotation of the car rollers shall not exceed 350 r.p.m.

C. Platform: The car platform shall be constructed of wood, steel, or steel-and-wood sandwich and shall be suitably braced to meet ANSI Code deflection requirements. The platform shall be mounted on rubber, or equal, vibration and sound-absorbing pads within a steel frame. This frame shall be securely fastened to the plank channels and shall be amply braced so that no strain will be transmitted to the car enclosure. The underside of platform, if of wood, shall be covered with sheet steel not less than No. 26 U. S. gage.

D. Floor Covering: 1/8" thick vinyl asbestos floor tile shall be laid on 1/16" thick asphalt felt. Both tile and felt shall be securely cemented in place. The finish surface of the tile shall be flush with the top surface of the sill. The tile shall match the tile chosen by the Architect for other parts of the building as specified in Section 0965.

E. Sill: A narrow extruded white bronze or nickel-silver sill shall be securely fastened to the platform. The sill shall have accurately machined slots for guiding the door gibs. It shall be of sufficient height above the platform to provide a flush line with the floor covering and shall be arranged so that no tripping hazard exists across the entrance where the sill meets the floor covering. The nosing of the threshold shall have a machined rabbet to receive the toe guard and shall be of such depth to provide a flush surface from the nosing to the toe guard.

F. Toe Guard: An apron, or guard, constructed of not less than No. 14 U. S. gage steel, shall be fastened to the car sill and shall be securely braced to the platform. It shall extend 3" beyond both sides of the widest hoistway opening and shall conform with the ANSI Code, Rule 203.9.

G. Door Operator:

1. General: A high-speed, heavy-duty, master-type door operator shall automatically open the car and hoistway doors simultaneously when the car is leveling into a landing and automatically close the doors simultaneously at the expiration of the open timing.

2. Construction: The direct-current motor shall be of the high-internal resistance type, capable of withstanding high currents without damage to the motor. All door operating arms shall be constructed of substantial steel members and pivot points shall have ball or roller bearings.

3. Operation and Speed: The door operator shall be capable of opening a car door and hoistway door simultaneously at a maximum speed of not less than 2-1/2 f.p.s. A reversal of direction of the doors from the closing to opening position, whether initiated by the door edge reopening device, the photoelectric device, or the door open button, shall be accomplished within no more than 2-1/2" of door movement. Particular emphasis is to be placed on obtaining quiet interlock and door operation, and smooth, fast, dynamic braking for door reversals and stopping of the doors at both extremes of travel. The door operating mechanism shall be arranged so that in case of interruption of power or failure of the operating

circuits, the car and hoistway doors can be readily opened by hand from within the elevator car.

H. Car Door Electrical Contact: An electrical contact shall be provided to operate in conjunction with the car doors so that the elevator cannot be operated unless the doors are closed or within the tolerance allowed by the ANSI Code.

I. Header: A header shall be installed which shall be constructed of at least 3/16" thick steel and shall be shaped to provide stiffening flanges at top and bottom, extending its entire length.

J. Car Door Hangers and Tracks: The car door hangers and track shall conform to the specification on the Hoistway Entrance Hangers and Tracks, Paragraph 2.3 H.

K. Door Reopening and Control Devices:

1. Safe Edge Device: A mechanical device shall extend the full length of each leading car door panel and project no less than 1-3/4" nor more than 2-1/2" beyond the edge of both car and hall door panels. This device shall be so arranged that should it touch a person or any object in its path while closing, it shall automatically cause both the car door and hoistway doors to return to the open position. Safety edge movement or compression of not greater than 1/2" shall initiate door reversal. The safety edge shall retract to a position flush with the car and hoistway doors when in the fully open position. The door edge shall function at all times when the doors are not closed, irrespective of all other operating features.

2. Photoelectric Beam Control: Photoelectric devices, consisting of photoelectric tubes and light sources shall be located on the elevator car on the hoistway side of the car door. The tubes shall project 2 parallel light beams across the elevator car entrance. The beams shall be located at the heights of 6" to 10" and 35" to 40" above the platform. The light sources shall be housed in light-tight enclosures with infrared filters over the lens. The interruption of the light beams when the doors are closing shall automatically cause the doors to fully reopen and remain open until the light beams are reestablished. A switch in the car control station shall permit disconnecting the photoelectric device, when desired.

3. Door Open Timing Device: A timing device shall operate in conjunction with the photoelectric door control device to enable the following variations in door operation:

a. Separately adjustable timers to enable varying the time that the hoistway doors remain open after the stopping in response to a car call or a landing call. The timing for a car call stop shall be adjustable between 1 and 4 seconds, and the timing for a landing call stop shall be adjustable between 3 and 6 seconds. If a stop is made in response to both landing call and a car call, the timing of the landing call shall predominate.

b. In the event the light beam is interrupted while the doors are opening or after the doors are fully open, the time that the doors remain open after the light beam has been reestablished shall be reduced to an adjustable time between

1/2 and 1 second, depending upon whether a landing call or a car call predominated. This time shall also be a minimum time that the doors remain open if the beam is interrupted and reestablished before the door is fully open.

c. In the event a light beam is obstructed for more than 20 seconds after automatic door closing has been initiated, the beam control shall be cut out, a buzzer shall sound and the doors shall close at a gentle, reduced speed.

4. Door Hold Open Button (Car No. 6 Only): Provide button in car station to extend door hold open time up to 30 seconds when pressed. Registration of car call or pressure on door close button shall cancel time.

L. Car Control Stations: Two car control stations, each consisting of a metal box containing the operating fixtures, shall be mounted in the front return panels. The faceplate shall match cab material and shall be engraved with identifying number of the elevator and its capacity. Floor buttons, alarm button, door open button and emergency stop switch shall be suitably identified by engraved and painted letters or by inlaid plastic or metal inserts. Braille identification shall also be provided adjacent to each pushbutton and control. Stations shall contain the following:

1. Mechanically operated car floor buttons with 1/2" numbers in the face of the button corresponding to the floors served for registration of car stops. Car buttons shall not protrude beyond the faceplate when in the normal position. Call registered lights, located within or behind the buttons, shall illuminate the floor number corresponding to the call registered. Maximum height of these buttons shall be as indicated on the drawings.

2. An ALARM button shall be provided at the top of the car station to ring a bell located in the hoistway near the lower lobby.

3. A red EMERGENCY STOP switch shall be provided at the top of the car station to interrupt the power supply to the elevator motor and apply the brake independently of the regular operating devices. The switch shall be so arranged that when operated, it will sound the alarm bell. The actuation of this switch shall not cancel registered landing calls.

4. A DOOR OPEN button which shall stop the closing motion of doors and cause them to return automatically to their fully open position. This button shall be effective while the car is at a landing and until the car starts into motion, regardless of any special operational features.

5. A key-operated FIREMAN'S SERVICE switch in one station per car.

6. A cabinet for a TELEPHONE unit which shall be located below the left-hand car control station and shall have a faceplate fabricated of the same material and finish as the station faceplate.

7. A lockable SERVICE panel with an integral certificate frame shall be located above the right-hand car control station. The service panel shall contain the following circuits with each control and its operating positions identified by engraved letters painted black:

a. A LIGHT RAY cutout switch to disconnect the light rays from the door-closing circuits.

b. An INSPECTION switch for disconnecting all automatic operation, limiting the car speed and rendering effective the hoistway access switch when the car is at the top or bottom terminal, conforming to the ANSI Code.

c. A LIGHT switch.

d. A 3-position FAN switch.

e. An INDEPENDENT SERVICE switch to select independent or automatic operation.

f. A single 110 volt AC electrical convenience outlet.

g. A FREIGHT/AUTOMATIC switch on Elevator No. 6 to allow operation in response to the freight hall pushbuttons. This switch may alternately be mounted in the lobby control station.

h. Emergency telephone jack.

8. Emergency service indicator in Elevator No. 6.

9. Door hold open button in Elevator No. 6 to hold the doors open for a predetermined length of time.

M. Inspector's Control Station: A permanently installed control station shall be provided on top of each elevator car for inspection purposes in accordance with ANSI Code, Rule 210.1.d. The control station shall consist of a metal box securely mounted to or from the car crosshead and shall contain the following:

1. Up and down constant-pressure pushbutton.

2. A switch to disconnect all automatic features, including all buttons and switches in the car and landing stations.

3. A switch to disconnect all power to the elevator car.

N. Emergency Exit Contact: Emergency exits in the elevator enclosure shall be provided with an electrical contact to prevent operation of the elevator when an emergency exit is open. In the event an emergency exit is opened, while the elevator is in motion, the elevator shall be brought to a stop.

O. Work Light and Plug Receptacle: A lamp receptacle fitted with guard, together with a plug receptacle, shall be mounted on top of the elevator car. The fixture shall be subject to an ON-OFF switch in an easily accessible position.

2.5 LANDING CONTROL STATIONS

A. Faceplate Materials: The landing control station equipment faceplates shall be stainless steel.

B. Pushbutton Stations: A single riser of pushbuttons shall be provided for each elevator group. Pushbuttons shall also be provided for Elevator No. 6 in entrance frame at each floor for freight operation. At all intermediate or typical floors, each fixture shall contain an up and down button for registering calls and call registered lights in the buttons to indicate when the call has been registered. At the terminal floors, a single button with a call registered light shall be mounted in the center of the faceplate. The up or down registered light shall illuminate when an up or down call is registered and shall be extinguished when an elevator traveling in the corresponding direction initiates its stop in answer to the call. All pushbuttons shall be mechanically activated. Combination pushbutton station and ashtray units shall be provided in accordance with the bid drawings. Provide illuminating sign, FREIGHT ONLY, in special riser for Car No. 6.

C. Hoistway Access Switches: Hoistway access switches shall be located at the top landing on all elevators and at the bottom landing on Elevators No. 4, 5 and 6. A continuous-pressure, spring-return, key-operated switch shall be provided in the left-hand jamb of the entrance frame. The switch shall protrude through a cutout in the entrance jamb with no separate faceplate. The access switch shall be made operative at the same time that all automatic features are disconnected. The car shall be limited to a speed of 150 f.p.m. by actuating a switch in the car operating panel when the car is at the floor where the hoistway access switch is located.

D. Lobby Control and Indicator Panel: Each elevator group shall be provided with a flush panel with a stainless steel frame and door. Complete circuitry including controls and indicators shall be provided for future units. The panel shall be wall mounted and shall contain the following equipment behind the hinged, lockable door:

1. A key-operated switch and pilot light numbered to designate the particular elevator it controls. This switch shall operate to place that specific elevator in or out of service. The pilot light shall illuminate to indicate cars in service.

2. A cabinet for a telephone unit.

3. Emergency power selection switches.

4. Readout or dial position and direction indicators for each elevator.

5. Fireman's Operation, Keys and Instructions: Lobby return switch shall be exposed and identified.

2.6 SIGNALS

A. Faceplate Materials: The signal equipment faceplates shall be stainless steel.

B. Hall Lanterns: The hall lanterns shall be provided as indicated in the Equipment Summary. The lanterns shall be installed near the corresponding elevator entrance to indicate the intended direction of travel of the elevator to waiting passengers. The fixture shall contain 2 incandescent lights, suitably shielded, and a single-stroke gong mounted in a metal box fastened in the wall. When

illuminated, the lens indicating up shall be white and the lens indicating down shall be a bright red color. The up or down light shall be illuminated and a gong sounded at least 4 seconds prior to the car's arrival at the floor. The light shall remain illuminated until shortly before the elevator doors start to close. The design shall be as selected from the Elevator Contractor's standard line.

C. Car Position Indicator: A directory-type position indicator shall be provided across the front of the elevator as shown by the drawings. The entire position indicator shall be continuously illuminated with white light. Position shall be indicated by red illumination behind the specific window corresponding to the landing at which the elevator is located. When the car leaves or passes a floor, the respective red light in the position indicator shall be extinguished and the red light representing the next floor shall be illuminated, etc., thereby indicating the position of the car in the hoistway at all times.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Related Work Specified Elsewhere:

- | | |
|------------------------|---------------|
| 1. General Provisions: | Section 14010 |
| 2. Elevator Cabs: | Section 14230 |
| 3. Elevator Entrances: | Section 14240 |

C. Equipment Summary:

- | | |
|----------------------------|---|
| 1. Number: | Elevator No. 13 |
| 2. Capacity: | 5000# |
| 3. Speed: | Maximum with 30 horsepower motor |
| 4. Landings and Entrances: | Front: Basement, basement mezzanine,
and 1st
Rear: 1st |
| 5. Travel: | 22'-8" |
| 6. Operational Control: | Selective collective |
| 7. Entrance Size: | 4'-4" wide x 7'-0" high |
| 8. Entrance Type: | 2 speed, center open |
| 9. Door Operators: | Medium speed, medium duty with DC motor |
| 10. Door Protection: | Safe edges and double light rays |
| 11. Signals: | Car direction indicator, car position indicator, illuminating pushbuttons |

- | | | |
|-----|------------------------|--|
| 12. | Communications: | Telephone |
| 13. | Machine: | Oil hydraulic pump |
| 14. | Power Characteristics: | 480 volts AC, 3 phase |
| 15. | Additional Features: | Fireman's return
Hoistway door unlocking devices
Nickel-silver car sills
12-month full maintenance
Platen isolation
Car top station
Drill hole and install protective casing
Oil scavenger line |

PART 2: PRODUCTS AND INSTALLATION

2.1 OPERATION

A. General: The elevator operation shall be controlled by hall buttons located at each floor and car button located in each car which correspond to the floors served. The elevator shall be operable without an attendant and shall automatically start in response to calls registered by momentary pressure on the hall or car buttons. The elevator shall slow down and stop automatically at the landing corresponding to the call registered on the hall or car button. The stops shall be made in the order in which they are approached by the elevator for each direction of travel, irrespective of the order in which they were registered. Simultaneously to the initiation of the slow down of a car for a hall call, the call shall be automatically canceled and shall remain so and the hall button corresponding to the elevator's direction of travel shall remain ineffective until the car leaves the floor. The calls registered on the car buttons shall cancel in the same manner as the hall buttons.

B. Operational Control: The registration of a landing call, when the car is idle, shall automatically start the elevator and dispatch it to the corresponding floor. If a call is registered at the landing where the car is idle, the doors shall automatically open. Once the direction of travel has been established, the elevator will not reverse direction until all car calls have been answered or until all landing calls, ahead of the car and corresponding to the direction of car travel, have been answered. The car shall only answer calls corresponding to the direction in which the car is traveling except that it may answer a call in the opposite direction if that call is the highest (or lowest) call registered. Upon answering the last call in one direction of travel, the elevator shall proceed to answer calls in the opposite direction, starting with the highest or lowest call, depending on the location of the car.

C. Type of Equipment: The equipment shall consist of a hydraulic pump driven by an induction motor, controller equipment, control valves and hoistway switches. Oil

pressure, in the piston beneath the elevator, provided by the electrically driven hydraulic pump shall move the elevator up and gravity shall move the elevator down. Oil flow shall be controlled by valves.

D. Automatic Leveling: An automatic 2-way leveling device shall be provided, designed to govern the leveling of the car to within 3/8" above or below the landing sill. The leveling operation shall be effective to avoid overtravel, as well as undertravel, of the car and maintain the leveling accuracy regardless of the load in the car or direction of travel.

E. Door Operation: Doors shall open automatically when the car arrives at a terminal to permit egress of passengers. If no demand for service exists, the doors shall be allowed to automatically close after a timed interval. Selective door operation at the 1st floor shall be provided.

F. Emergency Features:

1. Emergency Lighting: Emergency power for the car lights and blower shall be provided via the normal power conductors. Emergency car lights and blower shall continue to operate in the event of a normal power failure.

2.2 MACHINE ROOM EQUIPMENT

A. General: All equipment specified hereafter shall be located in the machine spaces as indicated in the drawings. The pump unit, controller, mainline and auxiliary switches shall be provided with identifying decal or painted numerals.

B. Pump Unit:

1. General: The pump unit shall be compactly designed as a package unit enclosed with sound-absorbing removable panels and sound isolated from the building by means of vibration-absorbing pads. The pump unit shall include the following components:

2. Pump: The pump shall be of a design suitable for oil hydraulic elevator service of the positive displacement type with special effort given to keeping pulsation and noise to a minimum. The pump output shall not vary more than 10% between full-load and no-load conditions on the elevator car.

3. Motor: Driving motor shall be of the AC high internal resistance squirrel-cage type and shall be supported by ball or roller bearings. The motor shall not exceed 1800 r.p.m. The motor shall be rated in accordance with the standards of the AIEE for 70 degrees F. for 15 minute rating motors and shall have sufficient capacity to operate the elevator with rated control load at rated contract speed without overheating.

4. Control Valves: The externally adjustable relief valve shall, in the event of excessive pressures, be capable of by-passing the total oil output of the pump to prevent damage to the pumping unit. The spring-loaded check valve, located in the pump discharge line, shall prevent a reverse flow of oil, resulting in a lowering or settling back of the elevator car when the pump is disconnected. The

up-starting by-pass valve shall momentarily by-pass the hydraulic oil to relieve the pressure on the pump and motor during starting and shall insure smooth acceleration to full speed as the valve closes. External adjustments shall be provided. The up-stop valve shall be externally adjustable to by-pass high-pressure oil surges which occur when stopping. The lower and leveling valves shall be magnetically operated with external adjustments for controlling the lower speed, leveling speed and stopping accuracy to insure smooth starts and stops.

5. Oil Reservoir: The storage tank, for the oil, of a size to have at least 10 gallons more capacity than required to raise the elevator to its full height, shall be constructed of No. 14 gage sheet steel and provided with an oil-level gage, a tight-fitting cover and a protected-vent opening. Foreign matter shall be prevented from entering the pumping unit by means of filtering screen mounted over the suction inlet.

6. Piping and Oil: All necessary piping, connections and oil shall be provided by the Elevator Contractor for connecting the pump to the jack unit. Isolating couplings shall be used between the pump unit and oil line.

7. Silencer: A muffler device shall be installed in the oil discharge line near the pump unit. The unit shall suitably dampen and absorb pulsations of oil and sound by means of absorbing material inserted in a blowout-proof housing.

C. Controller: The controller shall be of substantial design for mounting on pumping unit or on the wall and shall be completely enclosed by a sheet steel cabinet with hinged doors. If cabinet is wall mounted or there is little space for access to wiring on back of control panel, it shall be mounted on hinges within the steel cabinet. All switches shall be magnet operated with silver-to-silver contact on all relays, so designed to insure maximum conductivity and provide a wiping action to prevent sticking due to fusion. Suitable overload relays shall be provided to protect the pump motor against excessive currents due to overload and single phasing. Provision shall also be made to prevent operation in the event of phase reversal. Where time delay relays are employed in the circuits, they shall be of an accepted design that is reliable and consistent, such as condenser timing or electronic timing circuits. Wiring on the controller, whether factory or field wiring, shall be done in neat, workmanlike order and all connections shall be made to studs and/or terminals by means of grommets, solderless lugs or similar connections. Terminal blocks with identifying studs shall be provided on the controller for connection of board wiring. Identifying symbols or letters shall be permanently marked on or adjacent to each device on the controller and the markings shall be identical with markings used on the wiring diagrams. In addition to the identifying marks, the ampere rating shall be marked adjacent to all fuse holders.

2.3 HOISTWAY EQUIPMENT

A. Guide Rails and Brackets: Guide rails shall be of T-section, accurately machined with tongue and groove joints to take the machined, steel-joining plates. Guide rails shall be fastened to the substantial steel brackets by approved heavy-rail clip and shall extend from the pit to the underside of the overhead slab. They shall be erected plumb and parallel and shall not deviate more than 1/8". Where guide rail brackets are fastened to concrete walls, suitable inserts together with

all information relative to their location shall be furnished for installation by others.

B. Buffers: At least 2 heavy-spring buffers shall be mounted and located symmetrically with the car frame. They shall be of sufficient height to protect the cylinder head should the car for any reason descend past the bottom limit switch setting. Any buffer blocking required shall be provided.

C. Cylinder: The cylinder shall be constructed of heavy-steel pipe, using a design stress of 12,000 p.s.i. maximum for mild steel and 1/5 ultimate strength for other metals, accurately machined on all wearing surfaces with a connecting pipe of proper size for transmission of the oil into the cylinder. The support at the top of the cylinder shall consist of channels extending between and fastened to the car guide rails. The steel cylinder head, equipped with an adjustable packing gland, internal-guide bearings, air bleeder and a recess for collecting oil, shall be securely fastened to the cylinder. The outside surface shall be protected against rust and corrosion by double wrapping of VID-20 Polyvinyl Trantex Tape, or equal. Provide oil drain and receptacle. The cylinder shall be fabricated in 2 pieces to facilitate removal.

D. Plunger: The plunger shall be constructed of heavy, seamless steel tubing, using a design stress of 12,000 p.s.i. maximum for mild steel and 1/5 the ultimate for other metals, accurately machined with a polished finish. A heavy-steel oversize plate shall be welded to the bottom of the plunger to prevent the plunger from leaving the cylinder. The plunger shall be fastened to a plate bolted to the underside of the car frame with isolating cushion between.

E. Well Hole: The required well hole shall be drilled and a seamless, Schedule 10, protective casing installed as a part of this work. The casing shall extend the full length of the hole and shall be plugged at the lower end with a minimum of 12" of quick-dry concrete. Any water standing in the casing shall be removed after plugging. Back-fill material shall be washed, clean sand compacted to 95% maximum dry density by approved means.

F. Normal Terminal Stopping Devices: Normal terminal stopping devices shall be provided, consisting of electrical contacts located on top of the elevator and operated by cams mounted at the top and bottom of the hoistway or electrical contacts located at the top and bottom of the hoistway and operated by a cam or cams located on top of the elevator car and shall operate so as to automatically bring the elevator to a stop at the top and bottom terminal landings with any load up to and including 125% of the contract capacity from any speed attained in normal operation. This device shall operate independently of the regular operating device and shall continue to function until the final limit switch operates. Switches shall be equipped with engaging arms provided with rubber-tired rollers for engagement with cams.

G. Electrical Wiring:

1. General: All wiring between the machine room, hoistway junction box, car junction box, landings, pit and other associated equipment shall be furnished and installed as part of this work. Wiring shall be copper, properly insulated and

have a flame-retarding and moisture-resisting outer cover and shall be run in galvanized or painted metallic conduit or duct, using strain boxes as required. All material used and method of installation shall conform to the National Electrical Code.

2. In accordance with Section 0130 and Article 1.9 of Section 1401, Contractor shall submit for approval shop drawings of electrical metallic tubing or metal wireways prior to installation. If metallic tubing is used, extra care shall be used to insure satisfactory mechanical installation.

3. Conduit: Except for the DC Loop, each conduit run or duct run shall contain 10% spare wires and in any event not less than one spare wire. Except as follows, conductors shall be run in rigid steel conduit, electrical metallic tubing or metal wireways, 1/2" and larger:

a. Traveling cable to elevator cars.

b. Connections, not exceeding 36" in length between risers and limit switches, interlocks, pushbutton boxes, door operator motors and similar devices may be run in flexible metal conduit.

c. Flexible hard service cord, Type S0, between fixed car wiring and car door switches.

4. Traveling Cables: The car operating panel, position indicator and other electrical equipment in the car shall be connected with the controller by means of flexible cable run from the bottom of the car to an approved outlet in the hoistway. Cables shall have a flame-retarding and moisture-resisting outer cover, shall have steel-supporting fillers and shall be suspended directly by them to relieve the conductors of strain. Each traveling cable shall contain 10% spare wires and in any event not less than one spare wire.

5. Terminal Connections: Terminal connections for all conductors shall be made on terminal blocks or studs having identifying numbers. All conductor connections shall be made with terminal eyelets of the solderless type.

6. Communications: Provide a minimum of 4 sets of insulated communication wires in the traveling cables, extending from hoistway junction box to car junction box and communication cabinet.

H. Entrance Equipment:

1. Hangers and Tracks:

a. Hangers: Each door panel shall be equipped with sheave-type, 2-point suspension hangers with provisions for vertical and lateral adjustments. The hangers shall consist of a malleable iron or steel bracket, approximately 1/4" thick, equipped with 2 sheaves, provided with ball-type bearings, properly sealed to retain grease lubrication.

b. Upthrust Rollers: Rollers, provided with ball type bearings, sealed to retain grease lubrication, shall be provided on the hanger bracket to take the upthrust of doors. An eccentric shaft mounting shall permit fine upthrust roller adjustments.

c. Tracks: Tracks for hangers shall be of basic open-hearth steel, approximately 190 Brinell hardness, not less than 2" x 2" x 1/2" thick, and be cold drawn to a smooth finish. The upper edge of the track shall have a contour to match that of the main sheave. Alternately, tracks may be formed, cold-drawn steel with smooth track finish. Track shall be fastened to the header at frequent intervals to insure permanent track alignment, and be removable for repair or replacement.

d. Interlocks: Hoistway doors shall be equipped with an electro-mechanical interlock, designed to prevent the starting of the car until the doors are closed and locked. Engaging components of the mechanical-locking device shall be free of noises.

e. Closers: A mechanical door-closing device shall be provided for each entrance to assure automatic closing of the hoistway doors and prevent the hoistway doors from standing open when the car is not at the landing. Weighted closers shall not run in frames attached to door panels.

I. Hoistway Door Unlocking Device: A hoistway door unlocking device shall be provided at each floor. Key holes shall be provided with a simple stainless steel escutcheon plate. An emergency key to open the hoistway doors shall be flush mounted in a permanent, break-glass receptacle at the 1st floor. The receptacle shall be marked ELEVATOR DOOR KEY FOR FIRE DEPARTMENT AND EMERGENCY USE ONLY.

J. Pit Stop Switch: An emergency stop switch, which shall function similar to the switch in the elevator car, shall be provided adjacent to the access of each elevator pit. It shall conform to the requirements of the ANSI Code, Rule 210.2.g.

K. Oil Scavenger System: An oil scavenger system shall be provided to return oil that has escaped from the jack unit back to the pump unit reservoir.

2.4 CAR EQUIPMENT

A. Frame: The car frame shall consist of steel channels securely fastened together, reinforced and braced to provide a rigid structure for mounting the platform and car enclosure. The car frame height shall be sufficient to enable installation of the specified car enclosure.

B. Guides: Flexible-type guide shoes shall be mounted on top and bottom of the car frame. The guide shoes shall consist of a swivel-type shoe assembled on an ample metal base in the manner to permit self-alignment. Springs located within the shoe shall provide pressure to the renewable, dry-type, composition, sliding gibs to take up the side play between guide rails. Roller guides may be provided.

C. Platform: The car platform shall be constructed of wood, steel or steel-and-wood sandwich and shall be suitably braced to meet ANSI Code deflection requirements. The platform shall be sound isolated by mounting it on rubber, or equal, vibration and

sound-absorbing pads, within a steel frame. This frame shall be securely fastened to the plank channels and shall be amply braced so that no strain will be transmitted to the car enclosure. If the plunger is sound isolated from the plank channels by rubber, or equal, padding, the sound-isolated platform and frame will not be required. The underside of platform, if of wood, shall be covered with sheet steel not less than No. 26 U. S. gage.

D. Floor Covering: A 1-piece vinyl sheet shall be laid on 1/4" masonite. Both the sheet and the masonite shall be securely cemented in place. The finish surface of the sheet shall be flush with the top surface of the sills at the car ends and coved at the sides and return panels. The color and pattern shall be as selected by the Architect.

E. Sill: A narrow extruded white bronze or nickel silver sill shall be securely fastened to the platform at each entrance. The sill shall have accurately machined slots for guiding the door gibs. It shall be of sufficient height above the platform to provide a flush line with the floor covering and shall be arranged so that no tripping hazard exists across the entrance where the sill meets the floor covering. The nosing of the threshold shall have a machined rabbet to receive the toe guard and shall be of such depth to provide a flush surface from the nosing to the toe guard.

F. Toe Guard: An apron, or guard, constructed of not less than No. 14 U. S. gage steel, shall be fastened to the car sill and shall be securely braced to the platform. It shall extend 3" beyond both sides of the widest hoistway opening and shall conform with the ANSI Code, Rule 203.9.

G. Door Operator:

1. General: A medium-speed, medium-duty, master-type door operator shall automatically open the car and hoistway doors simultaneously when the car is leveling into a landing and automatically close the doors simultaneously at the expiration of the open timing.

2. Construction: The direct-current motor shall be of the high-internal resistance type, capable of withstanding high currents without damage to the motor. All door operating arms shall be constructed of substantial steel members and pivot points shall have ball or roller bearings.

3. Operation and Speed: The door operator shall be capable of opening a car door and hoistway door simultaneously at a maximum speed of not less than 2 f.p.s. A reversal of direction of the doors from the closing to opening position, whether initiated by the door edge reopening device, the photoelectric device, or the door open button, shall be accomplished within no more than 2-1/2" of door movement.

H. Car Door Electrical Contact: An electrical contact shall be provided to operate in conjunction with the car doors so that the elevator cannot be operated unless the doors are closed or within the tolerance allowed by the ANSI Code.

I. Header: A header shall be installed which shall be constructed of at least 3/16" thick steel and shall be shaped to provide stiffening flanges at top and bottom, extending its entire length.

J. Car Door Hangers and Track: The car door hangers and track shall conform to the specification on the Hangers and Tracks of Paragraph H.1 of this section.

K. Door Reopening and Control Devices:

1. Safe Edge Device: A mechanical device shall extend the full length of each leading car door panel and project not less than 1-3/4" nor more than 2-1/2" beyond the edge of both car and hall door panels. This device shall be so arranged that should it touch a person or any object in its path while closing, it shall automatically cause both the car door and hoistway doors to return to the open position. Safety edge movement or compression of not greater than 1/2" shall initiate door reversal. The safety edge shall retract to a position flush with the car and hoistway doors when in the fully open position. The door edge shall function at all times when the doors are not closed, irrespective of all other operating features.

2. Door Hold Open Button: Provide buttons in the car control station to extend door hold time up to 30 seconds when pressed. Registration of car call shall cancel time.

L. Car Control Stations: A car control station, consisting of a metal box containing the operating fixtures, shall be mounted behind the side wainscot. The faceplate shall match the cab material and shall be engraved with the identifying number of the elevator and its capacity. The floor buttons, alarm button, door open buttons and emergency stop switch shall be suitably identified by engraved and painted letters or by inlaid plastic or metal inserts. The station shall contain the following:

1. Mechanically operated car floor buttons with 1/2" numbers in the face of the button corresponding to the floors served by each separate entrance for registration of car stops. Car buttons shall not protrude beyond the faceplate when in the normal position. Call registered lights, located within or behind the buttons, shall illuminate the floor number corresponding to the call registered.

2. An ALARM button shall be provided at the top of the car station to ring a bell located in the hoistway near the lower lobby.

3. A red EMERGENCY STOP switch shall be provided at the top of the car station to interrupt the power supply to the elevator motor and apply the brake independently of the regular operating devices. The switch shall be so arranged that when operated, it will sound the alarm bell. The actuation of this switch shall not cancel registered landing calls.

4. DOOR OPEN buttons which shall stop closing motion of the doors and cause them to return automatically to their fully open position. This button shall be effective while the car is at a landing and until the car starts into motion, regardless of any special operational features.

5. Door hold open buttons to hold the doors open for a predetermined length of time.

6. A key-operated INSPECTION switch for disconnecting all automatic operation conforming to the ANSI Code in the main station.
7. A key-operated LIGHT switch.
8. A 2-position key-operated FAN switch.
9. A telephone cabinet with an integral certificate frame in the main station.

M. **Inspector's Control Station:** A permanently installed control station shall be provided on top of each elevator car for inspection purposes in accordance with ANSI Code, Rule 210.1.d. The control station shall consist of a metal box securely mounted to or from the car crosshead and shall contain the following:

1. Up and down constant-pressure pushbutton.
2. A switch to disconnect all automatic features, including all buttons and switches in the car and landing stations.
3. A switch to disconnect all power to the elevator car.

N. **Emergency Exit Contact:** Emergency exit in the elevator enclosure shall be provided with an electrical contact to prevent operation of the elevator when an emergency exit is open. In the event the emergency exit is opened, while the elevator is in motion, the elevator shall be brought to a stop.

O. **Work Light and Plug Receptacle:** A lamp receptacle fitted with wire guard, together with a plug receptacle, shall be mounted on top of the elevator car. The fixture shall be subject to an ON-OFF switch in an easily accessible position.

2.5 LANDING CONTROL STATIONS

A. **Faceplate Materials:** The landing control station equipment faceplates shall be stainless steel.

B. **Pushbutton Stations:** A pushbutton station shall be located at each landing served by the elevator. At all intermediate or typical floors, each fixture shall contain an up and down button for registering calls and call registered lights in the buttons to indicate when a call has been registered. At the terminal floors, a single button with a call registered light shall be mounted in the center of the faceplate. The up or down registered light shall illuminate when an up or down call is registered and shall be extinguished when a elevator traveling in the corresponding direction initiates its stop in answer to the call. The faceplate shall be flush mounted with a fixture design as selected from the Elevator Contractor's standard line. All pushbuttons shall be mechanically activated.

C. **Lobby Control Panel:** A separate lobby control panel shall not be required.

2.6 SIGNALS

- A. Faceplate Materials: The signal equipment faceplates shall be fabricated from stainless steel.
- B. Car Direction Indicators: A signal fixture shall be provided in the East cab entrance to indicate the direction of elevator travel to waiting passengers. The fixture shall consist of a metal box containing the incandescent light fixture suitably shielded to prevent light leakage. The faceplate shall contain 2 lucite or plexiglass acrylic arrows approximately 3" high, one pointing up and one pointing down. The arrows corresponding to the direction of travel of the elevator shall be illuminated when the doors are open until the car reverses for travel in the opposite direction. When illuminated, the up arrows shall be a bright white and the down arrows shall be a bright red color. A single-stroke gong shall sound once as the doors are opening.
- C. Car Position Indicator: A position indicator shall be provided in the transom panel above the East cab entrance. The fixture shall consist of a metal box mounted behind the transom panel and shall contain incandescent light fixtures representing the floor served and the direction of car travel. The faceplate surface shall be mounted on the transom surface and shall contain numeral and arrow cutouts with plastic inserts not less than 1" high. They shall be arranged so that the shielded light bulbs shall suitably illuminate the numerals and arrows. When a car leaves or passes a floor, the respective light in the position indicator shall be extinguished and the numeral representing the next floor shall be illuminated, etc., thereby indicating the position of the car in the hoistway at all times. The proper arrow shall be continuously illuminated to indicate the direction of travel.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Related Work Specified Elsewhere:

- | | |
|-------------------------|---------------|
| 1. General Provisions: | Section 14010 |
| 2. Traction Elevators: | Section 14210 |
| 3. Hydraulic Elevators: | Section 14220 |

C. Cab Summary:

- | | |
|----------------------|---|
| 1. Wainscot: | No. 4 through 9: Removable panels
No. 13: Rigidized stainless steel |
| 2. Front Returns: | No. 4 through 9: Removable panels
No. 13: Rigidized stainless steel |
| 3. Entrance Columns: | No. 4 through 9: Stainless steel
No. 13: Rigidized stainless steel |
| 4. Transom: | No. 4 through 9: Stainless steel
No. 13: Rigidized stainless steel |
| 5. Base: | No. 4 through 9: Black vinyl
No. 13: Coved floor covering |
| 6. Floor Covering: | Included in Sections 1421 and 1422 |
| 7. Ceiling: | No. 4 through 9: Plastic laminate
No. 13: Baked enamel |
| 8. Lighting: | Fluorescent |
| 9. Handrail: | No. 4 through 9: Stainless steel
No. 13: None |
| 10. Door Panels: | No. 4 through 9: Plastic laminate
with stainless steel binders and
kickplate
No. 13: Rigidized stainless steel |

- | | | |
|-----|-----------------|---|
| 11. | Ventilation: | No. 4 through 9: 2-speed exhaust fan
No. 13: 1-speed exhaust fan |
| 12. | Pads and Hooks: | Included on No. 6 and 7 only |
| 13. | Door Size: | No. 4, 5, 7, 8 and 9: 4'-0" wide x
7'-0" high
No. 6 and 13: 4'-4" wide x 7'-0" high |
| 14. | Door Type: | No. 4 through 9: Single speed, center
open
No. 13: 2 speed, center open |

PART 2: PRODUCTS AND INSTALLATION

2.1 ANCHORING CAB COMPONENTS

A. All components of the cab interior shall be anchored to withstand sudden movement or emergency stop without dislodgment or displacement.

2.2 SHELL

A. The sheet steel shell shall be constructed of not lighter than No. 14 U. S. gage furniture steel, amply reinforced. The shell shall be securely mounted on the platform so that the inner surface of the enclosure shall be not more than 2" from the edge of the platform at the sides and rear. The shell shall have cutouts for the car operating panels, signal fixtures and ventilation. The exterior surface of the shell shall be coated with a sound-deadening material no less than 1/16" thick.

2.3 CANOPY

A. The canopy shall be constructed of not less than No. 12 U. S. gage furniture steel and shall be amply reinforced to comply with the ANSI Code. It shall extend from the top of the steel shell a sufficient distance to contain the light fixtures and provide uniform lighting through the car enclosure. A cutout shall be provided for the exhaust blower with a diffuser mounted below the blower. A hinged emergency exit panel shall be provided to conform to the ANSI Code. The canopy shall have a baked enamel finish.

2.4 WAINSCOT

A. Elevators No. 4 through 9: Removable panels shall be provided on the walls of the cab not containing entrances. The panel core shall be constructed of 5-ply birch or Iuan mahogany Grade B-D, or 40# density particle board similar to U. S. Plywood "Monoply". A selected finish, standard grade 1/16" thick plastic veneer shall be bonded to the exposed face and to all edges of the core. Laminated plastic shall also be bonded to the unexposed face of the panel to prevent warpage. The upper edge of the panels shall be approximately 7'-8" above the platform. The bottom edge of the panels shall be approximately 4" above the platform and shall conceal the ventilation holes in the base. The panels shall be readily removable from within the elevator car.

B. Elevator No. 13: The interior side walls from the floor to the ceiling of the cab shall be faced with rigidized stainless steel. The stainless steel pattern and color shall be as selected from a standard line manufactured by Rigidized Metals Corporation, Buffalo, New York 14203. The actual thickness of the stainless steel before rigidizing shall be .025".

2.5 ENTRANCE COLUMNS AND FRONT RETURN PANELS

A. Elevators No. 4 through 9: The front return panels shall consist of removable panels faced with plastic laminate as specified for the wainscot. The entrance columns shall be fabricated from not less than No. 14 U. S. gage brushed finish stainless steel.

B. Elevator No. 13: The front return panels and entrance columns shall be fabricated from rigidized stainless steel as specified for the wainscot. There shall be no seam between the front return panel and the adjacent entrance column.

2.6 TRANSOM AND SOFFIT

A. Elevators No. 4 through 9: The door soffit and position indicator faceplate shall be fabricated from not less than No. 14 U. S. gage, brushed stainless steel.

B. Elevator No. 13: The transom and door soffit shall be fabricated from rigidized stainless steel as specified for the wainscot.

2.7 BASE

A. Elevators No. 4 through 9: The base shall be 4" high, applied black vinyl or rubber.

B. Elevator No. 13: The vinyl floor covering installed under Section 1422 will be coved per drawings.

2.8 DOOR PANELS

A. The door panels shall be of the flush hollow metal type formed from not less than No. 14 U. S. gage furniture steel. The sheet metal surfaces shall be separated by a sound-deadening fire-resistant material and shall be reinforced by steel shapes welded to the surface plates at frequent intervals. Top and bottom of door panels shall have a continuous stiffener channel welded to the surface plates. Reinforcing shall be provided where necessary for 2-point suspension hangers, power operation, door reopening device, etc. All joints of the surface plates shall be welded and ground off smooth. Each door panel shall be provided with 2 removable type gibs or guides to run in sill slots with a minimum running clearance. The gib mounting shall permit easy replacement of gibs without removing door panels from hanger tracks. The door panel facing material shall be as outlined in the Equipment Summary.

2.9 CEILING

A. Elevators No. 4 through 9: A plastic laminate plenum shall be provided per drawings.

B. Elevator No. 13: The underside of the canopy shall have a selected color, baked enamel finish.

2.10 LIGHTING

A. Elevators No. 4 through 9: Fluorescent tubes shall be provided along the sides and rear of the ceiling plenum per drawings. All fluorescent tubes shall be furnished with light qualities similar to General Electric's warm white deluxe. High-power factor ballasts and instant starters shall be provided.

B. Elevator No. 13: Fluorescent lighting shall be mounted above the canopy and shall illuminate the car interior through a translucent plastic window mounted flush with the ceiling. The window frame shall be constructed of stainless steel and shall be hinged to provide ease in relamping. The fixture shall house four 40-watt fluorescent tubes and shall be located above the center of the cab. All fluorescent tubes shall be furnished with light qualities similar to General Electric's warm white deluxe. High-power factor ballasts and instant starters shall be provided. Alternately, 2 lighting units, each equipped with two 40-watt fluorescent tubes may be provided.

2.11 VENTILATION

A. A 2-speed exhaust blower, capable of moving 1-1/2 times the volume of air contained in the cab in one minute at a uniform rate on high speed and also capable of moving the volume of air contained in the cab in one minute at a uniform rate on low speed shall be furnished. It shall be located near the center of the canopy and be mounted on rubber, or equal, sound-isolation pads to keep vibration and noise to a minimum. A diffuser shall be securely mounted below the cutout in the canopy.

2.12 HANDRAILS

A. Elevators No. 4 through 9 shall have handrails across both side walls and the rear wall. Elevators No. 6 and 13 shall have double handrails per drawings. Handrails shall be 3" high x 3/8" thick and shall be mounted on bars made of identical material as specified for the handrail. The mounting bars shall be fastened to the steel enclosure. All handrail fastenings shall be concealed and the handrail shall be removable from inside the car enclosure.

2.13 PADS AND HOOKS

A. Cars No. 6 and 7: Removable, protective pads shall cover the sides, rear, return panels and entrance columns. All pads shall be of heavy quality, fire-resistant, treated canvas with 2 layers of cotton batting, or equal, securely sewed between canvas. The pads shall have heavy eyelets, properly spaced to suit pad hooks and shall have a neatly bound opening for the main car operating panel. Natural metal pad hooks shall be permanently installed.

2.14 SOUND DEADENING

A. The entire enclosure shall be mounted on a sound-isolated platform and provisions shall be made for isolating the car enclosure from the side stiles by means of rubber, or equal-quality, vibration-absorbing pads.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Related Work Specified Elsewhere:

- | | | |
|----|----------------------|---------------|
| 1. | General Provisions: | Section 14010 |
| 2. | Traction Elevators: | Section 14210 |
| 3. | Hydraulic Elevators: | Section 14220 |

C. Entrance Summary:

- | | | |
|----|---------------------|--|
| 1. | Type: | No. 4 through 9: Single speed, center opening
No. 13: 2 speed, center opening |
| 2. | Size: | No. 4, 5, 7, 8 and 9: 4'-0" wide x 7'-0" high
No. 6 and 13: 4'-4" wide x 7'-0" high |
| 3. | Finish: | Baked enamel |
| 4. | Sill Material: | Extruded aluminum |
| 5. | Frame Construction: | Welded |

PART 2: PRODUCTS AND INSTALLATION

2.1 STRUCTURAL MEMBERS

A. Struts: The struts shall be constructed of steel angles not less than 3" x 3" x 1/4" and shall extend from the sill to the structural beam overhead or to the guide rails and shall be securely fastened to both.

B. Headers: The header or hanger support shall be formed of at least 3/16" thick steel and shall extend between, and be bolted to, the vertical steel struts with not less than 2 bolts at each end. The top and bottom of the hanger support shall have a vertical and horizontal stiffening flange, respectively, approximately 2" wide and extending its entire length. The upper stiffener shall be designed to receive the fascia plate or dust cover.

2.2 SILLS

A. Narrow-type extruded sills shall be provided at all entrances of all elevators. Sills shall extend the entire width of the hoistway and shall be not less than 3/8" thick with uniform nonslip wearing surfaces and machine-planed door guide grooves. A nosing, approximately 1" deep along the full length of the sill on the hoistway side, shall have a machined rabbet to receive the toe guard or fascia plate. The rabbet shall be of a depth to provide a flush surface from the nosing to the toe guard or fascia. Sill support brackets or blocking shall be provided at each strut location, at each jamb and midway between jambs. Supports shall be secured to building floor.

2.3 ENTRANCE FRAMES

A. Construction: Entrance jamb and header shall be fabricated from not less than No. 14 U. S. gage steel. Frame shall be hollow-metal, welded, 1-piece type. The unexposed side of the frame shall be coated with a sound-deadening material approximately 1/16" thick. Jamb profile shall be as shown on the bid drawings. Entrance frames shall be UL B-label.

B. Erection: The jambs shall be fastened to the header and to the floor by the use of an angle clip welded to the bottom of each jamb. Finish wall treatment will be applied after the entrances have been installed.

2.4 DOOR PANELS

A. Panels: The door panels shall be of flush-type, hollow, fire-test construction, 1-1/4" thick. They shall be formed of not lighter than No. 16 U. S. gage furniture steel. The 2 surface plates shall be separated by a sound-deadening, fire-resistant material and shall be reinforced by steel shapes welded to the plates at frequent intervals. Top and bottom panels shall have a continuous stiffener channel welded to the 2 plates. All joints in the surface plates shall be welded the full length and ground off smooth before finishing. Entrance doors shall be UL B-label.

B. Gibs: Each door panel shall be provided with 2 removable-type gibs or guides to run in sill slots with a minimum running clearance. The gib mounting shall permit easy replacement of gibs without removing door panel from tracks.

C. Bumpers: Gum rubber bumpers shall be provided to cushion each door panel on overtravel in the open position and shall be securely fastened.

D. Astragal: The leading edge of one center-opening door panel shall be provided with a rubber astragal and the leading edge of the opposite panel shall have a shallow-curved groove. The rubber astragal shall run the entire height of the door panel and shall be readily replaceable.

2.5 NONVISION WINGS

A. A metal sight guard shall be provided on the leading edge of each panel. The finish shall be the same as for the door panel to which the nonvision wing is attached. Painted floor numerals, approximately 2-1/2" in height, shall be applied to each nonvision wing at a height of approximately 66".

2.6 INSIDE THE HOISTWAY

- A. Fascia Plates: Fascia plates shall be constructed of not less than No. 14 U. S. gage steel, reinforced to insure a flat-even surface throughout, and shall be securely fastened to the hanger support at one floor and the sill at the floor above. Intermediate fastenings shall be made where necessary to insure against waves or buckling. They shall extend the full width of the opening plus 3" on each side at all entrances, except below the bottom terminal and above the top terminal. The fascia plates shall have an enamel finish.
- B. Toe Guards: A toe guard shall be constructed of not less than No. 14 U. S. gage steel and shall extend the full width of the center plus 3" on each side at all bottom terminal entrances. The top of the guard shall be positioned in the rabbet provided in the sill, securely fastened with flat-head screws, and extend down and return to the wall at an angle of not greater than 30 degrees with the vertical. The lower edge of the toe guard shall be firmly secured to the hoistway wall. Toe guards shall have an enamel finish.
- C. Dust Cover: A cover plate shall be provided above the hanger supports at the top terminal entrance and shall extend the entire length of the door travel. It shall be constructed of not less than No. 14 U. S. gage steel and shall be fastened to the hanger support at one edge, returned to the hoistway wall at an angle to the vertical of not greater than 30 degrees and be securely fastened to the hoistway wall. The dust cover shall have an enamel finish.
- D. Hanger Covers: Hanger cover plates shall be constructed of not less than No. 14 U. S. gage steel in 3 sections. The center section shall be of the hinged or removable type, approximately the same length as the opening, and shall permit easy access to hangers from within the elevator car for servicing. The 2 side sections shall permit easy opening or removal, without special tools, by nonremovable fasteners. The hanger covers shall have an enamel finish.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 - General Requirements and Section 14010 General Provisions - Vertical Transportation apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Equipment Summary:

1.	Floors Served:	No. 1 and 2: 1st and 2nd No. 3 and 4: 2nd and 3rd
2.	Rise:	No. 1 and 2: 14'-0" No. 3 and 4: 15'-4"
3.	Size:	32"
4.	Speed:	90 f.p.m.
5.	Operation:	Reversible
6.	Balustrades:	Stainless steel
7.	Deck Boards:	Stainless steel
8.	Moulding and Trim:	Stainless steel
9.	Skirts:	Stainless steel
10.	Handrail Color:	Black
11.	Power Supply:	480 volts, AC, 3 phase
12.	Additional Equipment:	Full width landing plates, hinged floor pal at upper end

PART 2: PRODUCTS AND INSTALLATION

2.1 OPERATION

A. Each moving stair shall be capable of operating under full-load conditions in either direction for ascending or descending transportation. It shall be self-contained unit, consisting of all components required to provide a complete electric stairway. The angle of inclination shall be 30 degrees.

2.2 MACHINE ROOM

- A. **Driving Machine:** The drive machine shall be of the worm geared type with motor, brake, worm and gear mounted in a proper alignment. The steel worm shall be integral with the worm shaft and coupled with the motor shaft. Roller or ball bearings, with suitable lubrication means, shall be utilized. The brake shall be spring applied, electrically released and capable of stopping and holding a fully loaded moving stair traveling in the down direction. The driving motor shall be of the squirrel-cage type with sufficient capacity to operate the escalator at full contract load and speed, capable of continuous duty in either direction and shall be quiet in operation. A governor shall be provided on the motor shaft, which shall cut off power to the moving stair and apply the brakes should the step speed exceed the rated speed by 40%.
- B. **Controller:** The controller shall be of the electromechanical type with all relays and switches designed to insure maximum contact conductivity and provide a wiping action to prevent sticking due to fusion. The controller shall be enclosed in a portable steel cabinet that can be removed from the machine room for easy access to the contacts, switches and wiring. The controller shall contain a mainline circuit breaker to protect against overcurrent consumption. Suitable overload relays shall be provided to protect the motor against overload, phase reversal or single phasing.
- C. **Driving Sprocket:** The driving sprocket at the upper end of the truss shall be accurately aligned and rigidly attached to the truss at both sides. It shall contain large diameter, accurately machined sprockets at each side, over which the step chains or step chain rollers shall pass and transmit motion from the machine to the steps. If a chain drive is employed between the machine and the drive sprocket, an emergency brake shall be provided on the drive sprocket assembly which shall automatically function in the event the drive chain should break. Assembly shall have roller-type sealed bearings and shall be provided with means for lubrication and adjustment for wear.
- D. **Idler Sprocket:** The idler sprocket assembly shall be located at the lower end of the truss and shall be provided with a spring or weight tensioning device which shall take up slack in the step chain and maintain constant tension on the chain. The sprockets over which the step chains or step chain rollers pass shall be of large diameter and accurately machined. Assembly shall have roller type sealed bearings and shall be provided with means for lubrication and adjustment for wear.

2.3 WELLWAY

A. Truss:

1. **General:** The structural steel truss shall be designed and constructed to safely carry the entire load of the moving stair, including all parts of same, the full-capacity load, and the weight of the exterior balustrade and soffit material. The truss shall have a factor of safety in accordance with the requirements of the ANSI Code.

2. Support Beams: A single beam shall support the upper and lower ends of adjacent trusses terminating at the intermediate floors. All support beams will be provided and installed by the structural contractor. The support beams center-to-center distance shall be established by the Escalator Contractor and shall be shown on his shop drawings.

B. Balustrade Brackets: The balustrade brackets shall be constructed of steel shapes, securely fastened to the truss to provide a rigid support for the handrail guides, interior panels, deck covers, etc.

C. Drip Pans: Oil-tight drip pans of sufficient strength to withstand the weight of a workman shall be provided beneath each truss for its entire width and length.

D. Tracks: Tracks constructed of steel or other alloy of proper rigidity and hardness shall be installed and supported to insure perfect alignment and smooth operation of the running gear under all conditions. Track supports shall not be more than 4' apart.

E. Electrical Wiring: Furnish and install all wiring from the circuit breaker in the machine room to the controller, motor, brake and all other electrical devices on or in the stairway. Wiring shall be properly insulated and have a flame-retarding, moisture-resisting outer cover and shall be run in rigid metal conduit, electrical metallic tubing or in metal ducts securely fastened to the truss. All material used and method of installation shall conform to the current edition of the National Electric Code.

F. Step Chains: The step chains shall be made of the high-grade steel links with hardened pins, designed to maintain the exact relationship between adjacent steps, and accurately engage the drive sprockets to insure smooth operation. At each step location rubber or synthetic composition rollers with sealed ball bearings shall be provided on each chain to guide and support the chain and support the leading edge of the step. Step rollers shall be removable for replacement without disassembling the chain. Broken chain devices shall be provided, which will cut off all power to the machine and apply the brake in the event the tension in either or both step chains drops below a predetermined value or if either or both step chains break. Chain shall be designed to run without the steps for convenience in cleaning and inspection.

2.4 STEP ASSEMBLY

A. The step frame, constructed of steel or aluminum shall be amply reinforced and braced to support the maximum load under eccentric loading conditions without distortion. The frame shall be fastened to the drive chain and roller on either side and be provided with rollers which are tired with a suitable material to insure rotation and avoid flat spots. Roller shall have sealed ball bearings. The steps shall be readily removable without dismantling the balustrade or step chains.

B. The step treads shall be die cast aluminum, designed with a cleated surface, to provide a secure foot hold and comfortable surface. They shall be securely fastened to the step frame and have a cleat design with not less than 3 cleats to the inch, 3/8" deep. The clearance from either side of the steps to the skirt guards shall not be greater than 1/8".

C. The step risers shall be cleated or grooved constructed, shaped to provide a constant minimum clearance between the adjacent step at all times of not more than 5/32". They shall be coated on the unexposed side with a sound-reducing material.

2.5 SAFETY DEVICES

A. Two safety device shall be installed at the lower end of the moving stairway where the steps begin leveling off and before they pass under the combplate. Both devices shall be of the self-resetting type, electrical contacts. One shall be installed to be actuated when an article becomes wedged between the step and skirt guard and the other shall be installed to be actuated when an article becomes wedged between the steps or for some reason a step roller is prevented from following the normal curvature of the track. These devices are primarily to afford protection with a down traveling escalator. Once the stairway has been stopped by the action of one of these switches, it shall be possible to move the stairway only in the up direction by use of the starting switch after the obstruction has been cleared.

2.6 HANDRAIL

A. Handrails constructed of laminated canvas and rubber shall operate on brass, bronze or steel guides fastened to and of the same curvature as the balustrade. Uniform clearance shall be maintained between the handrail and balustrade to eliminate any possible pinching hazard. Guides and handrails shall be arranged so that the handrail shall be difficult to throw off. Handrails shall form an endless belt. Laminated type shall be spliced and vulcanized with a smooth joint. Handrail drive shall be of the traction composition type driven from the top of the unit at the same speed as the steps. The newel shall be extended so that the handrail will enter and leave the balustrade at a point difficult to reach. Constant tension shall be applied to the handrails by a device within the truss. However, should this tension drop below a set value or if either or both handrails should break, a slack-tension device shall be provided to disconnect power to the unit drive motor and apply the brake.

2.7 BALUSTRADE

A. Interior Panels: The exposed surface of the interior panels of the balustrade shall have a natural metal finish. Panels shall have butted vertical joints to give a smooth surface and shall be removable for ready access to the interior of the balustrade for lubrication and adjustment.

B. Skirt Panels: The exposed surface of the skirt panels shall be finished in accordance with the equipment summary. If the skirt panels are made of solid sheet with sound-deadening material applied to the back of panels, they shall be not less than No. 16 gage. Sound-deadening material shall be fire resistant. If skirt panels are made of wood and metal lamination cemented together, the panels shall be not less than 3/8" in thickness. Back of panels shall be galvanized sheet steel and not less than No. 27 gage. They shall be installed to provide a clearance to the step treads of not more than 1/8" and shall extend beyond the combplates and wrap around the base of the newel.

C. Deck Boards: Deck boards shall be formed from natural finished metal. All material shall be not less than No. 14 gage, reinforced to provide a rigid panels with a smooth, flat upper surface. All lateral joints shall be butted to provide a smooth surface. The distance from the longitudinal centerline to the outside edge of either deckboard shall be 2'-2". There shall be no longitudinal joints in the deck boards.

D. Trim and Molding: All molding, for exterior and interior trim, shall be of natural finish metal.

2.8 LANDINGS

A. Combplates: Removable combplates shall be constructed of Textolite, aluminum or other alloy, with a nonslip surface. Between the combplate teeth at the intersection of the steps and combplates, the step cleats shall pass. The top leading edge of the teeth shall be depressed below the top surface of the step cleats. The steps shall be closely guided as they pass the combplates so that the cleats of the step will pass the comb teeth with a minimum clearance.

B. Landing Plates: The landing plates shall be constructed of aluminum, or other alloy, and provided with a nonslip surface. The lower landing plate shall extend from the combplates to the end of the truss and the upper landing plate shall extend from the combplates to the machine room access room. The landing plates shall extend the full width of the truss.

C. Machine Room Access Door: A hinged and counterbalanced floor pan shall be provided at the upper landing for access to the machine room. The pan shall receive the finish door material and shall extend from the landing plate to the end of the truss. The pan shall extend the full width of the truss. Hinged pit access floor pans shall be provided only if necessary.

2.9 CONTROL STATIONS

A. Control stations with flush-mounted faceplates matching skirt panel finish shall be provided in the upper and lower newels. The nature and operation positions of all switches and buttons shall be identified with engraved characters which are readily visible from a standing position. Each station shall contain the following:

1. Red EMERGENCY STOP buttons, which when actuated shall disconnect the power supply to the motor, automatically set the brake and bring the unit to a smooth stop.
2. Key switches to START the unit.
3. Key-operated DIRECTION switch to select direction of travel.

2.10 SHOP FABRICATION

A. The various parts of each escalator shall be fabricated and assembled insofar as practical in the shop to minimize field assembly. Parts which are not permanently

shop assembled, but require a close field fit, shall be trial assembled in the shop and given erection marks where necessary to eliminate fitting work in the field.

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MECHANICAL SPECIFICATIONS FOR

UNIT B/C OF THE
UNIVERSITY OF MINNESOTA
HEALTH SCIENCES EXPANSION
PROJECT NO. MINN. 18 (HP)

Clinton N. Hewitt
Assistant Vice President for Physical Planning University of Minnesota

Eugene A. Kogl
Special Assistant University of Minnesota

Paul J. Maupin
Health Sciences Planning University of Minnesota

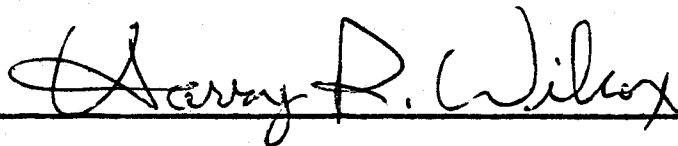
THE ARCHITECTS COLLABORATIVE, INC. Cambridge, Massachusetts

HEALTH SCIENCES ARCHITECTS & ENGINEERS, INC.
113 Hubbard Building, 2675 University Avenue Saint Paul, Minnesota
646-8875 55114

The Cerny Associates, Inc. Minneapolis, Minnesota
Hammel Green and Abrahamson, Inc. Saint Paul, Minnesota
Setter, Leach and Lindstrom, Inc. Minneapolis, Minnesota

As to Mechanical Engineering:

I hereby certify that these plans, specifications or reports were prepared by me or under my direct supervision, and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.



Date: September 2, 1975

Reg. No. 9603

PART I: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this Division. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. These conditions supplement provisions of General Conditions and Division I.

1.2 SHOP DRAWINGS AND EQUIPMENT BROCHURES

A. Refer to and comply with Section 01300.

1.3 DRAWINGS

A. In general, the drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor should consult the architectural and/or structural drawings. Drawings shall not take precedence over field measurements.

B. Plans of piping and ductwork although shown on scale drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of his work without additional cost to the Owner, in accordance with directions from the Architect/Engineer.

C. Where discrepancies are discovered after certain portions or phases of any contract have been installed, the Architect/Engineer reserves the right to require the Contractor to make minor changes in pipe, duct, fixture, or equipment locations or arrangements to avoid conflicts with other work at no additional cost to the Owner.

D. Because the drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. Contractor shall furnish all incidental labor, material or equipment for the systems in their control so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

E. In general, pipe lines requiring drainage shall be laid out at the site first, then large pipe mains, then space for air ducts, then electrical conduit. The Mechanical Contractor shall provide extra stub risers, drip-trap-and-rise

installations, and drip and trap assemblies at low points in steam systems as may be required; air vents, rises and drops in forced hot water mains as may be required; and extra lengths and fittings in all phases as may be required to install all systems in the space available and as necessary to avoid interferences.

1.4 CONNECTIONS AND LAYOUT

A. It shall be the responsibility of this Contractor to make connections at terminal points of contract. The piping, ducting and equipment, etc., may be shown with excess clearances for clarity. However, the Contractor shall group pipe and arrange all ducts and equipment to present a neat and workmanlike appearance and to avoid blocking of passageways.

B. All lines shall be constructed from the utility mains, shown on the drawings or designated by the utility company, and connecting to utility service lines on the site, in the building or other structures. Connections shall include furnishing and installing the meters, piping, fittings, valves, etc., from the utility main to the discharge size of the meter including primary regulating devices.

C. Contractor shall arrange for and pay for all costs involved in extending, rerouting and connecting the utilities whether or not part of the work must necessarily be performed by the various utility company crews. Any charges for connections to mains, valving, extending to curb property line or building, furnishing meters or equipment, etc., shall be paid for as part of the work of this division. Regardless of whether the Owner may have to sign with the utility company for any or all of these services, the Contractor shall apply for and include in his bid all fees, city inspection charges, permit charges, (except permits paid by University - see Section 01010) work charges, etc., and shall be ready to deposit with the utility company said fees when required at time of Owner's signing for same.

1.5 SERVICE INTERRUPTION

A. This Contractor shall schedule his work in such a manner that he does not interrupt any services to any University of Minnesota buildings unless authorized by the University. Refer to and comply with requirements of General Conditions, and Division 1.

B. Any service interruptions to a building, or portion of a building shall be cleared and scheduled with the University prior to the interruption.

1.6 MAINTENANCE AND OPERATING INSTRUCTIONS

A. Refer to and comply with Section 01700 requirements. The Contractor shall prepare a portfolio, as soon as possible after equipment has been ordered, of all mechanical equipment furnished by him on the project. This portfolio shall include manufacturer's shop drawings, parts' lists and operating and maintenance instruction of such equipment. Information shall be submitted in triplicate, neatly folded to approximately 8-1/2" x 11" size and bound in indexed loose-leaf binders of adequate size to contain the material. Each binder shall be properly

identified. Upon completion of these portfolios, the Contractor shall turn over to the Architect/Engineer, prior to the Owner taking over the building, for approval and delivery to the Owner.

B. Instructions shall contain the following information and services:

1. Manufacturer's recommended cleaning and maintenance procedures.
2. List of materials recommended for maintenance.
3. Complete operating instructions.
4. Name and address of authorized service organizations and parts depot.
5. Where indicated in the specifications, the Contractor shall provide the services of a factory trained representative to instruct the Owner's authorized personnel in the operation, control and maintenance of equipment.
6. Refer to Sections of specifications for additional information to be furnished by the Contractor.
7. The Mechanical Contractor shall instruct the Owner's representative in the use of all equipment and systems, as specified in Section 01700, including the proper procedure for draining and filling chilled water coils.

1.7 OTHER WORK

A. Other work will be performed by separate trades. This Contractor shall give careful consideration to work of all of the general, electrical, elevator and other trades, and all subsidiary trades, and shall organize his work so that it will not interfere with the work of other trades. He must consult all the specifications for correlating information and all drawings for details, dimensions, foundations, pits, etc.

B. Particular care should be taken in the co-ordination of mechanical work in the Basement areas of Unit B/C where piping, ductwork and electrical conduit are installed above suspended plaster ceilings. Careful co-ordination should also occur where ductwork and piping occur above and below a suspended plaster "heat shield" (located over the chiller pit area.) In both these instances, each mechanical strata will have to be installed, tested and insulated as required before the next strata is installed.

C. In Unit 'A' basement the existing "Heat Shield" will be removed by the General Contractor as required and as shown on the area drawings for new mechanical work as shown on the drawings.

D. All scaffolding required for mechanical work shall be provided by this contractor.

1.8 CLEANING

A. Refer to and comply with requirements of General Conditions, Section 01010 and 01070. The Contractor and Subcontractors for the various phases of the work of this Division shall promptly clear away all debris, surplus materials, etc.,

resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first-class condition.

B. Air surfaces of all coils, convectors, fan housings, fan wheels, fan motors, air unit plenums and all air filters shall be wiped or vacuumed clean or washed, if required, leaving the installation in a first-class condition.

C. All plumbing fixtures shall be thoroughly cleaned of all plaster, stickers, rust stains, and other foreign matter or discoloration, leaving every part in an acceptable condition and ready for use. The surface of all floor drains, clean-outs and other equipment shall be cleaned and each item shall be left in a first-class condition. Thoroughly clean all items of equipment furnished such as traps, strainers, pumps, motors, compressors, condensers, etc., leaving each item in a clean first-class condition.

1.9 PAINTING AND STENCILING

A. Painting of final field coats on materials and equipment furnished under the mechanical portion of the contract will be done under the general construction contract as described in Section 09900. This Contractor shall, however, refinish and restore to the original conditions and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Section 09900. All painting or paint finish referred to in Division 15 is to be provided by this contractor. This Contractor shall identify piping and indicate direction of flow, by marking the equipment as frequently as necessary for painting and stenciling by General Contractor. Laboratory water piping systems shall be labeled "Water Unsafe for Drinking" in accordance with the Minnesota State Plumbing Code.

1.10 DEMOLITION, REMODELING, CUTTING AND PATCHING

A. Refer to and comply with requirements of Section 01910.

B. The relocation of existing equipment and piping systems shall be accomplished in the least possible time. Work shall be scheduled so as to minimize the down time for the respective systems involved, and the schedule approved by the University in advance. This will be required for existing services being revamped and/or relocated and all interconnecting portions of these systems shall be installed as complete as practicable prior to actual shut-down for final connections.

C. As applicable, work shall be coordinated with the other contractors, other trades and with the University. In areas where work involved may interfere with existing building operations or require temporary or permanent cessation or relocation of building functions, the University must be consulted so that work schedules can be set up acceptable to all concerned.

D. This Contractor shall furnish and install all materials and equipment to complete remodeled areas of the existing buildings as shown on the plans specified herein, or required to complete the work indicated under this Contract, including all minor items necessary for complete and operating installation. This Contractor shall offset existing piping and ductwork as indicated on the drawings or as required to accomplish the remodeling indicated.

Refer to the architectural drawings for remodeling required.

E. This Contractor shall be responsible for all necessary cutting and patching required in connection with his work and where necessary because of removal or change of existing work. Cutting of structural members and finished surfaces shall not be allowed without permission from the Architect or Structural Engineer. These cutting and patching requirements will be modified only if general construction specifications and drawings specifically and clearly state that certain or all portions of same required for each of the various trades is to be performed by the General Contractor.

F. This Contractor shall remove existing mechanical work as shown, or is required to accomplish the work as indicated on the drawings, from the existing Diehl Hall, Unit A, and Mayo Hospital Complex. Where required, existing piping, ductwork and other mechanical work and systems shall be relocated or rerouted to accomplish and complete the work.

G. Cutting and patching to expose and remodel existing mechanical systems shall not be construed as the work of another contract unless specifically called for on another contractor's documents. In general, all patching caused by Mechanical Contractor's cutting and demolition work to accomplish the work of the Mechanical Contractor shall be done by the Mechanical Contractor, except as indicated to be done by the General Contractor on the Architectural Drawings.

H. Cutting required for plumbing, heating, ventilating and air conditioning work, etc., shall be done by the Mechanical Contractor to the entire satisfaction of the University and Architect/Engineer. Cutting shall be kept to a minimum which will allow the proper placement of the materials.

I. All unsalvagable materials shall be removed in a manner that will avoid damage to materials or equipment to remain and shall be completely removed and legally disposed away from the site.

J. Salvagable materials designated for re-use or relocation shall be carefully removed and shall be protected from damage until they are incorporated into the new work.

K. Salvagable mechanical equipment not specifically stated or specified to be reused should be reviewed with the University's representative as to disposition. If the University desires to retain, the equipment should be carefully removed, protected from damage and turned over to the University at a location outside the building. If the University does not desire the equipment, it should be completely removed and legally disposed away from the site. Equipment shall include but not be limited to air handling units, ductwork, diffusers, control instruments, tubing, piping, valves, plumbing fixtures, trim, drains and cleanouts.

L. See Sections 01010 and 01500 for special requirements such as the use of construction tools, barricades, and protection of the existing building.

M. The Mechanical Contractor shall repaint all areas where he has performed cutting and patching at rooms, spaces or locations that are not repainted under

the General Contract, generally these will be locations where no demolition, cutting and patching is performed by the General Contractor.

N. Refer to Sections 09110, 04200, 09100 and 09900 for execution and requirements for patching and painting and comply with applicable provisions as to materials and workmanship.

1.11 EXCAVATING

A. This Contractor shall do all trenching, excavating and backfilling required for his work. Any street, sidewalks, curb or paved area repairs necessary because of this work shall be his responsibility. Refer to General Conditions, Section 02200 and Section 02400 for requirements of trenching, excavating, backfill and compaction; comply with applicable provisions.

1.12 GOVERNING CODES

A. The mechanical installation shall conform to the current provisions of all local and State codes pertaining to plumbing, heating, ventilation and refrigeration work including, but not necessarily limited to the following:

1. Minnesota Building Code
2. Minnesota State Plumbing Code
3. American Water Works Association
4. National Electric Code
5. Minnesota State Board of Health
6. Minnesota Safety Code and Regulations
7. Sheet metal and Air Conditioning Contractors National Association
8. Local applicable ordinances

1.13 STANDARDS

A. All materials supplied under the mechanical contract requirements shall conform to the latest editions of the following standards:

1. All applicable standards as published by the American Society of Testing Materials.
2. All applicable standards as published by the National Fire Protection Association.
3. American Standards Association
4. American Society of Mechanical Engineers
5. American Society of Heating, Refrigeration and Air Conditioning Engineers.

6. Air Moving and Conditioning Association

1.14 TESTS

A. All work shall be inspected, tested and approved as required by the State of Minnesota and local regulations. Tests shall be made in presence of proper Inspectors and Architect/Engineer or their duly authorized representatives. All tests shall be made by the Contractor at his own expense, and he shall furnish three (3) test certificates each to the University and Architect/Engineer.

B. All work shall prove absolutely tight under required tests. All types of piping systems, except final tests of completed systems shall be made before pipe is covered or connected to fixtures and equipment. Tests required shall not be less than specified in the following paragraphs.

C. All gauges, tools, pumps, gas, air or other equipment required for testing and initial adjusting of piping systems shall be purchased and provided by this contractor.

D. Piping Tests

1. Sweat copper joints. Provisions shall be made for removal of one (1) percent of the sweat joints in copper piping for inspection and testing. Additional joints may be required to be removed if failure occurs in original one (1) percent tested.

2. Silver Brazed Copper Joints. Mechanics doing silver brazing are required to pass a certifying test. Test shall simulate job conditions using fittings of size and type specified.

a. Test sample shall be two (2) nipples (12" long) and one (1) coupling of the largest size to be used at the job (2" minimum size). Execute one (1) sample in horizontal position, 6'-0" above floor, and one (1) sample in vertical position 5'-0" above floor with upward flow of brazing.

b. Test samples shall be sent to an independent testing laboratory by the contractor, and contractor shall pay all costs of test.

3. Welding

a. All welding shall be done by certified welders and licensed fitters who are thoroughly trained in electric arc and/or gas welding and experienced in the welding positions and materials required. Certification shall be for type of work being performed by welder and shall be accomplished in accordance with ASME "Qualification Standard for Welding Procedures, Welders and Welding Operations." No welds shall be made by any welder until copies of his certification have been submitted to Engineer/Architect.

b. Test Coupons shall be taken as follows, unless otherwise directed by the University as work progresses:

- 1) Less than 25 welds - 2 coupons
- 2) Over 25 welds - one coupon, and one coupon per each 50 welds

c. Location of test coupon to be selected by University.

d. In lieu of test coupons as above specified, or in the event of evidence of coupons failing to pass; then X-ray may be used to evaluate the welding.

e. All welds shall be stronger than the parent metal. A minimum of two passes shall be used on all arc welded joints.

f. The University will pay for all laboratory tests of the coupons, except tests taken as a result of failures which shall be paid for by the Contractor.

E. Systems Tests

1. All soil, waste, storm water and vent conductors, etc., shall be tested with air of 5 psi pressure and shall remain constant for 15 minutes without the addition of air.

2. Cold, hot and recirculating hot water piping shall be tested and proven watertight under a hydrostatic pressure of 125 psi pressure or 1-1/2 times the working pressure, whichever is greater, for a period of two (2) hours prior to application of pipe insulation and final connection to fixtures.

3. Gas piping shall be tested with air at 50 psi pressure for a period of two hours. Soap test all joints.

4. Compressed air piping shall be tested with a 150 psi without drop other than that due to temperature differential over a 24-hour period. Testing medium shall be water pumped compressed air or nitrogen only.

5. Vacuum piping systems shall be tested at 25 inches of vacuum for a period of one hour with all outlets closed and pump not working. The drop in vacuum shall not exceed 1/4" of mercury during the test.

6. Dental oral suction piping system shall be tested at 10 inches of vacuum for a period of one hour with all outlets closed and turbine pumps not working. The drop in vacuum shall not exceed 1/4" of mercury during the test.

7. Oxygen Piping System

a. After installation of the piping, but before installation of the outlets, the system shall be blown clear of free moisture and foreign matter by means of water pumped (oil free) dry nitrogen or air.

b. After installation of the station outlet valves, each section of the piping system shall be subjected to a test pressure of 1-1/2 times maximum working pressure, but in no case less than 150 psi, by means of water pumped (oil free) nitrogen or air. This test pressure shall be maintained until each joint has been examined for leakage by means of soapy water. All leaks shall be repaired and the section retested.

c. A 24-hours standing pressure test with water pumped (oil free) nitrogen or air at 1-1/2 times maximum working pressure, but in no case less than 150 psi, shall be made to check the completeness of previous joint tests. Only normal pressure changes due to temperature changes will be permitted.

8. Nitrogen Piping System. Same as Oxygen Piping System as specified in 7.
9. Nitrous Oxide System. Same as Oxygen Piping System as specified in 7.
10. Carbon Dioxide System. Same as Oxygen Piping System as specified in 7.
11. The Standpipe and Sprinkler Piping System shall be tested hydrostatically at 250 psi water pressure for a period of two (2) hours.
12. Distilled water piping shall be hydrostatically tested at 75 psi pressure for a period of two (2) hours. The distilled water distribution borosilicate glass system shall be guaranteed in writing to continuously deliver distilled water of the following quality:
 - a. Less than 10,000 ohm centimeters specific resistance change from the storage tank to the most remote user station.
 - b. Less than 100 total bacteria per millimeter increase from the storage tank to the most remote user station.
 - c. The distilled water at the user stations shall have:
 - 1) Less than 4 parts per billion copper.
 - 2) Less than 10 parts per billion total heavy metal
 - 3) Less than 20 parts per billion sodium
 - 4) Less than 5 parts per billion boron
 - d. In addition to the above guarantee, the manufacturer shall submit recommended procedures for obtaining and maintaining the water quality specified.
 - e. After the piping systems have been completed and pressure tested, the entire distilled water system shall be flushed and cleaned to obtain the above quality standards.
13. All Steam and return piping shall be subjected to an air test of not less than 75 psi pressure or 1-1/2 times the working pressure whichever is greater. The pressure shall be maintained for a period of two (2) hours with no drop in pressure. Soap test all joints.
14. All Hotwater Reheat and Radiation Piping; same as Steam Piping System as specified in 13.
15. All heat recovery supply and return piping; same as steam piping system specified in 13.
16. Chilled Water System shall be subjected to an air test of not less than 225 psi pressure. The pressure shall be maintained for a period of two (2) hours with no drop in air pressure. Soap test all joints.
17. Condenser Water System Condensing Unit Cooling Water and Glycol-Engine Coolant System shall be subjected to an air test same as specified for chilled water.
18. Fuel Oil Piping System shall be tested at 1-1/2 times operating pressure.

19. Pump Motors. All motors and/or equipment under the mechanical contract shall be tested under load conditions with the RPM and amperage readings taken and listed on the required certificate.

a. All pumps in addition shall have flow and head listed.

20. Heating, Ventilating, and Air Conditioning

a. All ventilating and air conditioning systems shall be balanced by an independent test and balance agency retained by the University of Minnesota. The agency will be a fully certified member of the Associated Air Balance Council.

b. The Mechanical Contractor shall have ventilating and air conditioning systems installed, cleaned and operating in all areas delivering air through inaccessible ceiling areas so as to remove construction dirt and dust from duct prior to installation of ceilings.

c. All equipment shall be freshly oiled, filters charged with clean media, and installation completely finished prior to acceptance.

21. Hydronic Systems, Chilled Water, and Condenser Water Systems.

a. All hydronic systems, chilled water and condenser water systems will be balanced by an independent test and balance agency retained by the University of Minnesota.

22. Fire Safety Precautions

a. See Article 1.33 Section 01010

23. Automatic Temperature Control

a. The Temperature Control System is specified under Division 16 and as such is assigned to the electrical portion of the contract as a responsibility of the Electrical Contractor.

24. Sterilization of Domestic and Laboratory Water Pipes

a. Upon completion of cold, hot water, and circulating hot water piping systems, including water service connection, this Contractor shall sterilize these systems with chlorine before they are placed in operation. Amount of chlorine applied shall be such as to provide a dosage of not less than 50 parts per million. Following a contact period of not less than 6 hours, the heavily chlorinated water shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million. All valves in water lines being sterilized shall be opened and closed several times during the 6 hour period.

b. All sterilization work shall be performed in a manner and with methods such as to meet approval of inspector's Office of State Board of Health. Water shall be sampled and tested by the Division of Environmental Health, University Health Service before being placed in service.

c. Special care shall be taken in sterilizing, cleaning and flushing piping to eyewashes and emergency showers.

25. Cleaning and Flushing of Piping Systems. The Contractor in the presence of the University shall thoroughly flush the chilled and condenser water system, condensing unit cooling system, hydronic heating systems, Glycol-heat recovery and engine coolant systems, using Wyandott Chemical Corporation's "Conquer" liquid cleaner. The cleaning and flushing procedure shall be in accordance with the following:

a. After the piping systems have been completed and pressure tested, set all hand valves and control valves in an open position.

b. Fill the systems with clean water and start the system pumps.

c. Using the chemical feeders on the chilled water system and the hydronic systems, add one (1) liquid ounce of "Conquer" liquid cleaner per gallon of water in the systems. The liquid cleaner may be added directly into the cooling tower basin using one (1) liquid ounce of cleaner per gallon of water in the system. The liquid cleaner may be added in the same proportion in the Glycol Systems at the point of Glycol fill, then flushed as described below prior to the introduction of the Glycol/Water mixture.

d. After the cleaner has been added to the systems, continue to run the pumps for a period of 4 hours. During this period, the pump strainers shall be inspected and cleaned as required to prevent damage to the pumps, but in no case shall inspection and cleaning be done at greater than one hour intervals.

e. At the end of the 4 hour run, drain all systems completely, then flush with clean water for a 2 hour period discharging dirty water to sewer.

f. Drain systems, remove, clean, and replace all strainer screens and fill systems with clean water.

1.15 IDENTIFICATION

A. All mechanical equipment furnished under these specifications shall be identified with black-white-black laminated 1/8" plastic plates. Plates attached with self-tapping screws.

B. Provide 1/8" engraved plastic plates at each outlet of the laboratory water system with the legend: Water Unsafe for Drinking. Letters to be 1/4" high, Helvetica Medium letters, in one or two lines as selected by Architect, color as selected by Architect. Attach to surface (wall or splashback) closest to the fixture, using 2 screws. If no adjacent surface, attach to fixture with a chain. Verify typical locations with Architect prior to installation. Submit samples of one and two line plates for approval prior to ordering.

1.16 RESTORATION OF CONSTRUCTION DISTURBED FOR UTILITIES

A. Refer to General Conditions and Section 01010.

1.17 FUTURE ADDITIONS

A. Pipes and ductwork shall be valved and capped for future completion of spaces as shown on the plans.

1.18 CONNECTIONS TO EXISTING BUILDINGS

A. Connections to the existing building shall be made as shown on the plans. Any existing equipment and/or systems affected by these connections shall be replaced into proper operation. Add isolating valves at point of connection to existing services.

1.19 ENTRY OF LARGE EQUIPMENT

A. If any equipment cannot be brought through regular entrances, Contractor shall so notify the University and Contractor for General Construction, and arrange with him to leave suitable openings for accommodation of such large equipment. All such arrangements shall be subject to approval of Architect/Engineer. Without such arrangements, equipment shall be delivered in sections small enough to permit use of regular entrances. This latter practice is not preferred.

1.20 TEST AND BALANCE SERVICE

A. Under a separate contract, the University will retain a qualified independent firm to provide the services of testing and balancing the air, hydronic, chilled water and condenser water systems of this Project. The consultant will be responsible to the University and the Architect. It is intended the services will be provided by a firm specializing in testing and balancing air and hydronic systems in building construction and be certified by the Associated Air Balance Council (AABC).

B. It is intended the separate contract will include all services of testing and balancing in accordance with the published standards of the AABC National Standards for Field Measurement and Instrumentation, Total System Balance. The service will include the Pre-construction Plan Check and Continuous Inspection Plan of the AABC. The consultant shall also act as an inspection agency during construction and shall report to the University any discrepancies or items not installed in accordance with the Contract Documents pertaining to the systems he will be testing and balancing.

C. The consultant will provide the testing and balancing service for air and piped systems, such as:

1. Complete ventilating, air conditioning and exhaust systems, including fume hood tests, balancing the air flow to and from all openings, adjusting dampers, fan speeds and other adjustments required to meet the required adjustments to inlet vane and scroll by-pass dampers; and such other adjustments necessary to provide fully balanced systems performing as intended by the Contract Documents.

2. Piped/pumped systems of all hydronic, chilled water, condenser water, recirculating domestic water, heat recovery and other systems, balancing the flow to/from each device and making such tests and adjustments necessary to meet the required volume and performance intended by the Contract Documents.

D. Where applicable, the consultant shall test and balance systems in operation at both the normal and emergency mode conditions.

E. The Mechanical Contractor (and his subcontractors and suppliers) shall coordinate his Work and cooperate with the test and balance consultant throughout construction as necessary for the consultant to satisfactorily and efficiently perform his services. The Mechanical Contractor shall:

1. Provide the consultant with a schedule of the Work, updating the schedule as the Work progresses and giving the consultant timely notices to allow examinations and permit test and balance services to be accomplished at appropriate times.

2. Advise the consultant of changes, modifications and rearrangements made during the construction progress.

3. Provide a copy of pertinent shop drawings, pertinent equipment brochures, fan curves, coil data, grille register and diffuser submittals, pump submittals, pump curves, control diagrams, other similar data, and any other necessary information required to perform the balancing and adjusting of the HVAC and piped/pumped systems. All such data shall be the final copies accepted by the University and Architect/Engineer.

4. Leave all air and piping balancing devices in the wide open position, and instruct all workmen and subcontractors of this requirement, and free all operating arms and adjustments so they can be easily operated.

5. Allow access to all areas of the Work as necessary to accomplish the test and balance services.

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3/28
24.1.1.8

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. This section specifies the basic materials and workmanship for the various mechanical trades. Its provisions apply to all work of the Mechanical Contractor.

PART 2: INSTALLATION

2.1 GENERAL

A. All pipes shall be required size, round and straight and shall be cut, reamed, threaded, beveled for welding and/or otherwise prepared for joining with proper tools. All piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out, properly insulated and protected where required, and run in a neat and orderly manner to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceilings, chaseways or similar spaces shall be installed to permit such enclosure as intended. This Contractor must lay out his work, properly locate the apparatus and add necessary pipe, sleeve, etc., and take his own measurements at building.

B. All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable. Pipe sizes shown on the drawings are nominal pipe sizes and not outside diameters. Pipes shall be run substantially as indicated on the drawings; however, Architect/Engineer reserve the right to require this contractor to make minor changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

C. All piping shall be installed with ample provisions for expansion and contraction to prevent damage to same or to building structure. Such provisions shall be made by means of piping offsets, changes in directions, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offsets, loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or loops, except where specified and/or indicated on the drawings or where otherwise obviously necessary.

D. All heating and cooling piping systems shall conform with all applicable requirements of the Code for Pressure Piping, ASA B31.1 and with all applicable state and local codes, except where type and quality of materials, weights, thicknesses, design, pressures or fabrication techniques are called for in these specifications which exceed or upgrade such code requirements, these specifications shall govern.

E. Bolt and gasket sets for all steam piping, except condensate piping, shall be flanged bolts ASTM A193, grade B7 alloy steel with semi-finished hex nut A-194. Gasket shall be flexitallic type C-G, or equal. For condensate piping the bolt material shall be cold rolled steel flanged bolt with hex head and

heavy semi-finished hex nut. Gasket shall be 1/16 Cranite ring gasket, or equal.

2.2 PLUMBING PIPING SYSTEM

A. The continuous waste and vent piping method shall be followed for entire plumbing system. Provide laboratory and domestic hot, circulating hot and cold water, distilled water, compressed air, natural gas, carbon dioxide, oxygen, and vacuum lines to all outlets, junction boxes, and fixtures as shown on drawings or specified herein.

B. All water piping shall be pitched to drain points, and up from hot water tanks, supply mains or risers 1/8" per 10 feet wherever possible. Provide a 3/4" hose bibb drain at end of each main and base of each riser and elsewhere as indicated on drawings.

C. All waste and vent piping shall be properly pitched 1/4" to the foot where possible and 1/8" minimum unless indicated otherwise so that all waste piping will drain back to main stacks and vent pipe will drain back to fixture unless loop venting indicates other pitch. Piping shall be properly supported so that it will not sag and form pockets. Joints between cast iron pipe and fittings shall be caulked with pitched oakum, thoroughly forced into joints with caulking tools. The joints shall then be filled with molten lead solidly caulked even with the hub top. Joints for acid resistant waste and vent shall be glass bead with stainless steel or glass reinforced nylon compression type assemblies with teflon liner. Where acid resistant piping connects to cast iron piping, the connecting fitting and the common line shall continue as acid resisting material. Preformed molded rubber rings may be used where specified under Section 15110.

D. Glass pipe shall be installed in accordance with manufacturer's recommendation. Vertical runs of 3", 4" and 6" pipe shall be supported by a ring clamp under the coupling at each floor. 1-1/2" and 2" vertical runs supported every other floor. Horizontal runs supported every 8 to 10 feet.

E. All gas piping shall be installed with plugged drip pockets at low points. Pipe shall be extended to all gas equipment, including safety valves where required or noted to be installed.

F. Consult manufacturer's data and details of rooms containing plumbing fixtures on architectural drawings before roughing-in piping. Plug or cap piping immediately after installation. Waste stuffed in open ends of piping shall be removed before installation of next length of pipe. Minimum size of all water piping shall be 3/4" except for short stubs immediately at fixtures.

G. All groups of fixtures shall have main valves including drain cocks with valves spotted in accessible, but concealed locations. Sectionalizing valves shall be provided where shown to isolate each laboratory bench from the mains.

H. All compressed air piping shall be installed with drip pockets at low points of piping for elimination of moisture. Piping shall be connected near top of receiver with union and valve. Connections at equipment shall consist of a valve and union.

I. All dental oral suction pipe shall be properly pitched 1/32" to the foot in direction of flow to the separator.

J. All vacuum piping shall be run with as few offsets as possible. Special care shall be given to reaming ends of pipe for this system to eliminate all rough edges.

K. Circulating hot water piping systems shall be properly balanced so as to provide equal flow in all branches of the system. Provide a thermometer in each circulating branch.

L. The distilled water borosilicate glass system, as proposed, shall be a completely pressure beaded system, and shall not exceed the pressure ratings of the material installed. It shall be installed to accommodate internal and external stresses normal to a system so installed. All pipe supports, hangers, etc., shall be installed per manufacturer's recommendations. Static head on system is 96 psi.

2.3 HEATING PIPING SYSTEM

A. All steam and condensate piping shall be installed for gravity flow of condensate to traps and/or condensate receivers. Steam and return piping shall pitch at least 1/4" in 10 feet. Provide drip legs and trap assemblies at all rise locations where shown and/or as may be otherwise required. Steam lines shall be pitched for condensate flow in same direction as steam flow except where otherwise specifically shown on the drawings. Runouts to equipment utilizing steam and return shall pitch 1/4" to 1 foot.

B. All hot water heating piping shall be installed with a minimum pitch of 1/8" per 10 feet to free itself of water when drained and/or air when operating. If rises and drops are required in horizontal pipe runs, install a 3/4" IPS by 6" high capped pipe air chamber for hydronic main supply and return risers. See Article 2.5 of Section 15130. Through a reducer, connect a 1/8" copper tube and run the stubs to discharge over a janitor's slop receptor or an equipment room floor drain. On the end of the copper tube near the drain, install a key-operated manual air vent. Provide a gate valve and union on inlet to air vent. On the high side of all hot water finned tube radiation, furnish and install an air vent. See Article 2.5 of Section 15130. Furnish and install a bypass between pump suction and pump discharge with gate valve, strainer and balancing cock on all convertor installations. Bypass line shall be one half the size of the suction piping. Furnish and install on each reheat coil shut-off valves, unions, control valve and flow indicator and a full supply pipe size air chamber at least 4" long with reducer on top to a Taco, Dole, or standard type key-operated air vent valve. Provide copper tubing on air chamber outlets and run tubing to accessible location before installing air vent when necessary for access and when directed by Architect/Engineer.

C. Under no circumstances shall any pipe connections in the field be made by punching a hole in a pipe and inserting or saddling a branch take-off. Reduction in line size for all piping shall be with eccentric fittings, butt-weld, or screwed according to size and application. Flanged connections required to match field equipment may be made using slip-on flanges.

D. Work done in approved prefabrication shops may be done as follows: Headers and fittings may be welded without the use of backup rings. On pipes 2-1/2" and larger where pipe reduction is two sizes or more weldolet

and sockolets may be omitted and the joints may be made by properly saddling a branch take-off. On all pipes 2" and smaller, and on pipes 2-1/2" and larger where there is no pipe reduction or pipe reduction is only one size, welding tees must be used.

E. Trap assemblies for all but steam and drip points and preheat coils shall consist of dirt pocket, strainer, union, trap and gate valve.

F. Trap assemblies for steam main drip points shall consist of gate valve, union, strainer, trap, union, and gate valve.

G. Trap assemblies for preheat coils shall consist of dirt pocket, union, gate valve, trap, union and gate valve. See detail on the drawings.

H. All drip piping shall be welded except for connections to screwed strainers and traps.

I. In addition to paragraph "A" above this contractor, for stainless steel piping system on the medium pressure steam supply pipe shall support the pipe at 10 feet intervals by permanent hook-type hangers. Supports shall also be placed at each change of direction. When piping is cut, the contractor shall use proper cutting tools, especially designed to be used with this grade of pipe. All expanded tubing and ferrule joints must be face cut flush with the ferrule.

J. Glycol-heat recovery system piping and glycol-engine coolant systems shall be pitched similar to hot water heating systems.

2.4 AIR CONDITIONING AND COOLING WATER SYSTEMS

A. All chilled water piping, condenser water piping and condensing unit cooling water system piping shall be installed with a minimum pitch of 1/8" per 10 lineal feet to free itself of water when drained and of air when drained and of air when operating.

2.5 CONNECTIONS TO MISCELLANEOUS EQUIPMENT

A. Due to the fact that the manufacture of the equipment purchased may vary slightly from that specified and therefore requires some rearranging of equipment different from that indicated on the drawings, the Contractor shall make connections to such re-arranged equipment without additional cost to the Owner. That is for an initial installation arrangement other than that indicated on the drawings.

B. This Contractor shall make all water, waste, vacuum, oxygen, air, carbon dioxide, vent, gas, steam, condensate return, hot water heating and ductwork connections to all equipment that is installed for this project whether or not such equipment is furnished by this Contractor, other contractors, or by the Owner. This includes furnishing and installing piping, shut-off valves, unions, fittings, ductwork, air control devices and insulation.

C. The unpacking, assembling and setting of equipment furnished under other than mechanical sections of these specifications, will be performed

by other than this Contractor. This list includes, but is not necessarily limited to the following which are listed in the General and Electrical sections of the specifications and/or Architectural and Electrical drawings:

1. Laboratory Equipment other than what is specified in Section 15310.
2. Environmental Rooms.
3. Sterilizers.
4. Glass and Cage Washers.
5. Linear diffusers, registers, grilles, integral with ceiling components.
6. Louvers.
7. Temperature Control Valve Installations and Temperature Control Damper Set. See Section 16900.
8. Emergency Generators.
9. Fin tube radiation covers.
10. Film Developing Equipment.
11. Owner furnished equipment. Section 01010 (1.12).
12. Generally, connection types and sizes are described in the above lists and/or shown on the drawings.

D. The Mechanical Contractor shall coordinate work between the various trades to insure proper installation and operation of all systems. The following list is presented to assist the Mechanical Contractor with coordination and shall not be considered as inclusive for all coordination required.

1. Cooling tower connections.
 - a. Chemical treatment.
2. Preheat, Reheat and Cooling coil connections.
3. Diffusers, Registers and Grilles.
4. Fin tube radiation.
5. Items listed in paragraph (C).

E. Also included in this work are connections including shut-off valves, pressure reducing valves, unions, double check valves, open wastes and traps.

1. Make up supply water to:
 - a. Chilled water system.

- b. Condenser water systems.
- c. Engine radiator coolant systems.
- d. Radiation and radiant panel systems.
- e. Reheat systems.
- f. Miscellaneous Equipment
- g. Room connections and drains from overflows and units.

2.7 CONCRETE FOUNDATIONS AND SUPPORTS

A. Foundations, anchors, concrete cover, anchor bolts, sleeves, grouts, shims, etc., required for properly placing mechanical equipment furnished under this contract shall be provided by this Contractor, unless specifically stated otherwise. Housekeeping pads, four (4) inches thick, of 3000 pound, 28 day strength concrete, shall be furnished for all mechanical equipment located on floor slabs. See Architectural and Structural drawings for concrete work to be furnished by General Contractor.

B. All floor openings at equipment rooms above grade shall have 4" concrete curbs around them by the General Contractor.

2.8 ELECTRIC MOTORS AND WIRING

A. Motors:

1. Furnish electric motors as required for each motor driven unit. All motors must conform in every respect to the standard specifications of NEMA and bear nameplate of manufacturer, with current operating characteristics noted thereon.

a. Horsepower ratings: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed the motor horsepower nameplate ratings shall not be less than 107% of the driven unit brake horsepower requirements.

2. All motors shall be provided with ball or roller bearings complete with grease cups. Motors shall be quiet when operating under full load conditions.

3. Unless otherwise specified, motors shall be of the induction type and shall be of speeds, sizes and for electric current characteristics as given in this specification. Motors shall be mounted on sliding cast iron bases as required. Motors shall be General Electric, Century, Allis-Chalmers, Westinghouse, Wagner or approved equal.

4. Motors of 1/3 HP and smaller shall be wound to operate on 120 volts, single phase, 60 cycles, A.C. and motors 1/2 HP and larger shall be wound to operate on 480 volts, 3 phase, 60 cycles, A.C. except where otherwise indicated.

B. Wiring

1. All control wiring shall be by this Contractor as noted in these specifications.

a. All wire shall be soft annealed copper wire type THW.

2. This Contractor's electrical work shall comply with the requirements of the National Electrical Code. Where this specification or the plans indicate requirements in excess of those of NEC, the compliance with NEC will not relieve the Contractor from furnishing and installing work as shown or specified.

3. All switching, protective devices and control for equipment furnished under these specifications shall be identified with black-white-black laminated 1/8" plastic plates. Plates attached with self-tapping screws.

4. Refer to Motor Schedule on Sheet E-55 for reference to mechanical work.

2.9 EARTHWORK

A. This Contractor shall furnish all equipment, materials, skills and services required for excavation, backfill and compaction required to perform the work under this contract. Contractor shall refer to Section 0220, Earthwork for general information.

B. All trench work shall be dug, ripped, blasted or jack-hammered to the alignment and depth shown and in segments of minimum length to minimize the time of open trench. Trenches in soil shall be adequately braced and sheeted so as to provide safe and efficient working conditions. All trenches shall be kept free of water at all times. The trench width may vary with regard to required depth and the nature of the undersoil conditions. The finish trench shall be sufficient dimensions to allow the pipe to be laid and joined in the manner intended.

C. All pipes in soil shall be laid on a 6" gravel cushion foundation placed upon sound soil cut true and even so that the pipe will have a bearing for its full length. Gravel cushion to be in accordance with the 1972 Minnesota Standard Specifications for Highway Construction, Section 2502.2, Subdrainage Backfill. Pipe to be located in rock or soils with rock, shall be laid on a 12" minimum thickness sand foundation with at least 12" of sand at sides. At any area where soil stability is unsuitable or questionable, the Contractor shall further excavate until stable soil is reached. Contractor shall then backfill with compacted granular material until proper elevation is reached.

D. All backfill shall be clean granular fill (See Article 2.1, Section 0220) compacted in 8" lifts to 96% standard Proctor density (ASTM D-698-70).

E. The Owner shall retain an independent testing laboratory which shall provide the following tests:

1. Soil analysis of four samples which represent backfill material.

2. Field density tests of the compacted backfills in accordance with ASTM D1556. (One test on every third lift for every 100 feet of trench.)

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes performing all labor and furnishing all piping materials, fittings, joining methods, protection and pressure for piping used on this project to connect all fixtures and equipment, pipe and fittings of material and type for various services as list below:

C. Related work specified elsewhere:

1. Basic Materials and Methods: Section 15100.

PART 2: PRODUCTS

2.1 PLUMBING PIPE AND MATERIALS

A. At all fixture connections where nipples are necessary between copper tubing and fixtures, such nipples shall be standard weight full iron pipe size brass pipe nipples with suitable brass or copper adapters. Steel or iron nipples will not be permitted at any location in copper lines where connections are made to brass fixture valves or trim.

1. Water Piping

- a. Underground Piping: These lines shall be Government Type "K" sinous copper tubing with cast bronze or wrought copper fittings, 15% silver brazing alloy (Handry Harmon, Sil-Fos) or equal in joining pipe with silver solder. See Section 15200 for underground water service.

- b. Above-ground Piping: All water lines shall be Type "L" hard drawn ASTM B88-58, with soldered joints and fittings. For 2" and larger size pipe on cold, 140 degree F. hot and 140 degree recirculating hot water and all sizes on 180 degrees F. hot and recirculating hot water all soldered joints shall be made using silver solder with sil-fos, Eutectic 1800, or approved equal. For 1-1/2" and smaller size pipe on all cold, 140 degree F. hot and 140 degree F. recirculating hot water, tepid water supply and tepid water recirculating all soldered joints shall be made using 95/5 solder with No. 50 non-corrosive flux.

1. Galvanized steel Schedule 40, ASTM A120, with 150# galvanized malleable iron fittings. Victaulic Couplings and Companion Flanges, ASTM A-197 for 6" and over at the option of the Contractor.

2. Sanitary Sewage Piping and Storm Water Piping

- a. Underground - beneath building floors - For pipe sizes to 15"

these lines shall be extra heavy cast iron pipe with hub and spigot joints and fittings. Joints for sanitary piping shall be made using packed oakum and melted lead which shall be caulked even and solid with tools until filled full to bead line. For underground storm only, fittings to be C.I. hub and spigot coated with preformed molded rubber ring. Sealing rings shall conform to ASTM 564-65 requirements.

b. Underground - beneath building and outside of building: For pipe larger than 15" shall be reinforced concrete pipe (RCP). Class 5, ASTM 76. Joints shall be made with "O" ring type seal, such as Cretex R-4.

3. Waste Piping

a. Pipe - extra heavy cast iron (above grade in building). Piping under 2" shall be Schedule 40, galvanized steel with screwed joints.

b. Fittings - same material as pipe.

c. Joints caulked.

4. Vent Piping

a. Pipe - Schedule 40 galvanized steel with exception that urinal vents shall be cast iron.

b. Fittings - cast iron

c. Joints - screwed, caulked.

5. Rainwater Drainage

a. Pipe - Schedule 40 galvanized steel.

b. Fittings - black cast iron drainage.

c. Couplings normally furnished with lengths of pipe shall not be used in the installation of threaded piping. Extra heavy steel, malleable or drainage couplings shall be used.

d. Victaulic fittings and companion flanges may be used in lieu of screwed fittings as specified above for fittings.

6. Acid-Resistant Piping

a. Pipe - These lines shall be "Kimax" or "Pyrex" regular schedule glass pipe or Duriron with Mechanical Joint above grade and "Duriron" or Pyrex with Bury-Pac below grade.

b. Fittings - Hub and spigot below grade. Bead to bead or bead to plain end with compression type coupling made of stainless steel or glass reinforced nylon and teflon liner above grade. Slip joints not permitted after fixture trap.

c. All waste and vent piping above grade for the project shall be acid resistant with the exception of waste and vents for toilet rooms, drinking fountains, sterilizer waste, drains, receiving condenser water, bottle filling stations, showers, janitor receptors, sink-Dwyer unit, surgical scrub stations emergency eyewash drain piping and penthouse floor drains. Where horizontal acid waste piping connects to galvanized or cast iron piping, an acid wye shall be used and the common line shall continue as acid piping.

d. At the Contractor's option, polyethylene or polypropylene are considered acceptable substitutes for glass for horizontal branch lines to sinks, lab benches, etc., not exceeding 60 feet in length, subject to the following conditions:

1. All material furnished shall be self-extinguishing (fire retardant).

2. The contractor and manufacturer shall assume joint responsibility for the proper installation of the material culminating in the issuance to the University by the manufacturer of the following warranty and extended guarantee:

a) Manufacturer shall furnish a written one-year warranty guaranteeing all pipe, fittings, and accessories to be free of defects in material and workmanship.

b) Manufacturer shall provide an extended guarantee of at least 20 years after installation on all pipe, fittings and accessories of their manufacture against failure due to any of the following:

Joint leakage
Chemical corrosion
Environmental stress cracking
Expansion or contraction under system design conditions
at the time of original installation.

Under this guarantee, the manufacturer shall supply replacement parts at no charge to the University. In addition, the manufacturer will pay all reasonable direct out-of-pocket labor charges incurred in replacing such defective pipe or fittings in an amount not to exceed \$100.00 for each defective length of pipe or individual fittings.

3. The manufacturer shall be responsible for advising the University prior to material acceptance of original installation design conditions that cannot be covered by the extended guarantee.

7. Distilled Water

a. Pipe - Kimax or Corning, small bore low expansion borosilicate glass pipe, equal to Corning's 7740 beaded pressure pipe with minimum nominal pipe size of 1".

b. Fittings - Same requirements as pipe.

c. Joints - Bead end with compression type joint with teflon liner.

8. Air (Both Systems) and Vacuum Piping (Both Systems - H.G.)

- a. Pipe - Government Type "L" hard copper tubing.
- b. Fittings - wrought copper solder type.
- c. Joints - 95-5 solder.

9. Oxygen and Nitrous Oxide

a. The installation of oxygen and nitrous oxide piping system shall be in accordance with all prevailing codes and the latest Standards for "Non-Flammable Medical Gas System" as adopted by the National Board of Fire Underwriters, Pamphlet No. 56F.

- b. Pipe - Type "K" hard drawn copper.
- c. Fittings - wrought copper.
- d. Joints - Silver brazed.

10. Nitrogen and Carbon Dioxide

- a. Pipe - Type "K" hard drawn copper.
- b. Fittings - wrought copper.
- c. Joints - silver brazed.

11. Natural Gas

a. Pipe - Schedule 40 black steel pipe. Outside underground pipe shall be coated with two coats of No. 50B bitumastic.

- b. Fittings - Extra heavy black malleable iron fittings.
- c. Joints - Screwed. Welded when concealed.

12. Exposed Water and Waste Piping to Institutional Equipment

a. Pipe - Red brass pipe standard weight screwed full iron pipe size chromium plated.

b. Fittings - Screwed standard weight brass fittings chromium plated.

13. Deionized Water Lines

- a. Pipe - Schedule 80, normal impact, polyvinyl chloride.
- b. Fittings - PVC
- c. Joints - screwed.

14. Silencer Vent from Vacuum Pump

- a. Pipe - Schedule 40 galvanized steel
- b. Fittings - Same as pipe.
- c. Joints - screwed.

15. Condensate Drain Lines

- a. Pipe - Schedule 40 galvanized steel
- b. Fittings - Same as pipe
- c. Joints - Screwed.

16. Dental Oral Suction System (7" H.G.)

- a. Pipe - For pipe sizes to 6" - copper drainage tube (DWV) hard. For pipe sizes larger than 6", schedule 40 galvanized steel.
- b. Fitting - Wrought copper solder or black cast iron drainage type
- c. Joint - soldered or screwed.
- d. Victaulic fittings and companion flanges may be used in lieu of screwed fittings for galvanized pipe.

2.2 HEATING PIPE AND MATERIALS

A. The Contractor shall furnish and install all pipe indicated on drawings and other small pipes not indicated but necessary for proper operation.

1. Steam Pipe, All Pressures (except medium pressure supply pipe from electric boilers to sterilizers).

a. Welding flanges for medium and high pressure steam shall be welding neck flanges Tubeturn Part 31, 300# class and Tubeturn #30, 150# class for low pressure steam and hot water.

b. Pipe - standard seamless black steel pipe. Pipe 2" and less shall be A-53 electric resistance weld.

c. Fittings - up to 2" use socket weld fittings and couplings. Over 2" use butt weld fittings with back-up rings. See 15100, 2.3D for shop fabricated piping.

d. Joints: welded.

2. Medium Pressure Supply Pipe From Electric Boilers to Sterilizers

a. Pipe - Cherry-Burrell Corporation "I" line, or equal, Industrial type 316 stainless steel tubing polished I.D. and pickled O.D., 16 gauge for sizes 1-1/2" through 3" and 14 gauge for 4" size.

b. Fittings - Cherry-Burrell Corporation "I" type, or equal, 150 psi fittings, type 316 stainless, polished I.D. pickled O.D.

c. Joints - quick clamp with Viton gasket material.

3. Condensate Returns

a. Pipe - Schedule 80 seamless black steel pipe. Pipe 2" and under shall be A-53 electric resistance weld.

b. Fittings - same as for steam pipe except extra heavy weight.

c. Joints - welded.

4. Relief Vents From PRV and Exhaust From Emergency Generators and Diesel Engine Fire Pump

a. Same as for steam pipe.

5. Hot Water Heating

a. Pipe - Schedule 40 seamless black steel pipe. Pipe 2" and less shall be A-53 electric resistance weld.

b. Fittings - up to 2" - "XH" cast iron screwed. 2-1/2" and larger same as for steam piping.

c. Joints - welded or screwed.

6. Radiant Panel Heating

a. Pipe - Type L soft copper, continuous lengths within concrete slab. Type L hard copper remainder of system.

b. Fittings - Wrought copper, solder.

c. Joints - 95/5 solder.

7. Exposed Steam and Condensate Return to Institutional Equipment - All Pressures

a. Pipe - Red brass pipe standard weight screwed, full iron pipe size, chromium plated.

b. Fittings - Red brass pipe standard weight 125# steam, banded, screwed iron pipe size, chromium plated.

c. Joints - Screwed.

8. Fuel Oil Piping (Fill, Vent, Suction and Return)

a. Pipe - Schedule 40 black steel, ASTM Spec. A-120, Grade A.

b. Fittings - 2" and smaller 150# black malleable iron screwed pattern ASTM A-197. 2-1/2" and larger standard weight steel welded fittings ASTM Spec. A-234.

c. Underground oil piping shall be double wrapped outside with 3M tape No. 471.

B. All pipes 2" in diameter and less shall have screwed joints, unless otherwise specified.

C. No weldolets shall be used on pipe 2" in diameter or smaller. On pipe 2-1/2" in diameter or larger, where pipe reduction is two sizes or more, weldolets or sockolets may be used where applicable, subject to field inspection before connecting to branch line take-offs.

D. Eccentric and concentric reducers shall be steel butt weld fittings.

E. All welding fittings shall be of the long radius pattern wherever possible.

2.3 COOLING PIPE AND MATERIALS

1. Chilled Water Pipe

- a. Pipe - Schedule 40 seamless black steel pipe for sizes 10" and under. Pipe 2" and less shall be A-53 Electric resistance weld.
- Schedule 30 seamless black steel pipe for sizes 12" through 16".
 - Schedule 20 seamless black steel pipe for sizes 18" through 24".
 - Schedule STD. electric resistance welded black steel pipe for sizes 26" and over.

- b. Fittings - Up to 2" - 125# cast iron screwed.
- 2-1/2" and larger use butt weld with back-up rings.
 - Victaulic couplings and companion flanges may be used for fittings and joints.

c. Joints - Welded or screwed.

2. Condenser Water, Condensing Unit Cooling Water System Piping

- a. Same as for chilled water pipe.

A. All pipes 2" in diameter and less shall have screwed joints. All pipes larger than 2" in diameter shall have electric arc welded joints.

B. No weldolets shall be used on pipe 2" in diameter or smaller. On pipe 2-1/2" in diameter or larger, where pipe reduction is two sizes or more, weldolets or sockolets may be used where applicable, subject to field inspection before connecting to branch line take-offs.

C. Eccentric and concentric reducers shall be steel butt weld fittings.

D. All welding fittings shall be of the long radius pattern wherever possible.

2.4 GLYCOL - HEAT RECOVERY AND ENGINE COOLANT SYSTEMS

- A. Pipe - Schedule 40 seamless black steel pipe. Pipe 2" and less shall be A-53 electric resistance weld.
- B. Fittings - Up to 2" - XH cast iron screwed. 2-1/2" and larger same as for steam piping. Screwed ends shall be tightly drawn and teflon taped.
- C. Joints - Welded or screwed. With screwed joints tightly drawn and teflon taped.

2.5 RADIOLOGY - SERVICE CONDUIT

- A. Pipe - Schedule 40 Type I, PVC normal impact (Commercial Standard CS-207-60).
- B. Fittings - Schedule 40, Socket type ends, 45° elbows, Cabot Piping systems or equal.
- C. Joints - Socket type with epoxy cement as per manufacturers recommendations.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes furnishing and installing all valves where shown on the drawings and where necessary for proper control of equipment.

C. Related work specified elsewhere:

1. Basic Materials and Methods: Section 15100.
2. Piping Specialties: Section 15130.
3. Mechanical Support Devices: Section 15150.

PART 2: PRODUCTS AND INSTALLATION

2.1 GENERAL

A. All valves shall have name or trademark stamped or cast into body. All valves shall be designed for a minimum of 150 pounds working pressure unless otherwise noted, but figure numbers may indicate greater pressures.

B. Valves of Powell, Stockman, Walworth, Lunkenheimer, Crane, Sarco, Mueller, Ohio, Hoke, Jenkins, Nibco-Scott, Hammond, Rockwell Nordstrom, RP&C, or Hancock manufacture will be accepted.

C. Of the manufacturers listed, the Contractor is requested to standardize on one make as much as practical but not to the extent of sacrificing quality listed.

D. Provide positive dead-end shut-off valves at all pieces of equipment. Valves shall be individually supported so that equipment can be removed and piping system can remain unstressed and in operation.

2.2 VALVE SCHEDULEA. Domestic and Laboratory Water Valves

1. Valves 1-1/2" and smaller shall be soldered brass body, 150# WSP, non-rising stem, solid wedge disc gate valve, Crane #1320.

2. Valves 2" size shall be screwed brass body, 150# WSP, rising stem, solid wedge disc gate valve, Crane #431 UB, or Ohio 7150.

3. 2-1/2" and larger shall be flanged, cast iron body, bronze trim bronze stem, 125# WSP rising stem outside screw and yoke, solid wedge disc gate valve, Powell #1793, Jenkins 651A.

4. Valves 2" and 2-1/2" size on copper water piping may be Walworth #11WS.

5. Install a Sarco Company #1BW or Fairbanks #4502 combination balancing valve and shutoff valve on all hot water circulating lines. Valves shall be all brass construction for 200 psi working pressure with screwed connections.

6. All domestic water pressure reducing valves for pipe sizes 1/2" to 2" shall be Watts No. 1223, or approved equal. For 2-1/2" and larger pipe, the pressure reducing valve shall be Watts No. SC-2230, or approved equal. See drawings for pressures and capacities.

B. Compressed Air and Vacuum Valves

1. Valves on air and vacuum piping shall be Stockham B22 or Ohio 520 for 150# WSP with air disc.

C. Gas Valves

1. Valves on gas piping 2" and smaller shall be Walworth #559, brass square head gas cock.

2. Valves on gas piping for shut-off valves at mains and branches shall be Nordstrom No. 143, lubricated plug valve.

3. Valves on gas piping for shutoff shall be NCG Series 480090 ball valve, steel body, screwed. Worcester, Consolidated Brass, Lance and Hills-McCama are approved equal. Valves shall be mounted in recessed cabinet with latch and hinged glass door. Cabinet by this contractor. Minimum cabinet dimensions are 8" x 8" x 3-5/8".

D. Oxygen Valves

1. Valves on oxygen main piping shall be National Cylinder Gas 2500 Series valves. Valves shall be brass, diaphragm type globe valves of leak proof construction.

E. Nitrogen Nitrous Oxide and Carbon Dioxide

1. Valves for Nitrous Oxide and Carbon Dioxide shall be the same as oxygen.

F. Distilled Water

1. Valves on distilled water lines shall be Chemflow Model 2420 or approved equal with beaded pressure ends.

2. Check valves for distilled water pumps discharge shall be Chemflow Model CV1800, or equal, with beaded pressure ends.

C. Deionized Water

1. Valves on deionized water piping shall be Grinnell-Saunders No. 2406-1-R2 screwed, hand wheel operated, normal impact PVC, 150# with two-piece teflon diaphragm, non-rising stem. Check valves shall be Cabot Type 1-PVC ball check type.

H. High Pressure Steam (above 15 psig), High Pressure Condensate Return

1. Gate valves 2" and smaller shall have weld ends, unless specified screwed. Hancock #950, 600# WSP, forged steel body, rising stem, OS&Y renewable stainless steel seat rings, solid wedge.

2. Gate valves 2-1/2" and larger shall be Powell #3003, Crane #33-1/2 XUF, 300# WSP cast steel body, weld ends.

3. Globe valves 2" and under shall have weld ends, unless specified screwed. Hancock #5530, 600# forged steel body, rising stem, OS&Y, renewable stainless steel seat and disc.

4. Globe valves 2-1/2" and over shall have weld ends, unless specified screwed. Powell #3031S-WE, 300# WSP forged steel body.

5. Shutoff valves on medium pressure stainless steel piping shall be Pittsburgh Brass Manufacturing Co. 316 stainless steel, or equal, 150 psi with Cherry-Burrell "1" line connections, Model No. SP-H-CBI.

6. Check valves shall be Crane #36, Powell #560, Jenkins #762A, 200# WSP screwed brass body with regrinding seat and replaceable disc.

I. Low Pressure Steam (Up to 15 psig), Low Pressure Condensate Return

1. Gate valves 2-1/2" and over ahead of convertors and heating coils. Jenkins 651, Powell Figure No. 1793 flanged ends cast iron 125# WSP body renewable seat and solid wedge.

2. Gate valves 2-1/2" and over for other services than 1. above shall be flanged or weld ends, as specified for application, steel 150# WSP body, rising stem, OS&Y renewable stainless steel seat rings and solid wedge, Powell Figure No. 1503 or Jenkins 1009-CM or 2009-CM or approved equal.

3. Globe valves 2-1/2" and over shall be flanged or weld ends as specified for application, steel 150# WSP body, rising stem, OS&Y renewable stainless steel disc and seat, Powell Figure No. 1531, or approved equal.

4. Gate valves 2" and under shall be screwed ends, bronze 150# WSP body, rising stem, solid wedge, Lunkenheimer Figure No. 2151, Crane 431 UB, Powell No. 514S, or approved equal.

5. Globe valves 2" and under shall be screwed ends, bronze 150# WSP body, renewable composition disc, Powell Figure No. 150, Crane No. 7, or approved equal.

6. Check valves same as H.5 above.

J. Hot Water Heating, Chilled Water, Condenser Water and Condensing Unit Cooling Water System

1. Gate valves 2-1/2" and over shall have flanged ends, cast iron 125# WSP body, rising stem, OS&Y renewable seat and solid wedge, Powell Figure No. 1793, Jenkins No. 651-A, or approved equal.

2. Gate valves 2" and under shall have screwed ends, bronze 150# WSP body, rising stem, solid wedge, Crane No. 431 UB, Stockham No. B120.

3. Shutoff valves for reheat coil, shall be Crane No. 14-1/2P Globe, 300# WOG brass valve with plug type disc, renewable seat. Minimum size 1/2". Balancing valves for reheat coil shall be combination balancing and shut-off Illinois 2000 or Sarco 1BV.

4. Check valves 2" and under shall be screwed ends, bronze 125#, WSP body, Jenkins No. 92, or approved equal. Centerline and Metraflex.

5. Check valves 2" and over shall have flanged ends, cast iron 125# WSP body, Crane #373.

6. Check valves on chilled water and hot water heating pumps shall have flanged ends, semi-steel with bronze trim 125# body center guided silent check valve, renewable seats and discs, Williams-Hager Type 636, or approved equal. The same for condenser water pumps except 150# body.

7. Balancing cocks 2" and smaller shall be Crane #250, 125# W.P. Nordstrom #173, Rockford #350, 175# W.P. on all radiation. Dezurik balancing cocks are equal and approved.

8. Balancing cocks 2-1/2" to 4" shall be lubricated plug type, shall be Walworth No. 1796, 1797F 175# WOG. Dezurik balancing cocks are equal and approved.

9. Balancing cocks over 4" size shall be lubricated plug type Walworth No. 1718F. 200# WOG.

10. Where shown on the drawings and other areas at the Contractor's option chilled water and condenser water valves only shall be butterfly type with seat material appropriate for temperatures and pressure encountered. Valve shall have lug type body with threaded holes so that valve shall remain bolted to one pipe flange while other flange is removed. Shafts and disc shall be of stainless steel and ductile iron respectively bubble tight shut-off, and latch lock handle, or side winder gear operators on valves 6" and larger. Valves shall meet ASTM Specification 48. Valves shall be as manufactured by Pratt. Dezurik butterfly valves are approved as equal.

11. Hot water systems drain valves (riser and low points of mains). All 3/4" size shall be Rockford No. 350, or approved equal, 125#, bronze stem cock with hose end adapter.

12. Cooling coil relief valve shall be Crane 2606, or approved equal 1/2" size set at 125 psi.

13. Cooling coil air vent valves shall be Crane No. 734, or approved equal, brass try cock, 250#, 1/2" size.

K. Glycol-Heat Recovery and Glycol Engine Coolant System

1. Gate, Globe, Balancing Valve and check valves 2" and smaller, same as for hot water heating with screwed ends. Joints shall be tightly drawn and teflon taped.

2. Gate, Globe, Balancing valve and check valves 2-1/2" and over, same as hot water heating, and shall have flanged ends.

L. Fuel Oil Valves

1. Gate valves 2-1/2" and under shall have screwed ends, iron body 125# WSP rising stem, bronze mounted with leakproof stuffing box, specifically for oil service, A.Y. McDonald No. 844, or approved equal. (In both suction and return lines at entrance to building tag "Oil valves - Close only in Emergency".)

2. Check valves horizontal swing type 2-1/2 and under shall have screwed ends, iron body 125# WSP bronze trim, composition disc for oil service, A.Y. McDonald No. 816 or approved equal.

3. Relief Valve, screwed ends, bronze body and trim for oil service, 300# WSP. Consolidated No. 1488, or approved equal.

2.3 VALVE TAGS

A. All valves not in sight of fixtures or equipment isolated by that valve shall be provided with an approved aluminum, brass or plastic tag. Tags shall be 1/16" thick minimum for metal and 1/8" for plastic and 1.5" diameter (or 1" x 1.5" rect.). Plastic tags shall be P.V.C. or nylon material. Fastening hole drilled 1/4" dia. by 3/8" from edge. Tags shall be stamped for metal and engraved or raised for plastic and numerals filled with contrasting color. Numerals shall be 3/8" high. Fasten to hand wheel with "S" hook. The valve list shall contain the following information:

1. Valve numbers in sequence.
2. Service (with pressure and/or temperature). Identified in accordance with Section 09900.
3. Floor where located.
4. Room number.
5. Nearest column grid intersection.
6. Distance and direction from Item 5.
7. Description and room location of equipment isolated by subject valve. (Abbreviated description of equipment served)

The Health Sciences Physical Plant Maintenance and Operations Group will furnish the Contractor with blank forms to be used as a guide for the above requirements.

B. The gate valves on the emergency showers shall be wired open and tagged "DO NOT CLOSE".

2.4 CHAIN WHEELS

A. All valves having hand wheels located 7'-6" or higher above the equipment rooms floor shall have Lunkenheimer Fig. 1940, or equal and approved, adjustable sprocket rims with chain guide and rust-proof chain.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes all piping system specialties required to place the mechanical systems in complete working order.

C. Related work specified elsewhere:

1. Basic Materials and Methods: Section 15100

PART 2: PRODUCTS AND INSTALLATION

2.1 UNIONS AND FLANGES

A. Unions or flanged connections shall be used in piping adjacent to all equipment, valves, etc., as applicable for removal of equipment or to facilitate repairs.

B. On hydronic water piping 2" and smaller furnish and install malleable iron unions, 250# WSP with bronze to iron ground joint.

C. Unions for copper water piping shall be Streamline, or approved equal, ground joint type.

D. Furnish and install Petro #1150, 3000# WOG steel to steel, forged steel unions in the following piping systems.

1. Low pressure steam supply and return piping through 2" pipe size.
2. Medium pressure steam supply and return through 2" pipe size.
3. High pressure steam supply and return piping through 2" pipe size.
4. Gas piping, through 3" pipe size.

E. Low pressure (15# and under) steam supply and all hydronic water piping 2-1/2" and over use 150# forged steel gasket type welding neck flanges, Tubeturn Series 15.

F. High and Medium pressure (15# and over) steam supply piping 2-1/2" and over use 300# welding neck flanges, Tubeturn Series 30.

G. On all drip and condensate return lines use 300# welding neck flanges bored for extra heavy pipe.

H. Unions for stainless steel piping system shall be Cherry-Burrell Corporation, type 131U, or equal, unpolished, bolted, heavy duty, 150 psi, type 304 stainless steel with Teflon gasket material.

2.2 DIELECTRIC UNIONS AND FITTINGS

A. All copper water piping, copper drainage piping, compressed air piping and vacuum piping shall have insulated type unions wherever it contacts iron or steel. This includes copper piping connections to iron or steel valves, tanks, water heaters and piping. These connections to and including 1-1/2" size shall be Universal Insulating union, Series 2000, Styles 3 and 4.

B. The above piping connections 2" size and over shall be "Insulket" insulated flange joint as manufactured by Service Engineers, Inc. Gasket shall be sandwich type consisting of a 1/16" layer of Grade XX Industrial formica bonded between two 1/32" layers of non-graphitized asbestos gasket material. Provide one phenolic sleeve and two phenolic washers and two steel washers for each bolt. Washer shall be provided on each flange. Flange on copper side shall be brass or bronze.

2.3 STRAINERS

A. All strainers shall be Y type with brass screens, except stainless steel screens shall be used on high pressure steam (over 15 psig). All strainers shall be complete with blow down gate valve nipple and pipe cap on blow off. Strainer manufactured by Sarco, Mueller, McLean, and Metraflex are approved.

B. All strainers on high pressure steam lines (over 15 psig) shall be 250 pound construction.

C. Strainers shall be installed where shown on drawings and ahead of all traps. When trap used has integral strainer a separate strainer need not be installed. Where strainers are installed in steam lines to coils, convertors, etc., strainer before coil or convertor trap may be omitted. Strainers shall be full line size.

D. All drip piping shall be welded except for connections to screwed strainers and traps.

E. On sizes through 3" where used ahead of traps, or steam regulating valves, the screens shall be 20 mesh; from 4" through 8" they shall be 3/64" perforated and over 8", 1/16" perforated. On water service the screens on strainers through 3" shall be 20 mesh, over 3" shall be 1/8" perforated.

F. Strainers for oil service shall be bronze with threaded ends with brass basket strainer 1/32" perforations, Hayward No. 40 or approved equal.

G. Duplex strainers where shown on drawings shall be Hayward No. 50, bronze with brass basket strainer.

2.4 STEAM TRAPS

A. At the outlet of all blast heating surfaces, hot water generators, sterilizers, convertors and at the end of steam main drip points, furnish and install Armstrong bucket traps.

B. Series #800, high pressure traps shall be used on high pressure steam drip points and high pressure returns.

C. Series #880 inverted bucket traps with thermic vent shall be used on all low pressure steam lines, at drip lines, unit heaters, coils and low points in steam lines.

D. All bucket traps shall be furnished with integral strainers on smaller sizes where capacity permits. Brass strainers on low pressure traps and stainless steel strainers on high pressure traps.

E. Series 215 and 216 inverted bucket traps shall be used for high capacity flows.

F. Permissible condensate flow in pounds per hour (low pressure to 15 psig, 1 psig differential):

<u>Series No.</u>	<u>Pounds per hour</u>
880	240
881	460
882	840
883	1545
814	2370
215	4325
216	7560

G. At drip points of medium and high pressure steam lines (25 to 150 psig), traps shall be sized on a differential of not more than 20% of the inlet pressure.

H. A safety factor of 2 shall be used in determining the size of traps for all drip lines, hot water generators, sterilizers, and convertors and a safety factor of 3 shall be used in determining the size of traps for preheat coils.

2.5 AIR VENTS

A. Provide and install Bell and Gossett No. 17 Sr. automatic air valve, or approved equal on return side of all radiation as detailed. This air vent shall be designed to provide manual adjustment in three positions as follows: Automatic Venting Position, Manual Venting Position, or Complete Positive Shut-off. Air vents shall be 1/8 N.P.T.

B. Provide and install Sarco 13W or approved equal automatic air vent at top of all hydronic supply and return risers. Air vents shall be installed in accessible locations with a 3/8" discharge pipe run to nearest F.D. or janitor sink. Provide a gate valve and union on inlet to air vent.

2.6 EXPANSION JOINTS, GUIDES, LOOPS AND ANCHORS

A. Provide and install expansion compensators, expansion joints, guides and anchors as required, shown or specified to handle all thermal expansion and contraction in piping systems.

B. Wherever practical, properly installed expansion loops shall be used to compensate for thermal expansion in piping systems. The loops shall be made of dimensions shown, fabricated with long radius elbows and piping of maximum lengths that space permits where dimensions are not given. Loops shall be installed with "cold spring" so that loop in operation will have approximately equal contraction and expansion from fabricated position. Provide guides for loop as detailed on the drawings. Provide lead sheet wrap where copper pipe would otherwise come in contact with steel guide.

Wherever loops cannot be employed, the following expansion joints shall be used:

1. High Pressure Steam Lines

a. All expansion joints on high pressure lines (125# or above) shall be Yarway Gunpakt, or approved equal, 300# W.S.P. steel body, lubricated slip joint, internally-externally guided with weld ends.

2. Low Pressure and Medium Pressure Steam and Condensate Lines and Hot Water Heating Lines and Condenser Water Lines

a. All expansion joints on low pressure and medium pressure steam and return lines, hot water heating lines and condenser water risers shall be Yarway Gunpakt, or approved equal, 150# W.S.P. steel body, lubricated slip joint type, internally-externally guided with weld ends.

3. Hot Water Radiation

a. On all radiation runs over 30 feet in length, provide and install Flexonics Model HB compensators. Compensators shall be rated for a minimum of 12000 cycle life. Zallea, Robert Shaw-Fulton, or Tube Turn are approved equal.

4. Hot Water Plumbing Lines

a. Expansion compensators 3" and smaller shall be two-ply bronze, externally pressurized with internal guides and internal positive anti-torque devices. Units shall accommodate 1-3/4" pipeline expansion and 1/4" pipe contraction under a working pressure of 150 psi and 250 degrees F. temperature. Unit shall have properly located positioning clips to insure installation at correct end-to-end dimensions for full rated traverse. Units larger shall have sweat ends. Compensators shall be rated for a minimum of 12,000 cycle life as manufactured by Flexonics, Model HB, Zallea, Robert Shaw Fulton or Tube Turns.

b. Expansion joints larger than 3" shall be single or double, self-equalizing stainless steel with flanged ends. Units shall be complete with built-in internal sleeve, and be able to accommodate the expansion noted on drawings under a working pressure of 150 psi and 250 degrees F. temperature. Expansion joints shall be as manufactured by Flexonics, Zallea or Adscos. Provide dielectric fittings between dissimilar metals.

C. Anchors and Guides

1. Anchors and guides shall be provided as necessary as detailed on the drawings. Pipe guides are required on each side of an expansion joint in quantity required by manufacturer. This contractor shall submit detailed

drawings showing stops and guides for all expansion joints and loops. Guides for copper piping shall have lead sleeve for electrolytic isolation.

2.7 THERMOMETERS

A. Furnish and install Weiss Vari-angle thermometers or equal and approved with 8" stem. Thermometers shall be V-shape design, die cast aluminum, finished in baked epoxy enamel. Heavy glass protected front shall be firmly secured against rattles by spring action.

Adjustable joint shall completely enclose capillary to prevent tampering and foreign matter from entering instrument.

Locking device shall be made of machined brass and finished in natural color and designed to produce positive lock by simply turning in direction of "lock" position.

Mercury filled-magnifying lens "Red Reading" tube shall be Precision made to guarantee accuracy within 1% of scale range with Silicone shock mounting for lasting durability.

Scale shall be satin faced non-reflective aluminum with bold jet black markings permanently etched and locked in place and adjustable through device at top of scale.

Tapered bulb chambers for stem shall be made of steel, precision ground and uniformly copper-plated. The tapered chamber shall form a metal to metal contact with matching taper in separable sockets assuring maximum speed of response to temperature changes. Trerice, Weksler & March are approved.

B. Thermometers shall be installed in the following locations as well as those shown on drawings and where recommended by the manufacturer.

<u>Equipment</u>	<u>Location</u>	<u>Scale</u>
Reheat system Convertors	Inlet and outlet	30° to 240° F.
Radiation system Convertors	Inlet and outlet	30° to 240° F.
Radiant Panel Convertor	Inlet and outlet	30° to 240° F.
Condensate pumps	Inlet	30° to 300° F.
Refrigeration Chillers	Inlet and outlet	20° to 120° F.
Refrigeration absorbers	Inlet and outlet	20° to 120° F.
Refrigeration Condensers	Outlet	20° to 120° F.
Cooling Coils	Return and supply line	20° to 120° F.
Heat recovery coils	Return and supply line	20° to 120° F.
Lab hot water	Supply line from heaters	20° to 180° F.
Domestic hot water	Supply lines from heaters	20° to 180° F.
Recirc. hot water	Pump discharge	20° to 180° F.
180° Domestic hot water	Supply line from heaters	30° to 240° F.
Water Main	At building entrance	0° to 100° F.
Domestic Water Booster Pump	Pump outlet	0° to 100° F.
Condensing unit cooling water	Return and supply line	20° to 120° F.

2.8 PRESSURE GAUGES

A. Furnish and install pressure gauges on high pressure steam, low pressure steam and water lines where scheduled and indicated on the drawings. The pressure range of the gauge shall be 1-1/2 times the highest operating pressure.

B. Gauge types shall be as follows of Ashcroft Mfg. Marsh Trerice & Wek ler are approved.

1. High pressure steam --- Ashcroft #1010 with 6" dial, pigtail and Ashcroft #7000 Series shut-off valve.

2. Low pressure steam --- Ashcroft #1010 with 6" dial, gauge cock and Ashcroft #1092 gauge cock.

3. Waterlines --- Ashcroft #1010 with 6" dial, gauge cock and Ashcroft #1106B pulsation dampeners.

C. Pressure gauges shall be installed in the following locations as well as those shown on drawings and where recommended by the manufacturer.

Equipment

Location

Reheat System Pumps	Inlet and outlet
Radiation System Pumps	Inlet and outlet
Radiant Panel Pumps	Inlet and outlet
Chilled Water Pumps	Inlet and outlet
Condenser Water Pumps	Inlet and outlet
Refrigeration Chillers	Inlet and outlet
Cooling Coils	One gauge for each coil. Provide piping from gauge to inlet and outlet of each coil with cocks on each line.
High Pressure Steam Main	At building entrance
Pressure Reducing Station	High and low side of each
Domestic Cold Water Main	On building side of meter
Domestic Water Booster Pumps	Inlet and outlet

2.9 FLOOR, WALL AND CEILING PLATES

A. Where uncovered, exposed pipes pass through wall or floors, they shall be fitted with wall or floor plates. Plates shall be at least 1/32" thick, and shall be equipped with set screws for locking around pipe. Plates shall be finished cast brass chromium plated. Plates shall be set tight against wall or floor.

2.10 PIPE SLEEVES

A. Provide sleeves for all pipes that pass through walls, slabs or partitions. Sleeves shall be set and maintained in place by this contractor during the progress of the work. All sleeves shall be cut from new material, cut square and reamed.

B. All pipe sleeves through walls, slabs or partitions shall be 1/2" greater in inside diameter than the external diameter of pipe passing through sleeve except for insulated piping where sleeve shall be large enough to allow for insulation on the piping.

C. All sleeves through partition walls shall be Schedule 40 steel pipe extending full thickness of partition and shall be flush with the finished surface.

D. Sleeves through floor slabs for concealed piping shall be constructed of Schedule 40 steel pipe and shall extend 1/2" unless detailed otherwise above finished floor in classrooms, offices, corridors, etc. See Detail 2/M-88.

E. Sleeves through roof slabs shall be constructed of 22 gauge galvanized iron.

F. Pack space between pipe and all sleeves with oakum, leaving 1" depth for plastic caulking. Caulking shall be Presstite, Dura-gum or approved equal

2.11 WATER HAMMER ARRESTORS

A. Furnish and install water hammer arrestors, of the size called for, and location as noted, on the plan or on water riser diagrams. Provide arrestors at main ends, flush valve groups, glassware washers, sterilizers, ice machines, cooling tower make-up, distilled water pump (stainless steel).

B. Sizes and locations of water hammer arrestors are in accordance with data set forth by the Plumbing and Drainage Institute, Standard PDL-WH-201, for average plumbing systems.

C. Symbol designations shown on the drawings are for sizes established by PDI corresponding to units of various manufacturers that have been accepted by a certification testing program.

D. Provide and install at building side of domestic water meter a Zurn Accumutrol size 6000. Contractor shall charge unit and place it in operation.

E. Arrestors as manufactured by Josam, Wade, Zurn, Blake, Jay R. Smith and Precision Plumbing Products, are accepted.

2.12 VACUUM BREAKERS

A. Vacuum breakers shall be installed on all supplies to flush valve, domestic water, hose sprays, lab water outlets, janitor sinks, urinals and water closet flush valve, equipment connections, and at each point where code requires on the potable water system. Vacuum breaker shall be Chicago or Watts.

Direct connections of City water to the expansion tanks on the chilled water system. The radiation and reheat systems fill shall be through a Watts #9D vacuum breaker.

B. The central anti-syphon valves for the separation of the lab cold water from the domestic cold water and the lab hot water from the domestic hot water shall be as detailed and sized on Sheet M-88. The valve shall be Crispin Type S, standard threaded top, with stainless steel float modified as shown on Sheet M-88. A non-closing valve for continuous bleed shall be located as shown on drawings downstream of the central vacuum breaker systems.

2.13 HOSE BIBBS AND HYDRANTS

A. Furnish and install hose bibbs and hydrants as shown and located on the plans. Interior hose bibbs shall have 3/4" hose thread outlets with integral vacuum breaker. Exterior hydrants shall be of non-freeze with 3/4" hose thread outlets with loose key handles and include vacuum breakers. Similar hydrants as manufactured by Wade, Blake, Jay R Smith and Zurn will be accepted as equal.

1. Hose Bibbs - Chicago No. 998 rough chromium plated with vacuum breaker 293.4 handle. Support hose bibb with pipe clamp.

2. Wall Hydrant - Josam 1400N non-freeze for wall thickness encountered. Hydrant located in insulated wall panels shall be enclosed in housing by General Contractor. Provide loose key hydrant outlet.

3. Wall Hydrant - Josam 1430N, non-freeze for plaza thickness encountered. This hydrant shall be enclosed in cast brass housing with loose key locking cover and loose key hydrant outlet.

2.14 FLOW INDICATORS

A. Provide and install flow measuring venturies at each cooling coil and at each convertor system and as shown on the drawings as manufactured by Rinco Engineering & Gerrish Company. Robertson Venturis are equal and approved. This shall be a coordinated system, including individual Venturi Flow Stations. Each venturi station shall be complete with quick disconnect valves and a safety shut-off valve, metal identification tag on chain, giving pipe size, venturi series, station identification and meter reading at specified flow rate. Venturi stations shall be one piece brass screwed 3/4" through 2". Sized 2-1/2" through 12" shall consist of cast iron nickel plated venturi held between machined 150# weld neck flanges. Venturi size and series shall be selected so that design flow rates as shown on the drawings shall be between 10 and 40 inches of water pressure differential with permanent pressure loss of not more than 25% of indicated flow rate differential pressure. See Drawings for flow meter schedule.

B. Provide and install on each reheat coil, one KG flow indicator. Unit shall be 3/4" NPT pipe size furnished with two automatic quick disconnects, brass bar stock each stamped for unit location, GPM and pressure drop. The disconnects shall be adaptable to KG flow meter for determining pressure drop.

2.15 EMERGENCY GENERATOR EXHAUST PIPE

The emergency generators and their exhaust silencers and flexible connectors will be supplied by the Electrical Contractor. The Mechanical Contractor shall install the silencers, connectors and supply and install necessary exhaust piping as shown on the Drawings. NOTE: Exhaust piping includes minimum center-line bend radius of 22" for 6" I.D., 40" for 8" I.D. and 50" for 10" I.D.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing and installing of hangers and supports as required to install all lines under contract.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15
5. Mechanical Systems Insulation: Section 15160.

D. Hangers shall be of proper strength and placed on correct centers to support the lines with no sagging. (See Schedule below). Any additional steel members required to run the pipes or where indicated on drawings shall be furnished and installed by this Contractor.

E. Groups of three or four lines may be supported on trapeze type hangers in a neat evenly spaced manner. Where any piping, over groups of three, are run along walls or tunnels, they shall be racked vertically on side wall to allow maximum clearance space.

F. Pipe hangers and supports may be secured to steel trusses or beams by welding or using toggle expansion bolts, impact type fasteners or through bolts, as conditions require. Grinnell Fig. 66 welded beam attachment shall be used for large diameter pipes.

G. Where hanger attachments are welded to beams or trusses the attachment shall be fireproofed equal to supporting members.

H. Provide and install protective rubber or armafex type bumper on all hangers that could be dangerous to maintenance personnel.

PART 2: PRODUCTS AND INSTALLATION

2.1 PIPE HANGERS AND SUPPORTS

A. All individual pipes 3" and smaller shall be supported with Grinnell ring type No. 107-R, or approved equal; larger pipe shall be supported with Grinnell

Company #260 or approved equal. Clevis hangers as required of sizes to span the insulated pipe. Elcen, Carpenter and Patterson or Fee and Mason of identical type are approved equal. Hangers that support copper pipe shall be copper-plated.

C. Unistrut, Powerstrut or Grinnell vertical and horizontal structural supports shall be used with sufficient anchorage to side walls using inserts and anchor bolts. Any inserts or cinch anchors for pipe hangers shall be furnished and set in place by this Contractor unless otherwise noted. All piping except steam supply piping shall be supported as specified in A. above. All steam supply piping 3" and larger shall have insulation shields and shall be supported on Grinnell Company #175 or #171 pipe rolls. Floor supported pipe shall be supported on Grinnell Company Fig. #276, or equal. Where clearance conditions dictate that a Fig. #260 clevis hanger cannot be used, this Contractor shall use the Fig. #171 or 175 pipe rolls.

D. Trapeze hangers and tunnel support systems shall be Unistrut channels af top and wall 8'-0" o.c. Pipe straps shall be Unistrut P2558. Provide provisions for building in pitch as required. Support members in trapeze hangers shall not be a torch cut. On trapeze hangers provide full circle shield and U-clamp pipes to trapeze.

E. Hangers for insulated piping shall be large enough to encompass insulation and metal shield for same. Provide at hanger points hydrous-calcium silicate insulation in sections 2" longer than hanger shield. Insulation shall have same finish as adjacent covering.

F. Shields shall be provided for all insulated piping at hangers or trapeze bars. Shields for 4" and smaller shall be constructed of 16 gauge galvanized iron. Shields shall be 6" longer than pipe diameter; however, the shielding shall be a minimum of 6" long and a maximum of 18" long. Shields shall completely encompass the covering.

G. Vertical pipes shall be supported at each floor by riser clamps.

H. Piping subjected to thermal expansion may be guided at each floor in lieu of riser clamps. An anchor and base support will then be required.

I. Whenever copper piping comes directly in contact with steel support system, and copper plated hangers are not available for use, it shall be this Contractor's responsibility to wrap the pipe with two layers of Minnesota Mining and Manufacturing Company's #33 Electrolytic Tape. The length of tape shall be such to provide 2" overlap on each side of support.

J. Contractor shall consult and cooperate with all other contractors in arrangements of and routing of all supported lines so as to provide maximum clearances, minimum interference and a neat, first-class appearance and accessibility.

K. The following schedule shall be used in establishing distances between supports for steel pipe. When different sizes of pipes are supported on a common hanger, smallest size line shall govern unless an intermediate support is used.

<u>Pipe or Tube Size</u>	<u>Hanger Spacing</u>	<u>Minimum Rod Diameter</u>
1/2" tube only	5'	1/4"
1/2" - 1"	7'	3/8"
1-1/4" - 1-1/2"	9'	3/8"
2"	10'	1/2"
2-1/2"	11'	1/2"
3"	12'	1/2"
4"	14'	5/8"
5"	16'	5/8"
6"	17'	3/4"
8"	19'	7/8"
10"	22'	7/8"
12"	23'	7/8"
14"	25'	1"
16"	27'	1"
18"	28'	1-1/8"
20"	30'	1-1/4"
24"	32'	1-1/2"
30"	34'	1-3/4"
32"	36'	2"
34"	38'	2"

L. The following schedule shall be used in establishing distances between supports for copper pipe. The smallest pipe hung shall determine the distance between hangers where pipes are supported on trapeze hangers.

<u>Pipe or Tube Size</u>	<u>Hanger Spacing</u>	<u>Minimum Rod Diameter</u>
1/2"	6'	3/8"
3/4"	6'	3/8"
1"	8'	3/8"
1-1/4"	8'	3/8"
1-1/2"	9'	3/8"
2"	9'	3/8"
2-1/2"	10'	1/2"
3"	10'	1/2"
3-1/2"	10'	1/2"
4"	10'	1/2"
5"	12'	5/8"
6"	14'	3/4"

M. Pipe hangers and spacing for sewer and waste lines shall be as listed above except that horizontal runs of cast iron and acid resistant piping shall be supported at least once for each pipe section. If glass is used for acid waste piping the pipe hanger spacing shall be in accordance with the pipe manufacturer's recommendations.

N. Horizontal piping behind laboratory casework shall be supported individually every 6'-0" on Unistrut 13/16" channels with Unistrut standard pipe strap. One hole clamp for piping under 1" o.d. may be used.

0. For supporting stainless steel piping see Section 15100-2.3-1.

2.2 UTILITY CORE PIPE AND DUCT SUPPORTS

A. This Contractor may use Unistrut No. U 318 beam clamps with angle and flat clamps for attaching Unistrut channels to provide support for groups of vertical piping in the mechanical utility cores. Z-straps and channels may be used for support between catwalks and floor slabs. Provide shop drawings indicating style, arrangement and usage of this type of support for ones listed.

B. Where known future ductwork and piping is shown in utility cores, care shall be taken to ensure that these spaces are left open in the cores and not eliminated by support systems for present piping and ductwork.

2.3 PIPE SUPPORT BEHIND CASEWORK

A. The casework will be furnished with adjustable framing channels behind the casework for racking the service piping. This Contractor shall provide all other necessary channels, framing, fittings, braces, pipe clamps, bolts and nuts, etc., as required to install mechanical work that is to be installed on the frame such as cup sinks, drainage piping, vent piping, air, gas, vacuum and water piping and outlets.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the furnishing and installing all vibration eliminators required to prevent excessive vibration transfer to occupied areas.
- C. Related work specified elsewhere:
1. Basic Methods and Materials: Section 15100.
 2. Pipe and Pipe Fittings: Section 15110.
 3. Mechanical Supporting Devices: Section 15140.
 4. Mechanical Systems Insulation: Section 15160.
 5. Hot Water Heating System: Section 15650.
 6. Ventilation and Air Conditioning: Section 15800.
 7. Air Conditioning, Refrigeration: Section 15900.
- D. Mechanical equipment which shall have vibration isolation are pumps, motors, fans, cooling towers, engine coolant radiators, ceiling hung unit heaters and all moving or rotating units.
- E. Provide substantial bases under all units, fans and motors elevated above floor as noted on drawings. Units suspended from overhead construction shall be spring isolated from the structural frame work.
- F. Isolator types shall be Mason Industries, Consolidated Kinetics Corporation, Kor Fund Industries, Amber Booth, Vibration Mounting & Controls, Vibragenics, and Vibration Eliminator Company.

PART 2: PRODUCTS AND INSTALLATION

2.1 PIPING

- A. All piping on the inlet and discharge connections to all rotating machinery, such as pumps, compressors, etc., shall be vibration isolated from its supports over its entire length.

B. Piping runs within each mechanical equipment room or 30 feet from any connected machinery whichever is greater, shall be supported by resilient hangers providing a minimum static deflection of 1/4 inch. Metallic surfaces of resilient hangers shall be separated by a neoprene rubber element. For non-liquid filled pipes the resilient hangers shall be Mason Industries type HD, or equal. For liquid filled pipe the resilient hangers shall have spring diameter and hanger box lower hole large enough to permit the hanger rod to swing through a 30° arc before contacting the hanger box and short circuiting the spring. Hangers shall be decompressed to the rated deflection so as to keep the piping at a fixed elevation. The hangers shall be designed with a release mechanism to free the spring after installation is complete and the hanger is to be subjected to its full load. Deflection shall be indicated by means of a scale. Resistent hangers shall be Mason Industries type PC30N, or approved equal.

C. Piping runs more than 30 feet from connected machinery and not within a mechanical equipment room shall be supported by non-metallic elements providing a minimum of 1/4 inch separation between the pipe and both the building and any metallic support such as a hanger, clip or strap. Suitable materials include neoprene, glass fiber or felt, but shall in all cases be appropriate for the particular temperatures encountered. Metallic hangers, externally surrounding pipe that is insulated is sufficient for this separation. Hangers shall be Mason type HD or equal.

2.2 DUCTWORK

A. All supply, return and exhaust ductwork within mechanical equipment rooms or within 30 feet of a connected fan or housing whichever is greater, shall be resiliently supported by non-metallic element as providing static deflection of between 1/8 and 1/4 inch. Hangers shall be Mason Industries type WHD or equal.

2.3 EQUIPMENT ISOLATOR ASSEMBLIES

A. General: As noted on the drawings in the equipment schedules and in these specifications all mechanical equipment shall be mounted on vibration isolators to prevent excessive transmissions of vibration structure borne noise into the building structure. These specifications, and the equipment schedules on the drawings will indicate by alphabetical letters the type of vibration isolator assembly along with the minimum static deflection, in inches, of the isolators to be used. The static deflection referred to is that of the isolators under the combined load of the supported equipment plus any integral subbase or inertia block. Vibration isolators shall be selected in accordance with the weight distribution of the equipment so as to produce reasonably uniform deflection. Mounting systems exposed to high temperature, oil, rust, or other adverse environments shall be suitably resistant to deterioration in such environments. Isolator types described below are Mason Industries.

B. Description of Equipment Isolator Assemblies.

1. Type A Isolator Mounting

a. Double deflection neoprene mountings shall have a minimum static

deflection of 0.35. All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for those areas where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang. Mountings shall be ND or rails DNR.

2. Type B Isolator Mounting

a. Spring Isolators shall be free-standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be SLF.

3. Type C Isolator Mounting

a. Equipment with operating weight different from the installed weight such as chillers and boilers and equipment exposed to the wind such as cooling towers shall be mounted on spring mountings as described under Type B, but a housing shall be used that includes vertical resilient limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection and the installed and operating heights shall be the same. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Mountings used out of doors shall be hot dipped galvanized. Mountings shall be SLR.

4. Type D Isolator Mounting

a. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30° arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

5. Types E, F, and I, Isolators: Not Used

6. Type G Isolator Mounting

a. Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be 'T' or 'L' shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within

acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch. Bases shall be type WF.

7. Type H Isolator Mounting

a. Vibration isolator manufacturer shall provide steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment. Inverted saddles shall be type ICS.

8. Type J Isolator Mounting.

a. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Bases shall be type K.

D. Structural Ties and Rigid Connections

1. All vibration isolated equipment shall be free of any structural tie or rigid connection that can short-circuit or block the vibration isolators. All building trash shall be removed from under the base of any isolated equipment. Connecting piping, ductwork and electrical conduit shall not restrict movement of the equipment on its vibration isolators. The preferred method is to use a flexible connection of sufficient length and with a loop if necessary.

2.4 FLEXIBLE PIPE CONNECTORS

A. For all water, glycol/water, gas and oil connections to rotating equipment, such as pumps, compressors, emergency generators, etc., furnish and install Flexonics Model 301, Flexweld, Universla, Metraflex or approved equal, braided corrugated bronze metal hose for size up to 2 inches. For pipe sizes 2-1/2 inch to 4 inches use Flexonics Model 391, Flexweld, or approved equal. Hose construction shall be for 200 degrees F. water and 200 psi working pressure.

B. For each emergency generator exhaust pipe furnish and install two (2) Flexonics Model 401M, Flexweld, or approved equal, braided corrugated stainless steel metal hose. The two flexible hoses shall be installed at right angles at each pipe connection. Hose construction shall be for 1000 degrees F. exhaust gas and 150 psi working pressure.

C. At the suction and discharge of each radiation reheat and hot water and Glycol heating pump, furnish and install Flexijoint Model DIBA-4, Garlok, Resistoflex, Dore or approved equal, teflon connectors. Connectors shall have 125 psi flanges and rated for minimum of 250 psi burst pressure at 220 degrees F.

D. At the suction and discharge of each primary and secondary chilled water pump, and condenser water pump, furnish and install Flexijoint Model DIBA-3, Garlok, Dore' or Resistoflex approved equal, teflon connectors. Connectors shall have 150 psi flanges, and rated for minimum of 300 psi burst pressure at 110 degrees F.

E. At discharge of compressors and vacuum pumps furnish and install flexible pipe connections as specified in Paragraph A above for sizes up to 4". For pipe larger than 4" the flexible connections shall be the same as specified in Paragraph B above except temperature should be 200 degrees F.

F. All piping with flexible connectors shall be independently supported so that there is no weight on the connection.

G. At the suction and discharge of distilled water transfer pump furnish and install teflon flexible pipe connections equal to Resistoflex R-6904. Garlock, Dore' and Flexpoint are approved equal.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the thermal insulation of all hot and cold piping, ductwork, vessels, equipment and other components of the mechanical systems.
- C. Related work specified elsewhere:
1. Basic Materials and Methods: Section 15100.
 2. Painting: Section 09900.

1.2 DEFINITIONS

- A. Concealed insulated surfaces shall mean piping, ductwork and equipment located above suspended ceilings, and in chases.
- B. Exposed insulated surfaces shall mean piping, ductwork and equipment located in shafts, mechanical rooms, tunnels and rooms without suspended ceilings, etc.
- C. Mechanical equipment rooms shall be considered as un-airconditioned space for figuring the insulation of return air ductwork.

PART 2: PRODUCTS AND INSTALLATION

2.1 APPLICATION

- A. Insulation shall be applied to clean, dry surfaces with pipe surfaces at room temperature. Insulation shall be butted firmly together. Longitudinal and end joints shall be sealed with compatible jackets, facings and adhesives.
- B. Insulation shall be continuous through sleeves and wall and ceiling openings.
- C. Metal shields shall be provided at insulated piping hangers.

2.2 INSULATION MATERIALS

- A. Insulation materials shall be furnished by Johns-Manville, Owens-Corning Fiberglas, Baldwin-Ehert-Hill, Certainteed Saint Gobain, Gustin Bacon, or approved equal.
- B. Adhesives, mastics and coatings shall be furnished by Benjamin Foster (B.F.) Insul-Coustic (I.D.), Chicago Mastic (CMC) or approved equal.

C. All insulation shall have composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure ASTM E-84, NFPA 255 and UL 723. Flame spread rating shall not exceed 25 and smoke developed rating shall not exceed 50 or in the case of flexible insulation as specified herein (Armstrong Armaflex) flame spread rating shall not exceed 25 and smoke developed rating shall not exceed 150. Accessories such as adhesives, mastics, cements, tapes, glass fabric and asbestos cloth for fittings shall have the same component ratings.

D. Calcium silicate rigid inserts shall be installed at all outside hangers. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of equal thickness to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

1/2" to 2-1/2" pipe size	12" long
3" to 6" pipe size	15" long
8" to 10" pipe size	18" long
12" and over pipe size	24" long

2.3 JACKETS AND FACINGS

A. Type I. Factory applied glass cloth, white factory sized 102 pounds inch per inch width tensile strength, 215 ounces inch per inch beach puncture and 330 psi mullen burst. Jacket longitudinal laps and butt strips sealed with Insul-Coustic 215 adhesive or Chicago Mastic 17-465 adhesive applied to two surfaces.

B. Type II: Factory applied glass cloth vapor barrier for piping, presized glass cloth jacket bonded to a vapor barrier medium. Same tensile strength, beach puncture and mullen strength as Type I with water vapor permeability of 0.3 perms. Jacket shall be sealed with Insul-Coustic 215 or Chicago Mastic 17-465 in the field.

C. Type III: Factory applied vapor barrier jacket, bonded to 1 mil aluminum foil reinforced with glass yarn with water vapor permeability of .02 perms. Jacket shall be sealed with Insul-Coustic 215 or Chicago Mastic 17-465 adhesive applied to two surfaces.

D. Type IV: Factory applied vapor barrier jacket with positive type sealing system. System shall consist of a factory applied dry adhesive on the inside surfaces of longitudinal laps and butt strips of vapor barrier pipe insulation. Adhesive shall be activated in the field with activated solvent and applicator.

E. Type V: Factory applied reinforced aluminum foil and paper. Foil shall be .75 mil thick reinforced with fiberglass yarn mesh and laminated to 40 pound chemically treated UL rated fire resistant craft.

F. Type VI: Same as Type I, except applied in field.

G. Insulation on all cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal.

H. All exposed hot piping on roof shall be metal jacketed equal to Johns-Manville Metal-Loc, of insulation thickness as hereinafter specified. Hot piping shall include steam vents and reliefs and emergency generator exhaust.

2.4 COLD PIPING

A. Domestic and laboratory cold water, water service inside building, soil and waste piping located in soffits to a point 3 feet inside building, waste piping from laboratory sinks to main vertical stack, waste piping from drinking fountain and flushing rim floor drains to vertical stack, horizontal downspout offsets (including 1' above and 1' below horizontal), horizontal pipe from drains receiving condensate from cooling coils and horizontal pipe (and vertical piping where shown) from drains serving outdoor air intake, area drains and exhaust plenums. All piping associated with the condensing unit cooling water system for environmental cold rooms shall be insulated.

B. The insulation shall be sectional type fiberglass pipe insulation and shall have an average thermal conductivity not to exceed .22 BTU inch per square foot per degree F. per hour at 75 degrees temperature. Insulation shall be 1" thick all pipe sizes and 3#/cu.ft. Exposed piping shall have Type II jacket. Concealed piping shall have Type III or Type IV jacket. Fittings, valve bodies, flanges, etc. shall be insulated with fabricated insulation of the same material and thickness equal to adjoining pipe insulation (mitered pipe insulation segments) secured with 3 ply jute twine and finished with one coat of 301 cement. After cement is dry, fittings shall be finished with two coats of Benjamin Foster 30-35 reinforced with glass fabricated membrane or JM A-2070 asbestos cloth overlapping adjacent jacket. Stapling of vapor barrier jacket will not be allowed. Exception to above is that all insulated water and waste piping in chases behind casework may at the contractor's option be insulated with 3/4" flexible foamed plastic insulation similar to Armstrong "Armaflex".

C. Domestic and laboratory cold water, laboratory hot water and recirculating hot water, tepid hot water, recirculating tepid hot water, hot water, recirculating hot water less than 2-1/2" pipe size. Waste piping, less than 2-1/2" pipe size, from laboratory sink to main vertical stack and all waste piping from drinking fountains to horizontal main. Absorption unit exposed refrigerant circuit piping. Headers, cooling and lubrication lines and refrigerant sump piping. Cold water cooling to stills, environmental rooms, less than 2-1/2" size. Insulation shall be flexible foamed plastic tubular pipe insulation. Minimum density 6 pounds per cubic foot.

Insulation Material

Insulation Thickness

FR Armstrong Armaflex
(or approved equal)

3/4"

The pipe or tubing may be insulated wherever possible by slipping the molded insulation over the lines. Lines already connected shall be insulated by slitting the tubular insulation section and applying them around piping or tubing. All butt ends and longitudinal joints shall be sealed with O.C. 500, JM 57, Armstrong 520, C.M.C. 17-462. All fittings shall be insulated with fabricated sections of tubing insulation nesting sizes mitering joints and sealing with adhesive. Vapor barrier adhesive shall be applied to all seams and joints sealed in accordance with the manufacturer's recommendations to obtain proper adhesion. Where flexible foamed plastic tubular insulation is used, the section at each pipe hanger shall be rigid foam plastic of the same thickness and manufacturer as the adjacent insulation.

D. Primary and secondary chilled water supply and return. The insulation shall be sectional type fiberglass pipe insulation. The insulation shall have average thermal conductivity not exceeding .22 BTU inch per square foot per degree F. per hour at 75 degrees F. mean temperature. Thickness shall conform to the following schedule:

<u>Pipe Size</u>	<u>Thickness</u>
Up to 2"	1" thick
2-1/2" and larger	1-1/2" thick

All piping shall have Type II jacket, fittings, valve bodies, flanges, etc., for pipe size 3" and smaller shall be finished with Johns-Manville, 1 pound density Microlite wrapped under compression to thickness equal to adjacent pipe insulation and secured with 3 ply jute twine. Fittings over 3" shall be insulated with mitered segments of pipe insulation secured with 3 ply jute twine. A smooth coat of Johns-Manville 301 cement shall be applied over insulation. After cement is dry fittings shall be finished with two coats of Benjamin Fosters 30-36 reinforced with glass fab membrane or JM-A2070 asbestos cloth overlapping adjacent jacket.

Large strainers in chilled water system shall have flanges only left uninsulated for easy removal.

2.5 HOT PIPING

A. Steam supply, exposed and concealed, condensate return, exposed and concealed, glycol heat recovery supply and return in exposed areas, and glycol radiator coolant supply and return in exposed areas, hot water reheat supply and return in exposed areas, hot water radiation supply and returns in exposed areas. Radiant panel supply and returns in exposed areas. Safety relief valve vents and vapor vents shall be insulated with hydrous calcium silicate pipe insulation, 11 pounds per cubic foot density, with .016" aluminum jacket as per Owens Corning "Glasclad" lagging. Insulation shall have an average thermal conductivity not to exceed .37 BTU inch per square foot per degree F. per hour at a mean temperature of 300 degrees F. Thickness of the insulation shall conform to the following schedule:

<u>Pipe Size</u>	<u>Low Pressure Steam Supply and Condensate Return, Medium Pressure Condensate Return (25 to 75 lbs.), (all above concealed or exposed) Glycol Heat Recovery Supply and Return in Exposed Areas, and Glycol Radiator Coolant System Supply and Return to Heat Exchanger and Engine jacket water circuit in Exposed Areas, Hot Water Reheat Supply and Return in Exposed Areas, Hot Water Radiation Supply and Return in Exposed Areas, Radiant Panel Supply and Return in Exposed Areas, Vapor Vents and Safety Relief Valve Vent</u>	<u>High Pressure Return, Medium Pressure Steam Supply (25 to 75 lbs.)</u>	<u>High Pressure Steam Supply (above 75 lbs.)</u>
Thru 1"	1"	1"	2"
1-1/4" thru 5"	1"	1-1/2"	2"
6" and over	1-1/2"	2"	2-1/2"

Fittings, valve bodies and flanges for pipe size 3" and smaller shall be insulated with JM-301 cement equal to thickness of adjacent pipe insulation. Over 3" shall be insulated with mitered segments of pipe insulation secured with 16 gauge copper wire. A finish coat of 301 cement shall be applied over segments. All fittings shall be finished with "Zeston" or equal preformed fitting covers with Owens Corning ASJ, all service jacket finished as per adjacent piping.

B. Glycol heat recovery supply and return in concealed areas, and glycol radiator coolant supply and return in concealed areas, hot water reheat supply and return in concealed areas, hot water radiation supply and return in concealed areas, radiant panel heating supply and return in concealed areas, glycol-heat recovery, domestic and laboratory hot water and recirculating hot water, tepid-hot water and tepid recirculating hot water. The insulation shall be sectional type fiberglass pipe insulation with factory-applied jacket. Insulation shall have an average thermal conductivity not to exceed .22 BTU inch per square foot per degree F. per hour at 75 degrees F. mean temperature. Insulation shall be 1" thick all pipe sizes and 3#/cu.f.t. or Type III jacket. Fittings, valve bodies and flanges for pipe size 3" and smaller shall be insulated with JM-301 cement equal to thickness of adjacent pipe insulation. Over 3" shall be insulated with mitered segments secured with 20 gauge galvanized annealed wire. A finish coat of 301 cement shall be applied over segments. After cement is dry, a glass fabric membrane or JM A-2070 asbestos cloth, overlapping the adjacent jacket, shall be adhered and finished with Benjamin Foster's 30-36.

2.6 COLD EQUIPMENT

A. Chilled water pumps shall be insulated with 2" Foamglas encased in sheet metal. The pump casings shall be completely enclosed with insulation, except bearings and packings which shall be left uncovered. The enclosure shall be made in two pieces split halfway up so that the top half is easily removable for pump inspection. The enclosure shall be made as tight as possible using rubber gaskets and felt to seal cracks and other areas around openings. The insulated sheet metal enclosure shall be firmly attached to the pump base.

B. Roof plaza drain bodies and flushing rim floor drain bodies, water meter, expansion tanks, absorption unit refrigerant sumps, chilled water headers, hermetic pump motor, and refrigerant pump housings. Insulation shall be flexible foamed plastic sheet insulation. Minimum density shall be six pounds per cubic foot. Insulation thickness shall be 3/4". Type VI jacket on insulation in exposed areas. Apply brush coat of O.C. 500, Armstrong 520, C.M.C. 17-462, JM #67 adhesive to metal surface and also to back of foamed plastic sheet. After adhesive has dried to non-tacky state, press sheet firmly in place. All edges shall be coated with adhesive and pressed firmly together with 1/8" overlay pressure. All joints shall be staggered.

2.7 HOT VESSELS AND EQUIPMENT

A. Domestic and laboratory hot water instantaneous heaters, hot water reheat, radiant panel and radiation convertors, flash tanks, condensate receivers, air separators, stills and sterilizers. The insulation shall be rigid block hydrous calcium silicate insulation having a minimum density of 11 pounds per cubic foot.

B. Insulation shall have an average thermal conductivity not to exceed .37 BTU per inch per square foot per degree F. per hour at a mean temperature of 300°F. It shall be suitable for use with temperatures to 600°F and shall be

2" thick. Insulation shall be placed with joints staggered and all edges brought into firm contact and shall be cut or scored where necessary to fit the shape and contour of the vessel. Insulation shall be secured in place with 1/2" wide x .015 galvanized annealed wire on not over 12" centers. All joints shall be filled with particular manufacturer's recommended insulation cement well trowelled into the openings. The entire installation shall be covered with a layer of expanded metal lath weighing 2-1/2 pounds per square yard, laced together at all edges with 16 gauge galvanized soft annealed wire. Insulation shall be finished with a 1/2" coat of finishing cement to which Portland cement, to a maximum of 25% dry weight, may be added for a harder finish. A 20 x 20 glass mesh shall be applied over the cement embedded in one coat of B.F. 30-36 and brush coat applied over fabric.

2.8 DUCTWORK THERMAL INSULATION

A. Thermal insulation shall be applied to supply air, fresh air, return air and mixed air ducts as specified herein. Insulation shall be fiberglass board insulation.

B. Supply and Return Air Duct Insulation. Apply to all supply ducts from unit housing where double inlet supply fans are used to the ends of the duct runs, including diffuser necks, register ducts and diffuser plenums. Do not apply insulation over coil access panels and sound attenuators or on sound insulated ductwork. Refer to details on Sheet A-4-14 for supply diffuser plenum details. Owen Corning Fiberglas 25 ASJ is acceptable as equal to insulation and jackets specified.

<u>Insulation Material, Duct Type and Location</u>	<u>Material</u>
Supply ducts located in un-airconditioned rooms and/or areas. (Suspended ceiling spaces above air-conditioned rooms are to be considered as air conditioned areas). Utility shafts are to be considered as un-airconditioned areas.	Vapor seal duct insulation having a flame retardant reinforced foil face of .001" thick aluminum. Insulation shall be 1" thick, 3 lb. density, glass fiber. Finish with 6 oz. canvas.
Round supply ducts in air conditioned areas and in suspended ceiling spaces above air conditioned rooms.	Flexible glass fiber, 1" thick 1 lb. density with reinforced foil scrim Kraft vapor barrier facing.
Supply ducts located in air conditioned areas and in suspended ceiling spaces above air conditioned rooms.	Rigid glass fiber, 1" thick, 3 lb. density with reinforced foil scrim Kraft vapor barrier facing.
Return air ductwork in un-air conditioned spaces.	Rigid glass fiber, 1" thick, 3 lb. density, with reinforced foil scrim Kraft vapor barrier facing. Finish with 6 oz. canvas.
C. Kitchen Exhaust Ductwork. Insulate with 1" - 4# density glass fiber with 1" galvanized poultry netting on the outside. Insulation shall be guaranteed for operating temperatures up to 1000°F, blankets shall be butted firmly and laced with #16 galvanized annealed wire. Finish with 1/2" thick coat of hard finish insulating cement.	

D. Application of rigid duct insulation. Cut top and bottom pieces to lap side pieces on horizontal runs. Attach the bottom pieces with welded pins and caps on 15" centers. Attach the side pieces with welded pins and caps using two (2) pins per piece for insulation. Trowel adhesives on bottom, top, sides of duct in 4" wide strips on 1 foot centers and press insulation firmly in place. Caps shall be fiber washers or sheet metal discs of 1-1/2" diameter. Metal fasteners shall be Omark, Duradyne, or KSM capacitor discharge studs. Insulation adhesive shall be B.F. 85-20, C.M.C. 17-460 or 17-461 or I-C225. On foil faced duct insulation, all joints, pins and caps shall be sealed with B.F. 82-07, C.M.C. 17-465 or I-C225 adhesive over which shall be applied embossed aluminum foil tape in 4" widths so as to result in an unbroken vapor barrier surface and a neat exterior appearance. On vertical ducts, adhesives, pins and caps shall be used on all insulation surfaces using two (2) fastenings per piece of insulation. All ductwork in exposed areas shall be reinforced with corner bead. Apply tack coat of Benjamin Foster's 30-36 Sealfas. Embed JM Duramesh (20 x 20) or equal, into wet coating, smoothing to avoid wrinkles. Overlap Duramesh seams at least 2". Apply finish coat of 30-36 Sealfas to the entire fabric surface.

E. Application of flexible duct insulation. Insulation shall be adhered to the sheet metal ductwork with B.B. 85-20, C.M.C. 17-460 or 17-461, or I-C225 adhesive applied in strips 4" wide around the duct at 1 foot intervals. The insulation shall be wrapped around the duct, pressed firmly into the wet adhesive and shall lap at least 3". The insulation shall be further secured with soft copper wire half hitched into loops in 8" centers.

2.9 OUTDOOR AIR DUCT AND MIXED AIR DUCT AND UNUSED LOUVERS

A. Apply to all outdoor air ductwork from air intake plenum to supply unit housing, mixed air ductwork from point of return duct connection to the unit housing. The insulation material shall be 2" thick, rigid, 3 pound density, glass fiberboard. The insulation shall be installed in the double metal wall unit housing. The double metal wall housing shall be constructed using 18 gauge panels on exterior and 22 gauge panels on interior. This Contractor is cautioned to apply caulking compound to all joints and housing seams to insure a vapor tight seal on the exterior wall unit. This Contractor shall solder all joints on exterior wall for all ductwork located in outdoor air plenum. Unused portions of louvers shall be blanked off with above insulation and 22 gauge sheet metal cover.

2.10 EXHAUST AIR DUCTS

A. Apply to all exhaust air ducts from exhaust louver back through the duct system to exhaust air damper plus 3 feet. Insulation and application same as Article 2.10 above.

2.11 EMERGENCY GENERATOR EXHAUST PIPE

A. Emergency generator exhaust piping and muffler shall be insulated with hydrous calcium silicate pipe insulation, 11 pounds per cubic foot density with factory applied aluminum jacket, banded. Insulation shall have an average thermal conductivity not to exceed .60 BTU inch per square foot per degree F. per hour at a mean temperature of 700 degrees F. Total thickness of insulation shall be 3" consisting of two layers each of 1-1/2" thick. Fittings and flanges shall be insulated with mitered segments of pipe insulation

with aluminum jacket covering. Joints of insulation shall be staggered. Exhaust stacks shall terminate with a Kittel counterbalanced raincap.

2.12 SOUND INSULATION

A. Sound insulation shall be applied to the interior of all transfer ducts, and return, exhaust and supply ducts where indicated on the drawings, and/or in return and exhaust ducts for a distance equal to 10 duct diameter equivalents measured from fan inlets back through the duct system, and in the case of supply ducts for a distance of 6 feet measured from discharge air side of each reheat coil into the duct system. No sound insulation shall be installed in Animal Exhaust Fan Number E-4C system. All sound insulation shall be Johns-Manville Lina Coustic, Gustin Bacon Ultra-Liner, Baldwin-Ehert-Hill FFF90-A, Owens Corning Fiberglas Matface or approved equal, duct liner with a black fire resistant skin surface. Overall density shall be of 1-1/2 to 1-3/4 pounds per cubic foot. Lier shall be 1" thick and rated for velocities of 4000 fpm. Insulation shall meet NFPA Pamphlets 90A and 90B fire-resistant requirements and shall conform to the requirements of UL Pub. No. 181. The sound absorption coefficients shall not be less than the following:

Frequency (CPS)	125	250	500	1000	2000	4000
Absorption Coefficient	.10	.40	.60	.90	.90	.90

B. The insulation shall be applied in fabricated pieces sized to the interior duct surfaces with the black coated surface exposed to the air stream. It shall be firmly held in place with a fire resistant adhesive such as Benjamin Foster 85-10 or 85-20, or approved equal covering a minimum of 100% of the duct surface. In addition, insulation on the top and sides of horizontal ducts and all sides of vertical ducts shall be further secured with Omark, Duradyne KSM capacitor discharge studs and caps, or approved equal, on 15" centers. Discharge stud and cap shall be an integral unit so that the stud does not penetrate the cap. Exposed longitudinal edges of insulation shall be coated with a heavy layer of Benjamin Foster's 60-30 fire resistive mastic, or approved equal, prior to installation in the duct system. Transverse edges shall be covered with a "U" shaped sheet metal protector secured to the duct.

1. Duct sizes listed on the drawings are internal sizes. Where insulation is applied to the inside of the ducts, the metal size of the duct shall be increased in amount to result in internal dimensions equal to that shown on the drawings.

2. Where sound insulation is specified and/or shown for ducts which require thermal insulation as specified, the thermal insulation may be omitted on the outside of the sound insulated duct.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing equipment, materials and performing all labor necessary to connect the domestic and fire protection water service and domestic water booster pumps and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100
2. Pipe and Pipe Fittings: Section 15110
3. Valves: Section 15120
4. Piping Specialties: Section 15130
5. Mechanical Supporting Devices: Section 15140
6. Vibration Isolation: Section 15150
7. Mechanical Systems Insulation: Section 15160
8. Fire Protection System: Section 15500

PART 2: PRODUCTS AND INSTALLATION

2.1 WATER SERVICE

A. A 12" domestic water valved and capped service branch main and an 8" fire protection valved and capped service branch main are existing in a valve chamber as shown on Site Plan Sheet AM-1.

B. This contractor shall extend 12" domestic water and 8" fire protection services from these valved fittings into this building (Unit B-C) as shown on Sheets AM-1 and M-3 and terminated with flanged fittings. Minimum burial depth shall be (7) feet.

C. Note that the chambers and valves within the chambers are existing.

D. The two service mains to this building shall be extra heavy ductile iron with 250 lb. mechanical joints and lead-tipped gaskets. Provide insulating union at connection between copper and iron piping. The domestic cold water main will be used as ground by the Electrical Contractor. Provide ground jump at insulating unions on domestic cold water main. Provide clamps on cast iron bend fittings.

E. The domestic water meter shall be an 8" compound unit approved by the City of Minneapolis. The meter will be furnished by the City of Minneapolis and this Contractor shall install the same. All purchase costs, if required, shall be paid by this Contractor. Meter shall be capable of recording 850 GPM at a maximum pressure drop of 4 psi. See piping detail Sheet M-88.

1. Provide valves to permit shutting off of the bypass meter from the main line without shutting off the main line. Provide a test outlet so the meter can be tested while in service. Provide ASME standard flanges. Valves on each side of meter shall be meter size. See detail on Sheet M-88.

2.2 DOMESTIC WATER BOOSTER SYSTEM

A. The Contractor shall furnish and install where shown in the Plans a prefabricated three-pump water pressure booster system, capable of supplying 550 GPM as "100% flow" when maintaining a peak system pressure of 145 psi with a minimum suction pressure of 80 psi. System shall be equal to Synchroflo, as herein described.

B. All pumps shall be of the short coupled multi-stage diffuser type. Pump #1 shall be rated 175 GPM at 162' TDH and driven by a 10 HP motor. Pumps #2 and #3 shall be identical units, each rated 375 GPM at 162' TDH and driven by 25 HP motors. Pumps with flat head curve will not be considered for this service. Pumps shall be capable of operation at 2% of design flow without increase in noise level and shall operate without cavitation when effective differential pumping head is 60% of design head. Published pump performance curves shall be submitted for evaluation and approval. All pumps shall have a single mechanical seal. Seal shall be replaceable without pump disassembly, or disturbing piping. All pumps are to have Type "B-J" vibration isolator mountings for .75" static deflection. All pumps shall be 1800 RPM.

C. Normal pump sequencing shall be as follows: For loads from zero to 32%, #1 pump only shall run; from 32% to 100% pump #1 and #2 shall run; from 100% to 168% #1, #2 and #3 shall run together. Pumps #2 and #3 shall be transferable mechanically and electrically from selector switch on the control panel. Any one or any combination of pumps shall be capable of emergency running without automatic sequencing to maintain constant system pressure. System pressure shall be maintained by pilot-operated diaphragm type, combination pressure regulating and non-slam type check valve on each pump discharge line. Maximum permissible response time to reach and stabilize under an instantaneous pump load change of 50% shall be one second for regulating valves 2-1/2" and smaller, and two seconds for 3" and 4" valves.

D. Variable speed device, if used, shall be supplied on all three pumps and shall be mechanical fluid drive coupling type with suitable sized oil cooler, temperature control valve, thermometers, strainer and automatic speed control lever.

E. All flexible couplings shall be pin and rubber bushing type and shall be furnished with protective guards. Variable speed drive units shall be connected to both the pump and motor through flexible couplings.

F. All pump motors shall be hollow shaft type and shall be "quiet" label and shall operate within design load rating at any point on the pump curve. All motors shall be drip proof and suitable for operation on 460 volt, 60 cycle, 3 phase current with a maximum temperature rise of 40 degrees C. above an ambient of 40 degrees C. and conform to NEMA standards. Pump sizing for this project shall be such that total pump running BHP to achieve 100% system capacity shall not exceed 35 HP.

G. A power and control cabinet shall be supplied, factory wired and mounted. It shall be of heavy gauge shadow box configuration, NEMA 1 construction, complete with doors. Panel shall include for each pump a disconnect with external handle, fuse blocks, magnetic starters with 3 leg overload trip (reset in cover), 3 position hand-off-auto selector switch plus "run" indicating light. Electrical Contractor to run service from main power source direct to pumps #2 and #3. Service to pump #1 shall be arranged so that this pump may be operated off auxiliary power source should main power source fail.

H. Control components shall include a 460/120 volt transformer, key selector control power switch with "power on" light, time delay relays, alarm signal with alarm lights and terminal strip. Visual and audible signals shall indicate low suction pressure, low system pressure and system over-pressure. All indicating lights shall be located on outside of compartment cover, together with alarm silencing button. Control power shall be taken from pump #1 power source so that control power will be available from emergency power source.

I. Instrumentation shall include a mounted, pre-wired flow switch used to sequence pumps. A pressure gauge for each pump, a system manifold pressure gauge and a compound suction pressure gauge shall be furnished. A low pressure limit switch sensing suction manifold pressure, shall shut down all pump sets in the event of loss of suction pressure. In the event of power failure, system shall automatically return to service when power is restored. A manual-lock-reset switch, sensing system pressure shall energize circuit of #3 pump should system pressure drop to a predetermined low pressure for any reason. Indicating light on panel shall also signal this occurrence. Provide over-pressure switch to shut down all pumps should system pressure exceed setting. Time delay relays adjustable from 5 to 60 seconds shall be furnished and installed in conjunction with low system and system over-pressure switches and arranged so that system will not cycle to "emergency" conditions should these conditions occur for short duration.

1. All pressure gauges and switches shall be mounted in separate matching gauge panel installed above power and control panel and shall include snubbers.

2. An 120 volt outlet shall be provided in control panel for operation of Owner's pressure recorder.

3. Each pump casing or barrel shall be fitted with separate pre-wired temperature probe and approved electric purge valve installed immediately up stream of each PRV, with manifolded drain piping, (common purge valve on discharge header, not acceptable).

J. The entire booster system shall be factory prefabricated on a common structural steel stand with all interconnecting piping and wiring completed and operationally tested prior to shipment. Complete package shall also include isolation valves on the suction and discharge of each pump. Galvanized steel suction and discharge pipe manifolds, as well as copper tubing with the shutoff cocks for gauges and pressure switches, will be furnished assembled. The only field connections required will be system suction and discharge and power connections at the control panel.

K. All components shall be furnished by a single manufacturer of established reputation and the system shall be a standard catalogued product of that manufacturer. All piping, fittings, vibration isolators on pump discharges, control valves, etc., on discharge side of pumps shall be rated for 300 psig operating pressure.

All discharge piping, valves fittings, etc., for pumps #2 and #3 shall be 4". However, as initial load will be substantially below design capacity the pressure regulating valves shall be 3". At such time as design load is achieved, owner may install 4" valves if found to be necessary.

L. The factory shall certify in writing that the water pressure booster system and its component parts shall have undergone a complete electric and hydraulic test prior to shipment. Test shall be including a SYSTEM operating flow test from zero to 100% design flow rate under specified suction and net delivery pressure conditions. Certification shall include copies of the test data as recorded by X-Y plotter. System test may be witnessed by Owner, Architect or Engineer by reporting intent to do so to the factory.

M. The service of a factory-trained representative shall be made available on the jobsite to check installation and start-up and instruct operating personnel.

N. The internal multistage pumping assemblies and pressure regulating valves shall be guaranteed for five years from date of shipment against defective material and workmanship. Motors shall also be guaranteed for five years from date of shipment against burn-out from any cause when equipped with over-temperature protection system and maintained according to factory instructions.

Similar systems by "Liquitrol" or Weil "Verti-pump" are approved as equal.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary to connect the domestic and laboratory hot water systems and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.
6. Mechanical Systems Insulation: Section 15160.

PART 2: PRODUCTS AND INSTALLATION

2.1 INSTANTANEOUS HEATERS 140° AND 180°

A. The hot water heater shall be of the vertical shell and helical-coil design with steam in the coils and domestic water in the shell.

B. To permit descaling without dismantling the unit, no water baffles or tube supports shall be used in the design of the hot water storage generator. Descaling shall be accomplished by expanding and contracting the helical coils by thermal shock. A ten year guarantee shall be furnished against tube failure due to thermal shock or any mechanical action.

C. The heat transfer surface shall be a series of horizontal copper helical coils welded in parallel headers which in turn are connected to vertical bronze supply and return risers. Unions shall be provided between each coil and the riser for ease of cleaning.

D. The shell shall be fabricated of steel plate and shall be copper lined. The shell ends shall be cast bronze having tapped connections as follows: Pressure relief valve, thermometer, thermostat, cold water inlet, hot water outlet, steam inlet, steam condensate, recirculation connection outlet, blowdown descaling outlet and three supporting members.

E. The hot water storage generator shall be ASME stamped for 150 psi working pressure and a code certificate shall be issued.

F. The following model numbers are taken from the Aerco catalog.

2.2 HEATING SCHEDULE

<u>Item</u>	<u>Location</u>	<u>Service</u>	<u>Model No.</u>	<u>T GPM</u>	<u>Temp. Rise</u>	<u>Steam Press. Ahead of Press.</u>	<u>Sq.Ft. Heating Surface</u>	<u>Steam Load Lbs./Hr.</u>	<u>Valve Size</u>
WH-1	Basement	140°F Potable Flrs. B through 5	1010	45	100°	10#	50	2700	2-1/2"
WH-2	Basement	140°F Standby Flrs. B through 5	1010	45	100°	10#	50	2700	2-1/2"
WH-3	Basement	180°F Potable Flrs. B through 5	1006	20	40°	10#	30	480	1-1/4"
WH-4	Basement Flrs. B through 5	180°F Standby	1006	20	40°	10#	30	480	1-1/4"
WH-5	15th Flr.	140°F Potable & Laboratory Flrs. 6 through 15	2014	90	100°	10#	70	5350	4"
WH-6	15th Flr.	140°F Standby	2014	90	10	10#	70	5350	4"
WH-7	15th Flr.	Laboratory Recirc. Booster	1004	18	20°	10#	20	215	3/4"

2.3 CONTROL

A. The steam flow control valve shall be temperature-actuated by a thermal element, capillary tubing, thermal pilot and with a piston operated main valve furnished with the heater. The main valve (air operated) operation, shall be fully dynamically and statically balanced, single seated, tight-shut-off, full ported, full-stroking steam flow regulator with complete stainless steel trim, Teflon valve seat, cast iron body with flanged 125 psi 2" and above and screwed below 2". The valve shall be suitable for maximum working pressure of 125 psi and a maximum temperature of 375°F.

B. The control of the set temperature shall be maintained within a tolerance of 2-1/2°F in the water leaving the hot water generator when operating over a range of steam flow demand of 100% to 1%.

C. Provide and install Aerco orificed unions as required in condensate returns from each heater.

2.4 PRESSURE RELIEF VALVE SCHEDULE

A. Valves shall be set to relieve at 150 lbs. Pipe discharge to nearest floor drain.

B. The following Model numbers are taken from Watts Regulator Company catalog.

C. Schedule

<u>Heater No.</u>	<u>Model No.</u>	<u>Relieving Capacity</u>	<u>Size</u>
WH-1	174A	3795 MBH	1"
WH-2	174A	3795 MBH	1"
WH-3	174A	2445 MBH	3/4"
WH-4	174A	2445 MBH	3/4"
WH-5	174A	7020 MBH	1-1/4"
WH-6	174A	7020 MBH	1-1/4"
WH-7	174A	2445 MBH	3/4"

D. Heater Tappings

		<u>Wtr. Htr.</u> <u>Model</u> <u>No. 1004</u>	<u>Wtr. Htr.</u> <u>Model</u> <u>No. 1006</u>	<u>Wtr. Htr.</u> <u>Model</u> <u>No. 1010</u>	<u>Wtr. Htr.</u> <u>Model</u> <u>No. 2014</u>
Top:	Thermometer	3/4"	3/4"	3/4"	1"
	Thermostat	1"	1"	1"	1"
	Water inlet	1-1/4"	1-1/4"	1-1/4"	1-1/2"
	Relief	1"	1"	1"	1"
	Water outlet	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Bottom:	Condensate	1"	1"	1"	1-1/2"
	Steam	2"	2"	2"	3"
	Drain	2"	2"	2"	2"
	3 Leg supports	1-1/4"	1-1/4"	1-1/4"	2"
	Recirculation	2"	2"	2"	2"

See details on Sheet M-88 for piping connections.

2.5 CIRCULATING PUMPS

A. Pump Characteristics: Pumps shall have non-overloading characteristics and shall be furnished at the mid-point of the pump curve. Pumps shall have a flat curve characteristic and be capable of operating with a 10% variation on either side of the point of selection to allow for drift in the system curve. Unless noted otherwise all pumps shall operate at 1750 RPM.

B. Pumps specified shall be all-bronze construction.

C. Shaft Seal: Each pump shall be furnished with an extra mechanical seal.

D. Pump Supports: In line booster pumps shall be supported independent of system piping and base mounted pumps shall be mounted on fabricated steel or concrete base as noted on the plans.

E. The following pumps are taken from the Bell & Gossett catalog. Thrush, Pacific, Dunham Bush, Taco & Armstrong are approved equal.

F. Pump Schedule

<u>Pump No.</u>	<u>Pump Location</u>	<u>Serving</u>	<u>Capacity GPM</u>	<u>Total Head</u>	<u>HP</u>	<u>Model No.</u>	<u>Suction</u>	<u>Discharge</u>
P-38C	Bsmt.	WH-1 & WH-2	14	15'	1/4	Series 60-1AA	1"	1"
P-39C	Bsmt.	WH-3 & WH-4	5	15'	1/4	Series 60-1AA	1"	1"
P-40C	15th Flr	WH-5 & WH-6	19	15'	1/4	Series 60-1AA	1"	1"
P-41C	15th Flr	WH-7	26	15'	1/4	Series 60-1/4AA	1-1/4"	1-1/4"
P-42C	4th Flr	Thermostatic Mixing Valve 110°F	10	15'	1/4	Series 60-1AA	1"	1"

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes furnishing all equipment, materials and performing all labor necessary to connect the soil and waste piping systems and other related systems.

C. Related work specified elsewhere:

1. Basic methods and materials: Section 15100.
2. Pipe and pipe fittings: Section 15110.

PART 2: PRODUCTS AND INSTALLATION

2.1 GENERAL

A. All floor drains provided under this contract shall be of Josam Manufacturing Company, Jay R. Smith, Blake, Wade Manufacturing Company, Zurn Industries or approved equal, of type and size specified or indicated on the drawings. Except where otherwise specified or indicated, strainers for 2" floor drains shall be at least 5" in diameter, for 3" drains shall be at least 7" in diameter and for 4" drains strainers shall be at least 9" in diameter. Drains shall have nickel bronze strainers unless otherwise specified. Floor drains in floors resting on earth shall have spigot or hub outlet for caulked joint. The following numbers are taken from the Josam catalog.

B. Floor drains shall have threaded, spigot or hub outlet as required for proper connection to piping and shall be provided with a trap having a cleanout. When indicated on the drawings, floor drain or trap shall be provided with an auxiliary opening on inlet side of trap for indirect waste connection. There shall be no threaded auxiliary inlets in the ground. Drains installed in connection with waterproofing membrane, copper or lead flashing shall be provided with drainage flange, weepholes and flashing clamp.

C. The Contractor shall provide 16 oz. copper flashing or 8# lead flashing to extend 12" from clamping ring on all floor drains other than floor drains in slab on earth.

2.2 FLOOR DRAINS IN FLOORS ON GRADE

A. Mechanical Equipment Rooms: Josam No. 850-ZZV cast iron body floor drain, integral spigot outlet, cleanout flush with floor and backwater valve, and polished brass strainer.

B. Toilet Rooms and Showers and Miscellaneous Drains: Josam No. 200-ZZ-V, cast iron body floor drain, integral spigot outlet, Nikaloy strainer with backwater valve.

C. Where funnels are called for on the drawings, provide a Josam No. 510-Q-11 8" grate assembly. (Series 7020 floor drain grate modified to accept a type 5404 drain body.)

D. Acid Resisting: Duriron 7801-B or 9058-B with separate Palmer type backwater valve calked into Duriron tee. Provide a Durcomet 100 funnel and strainer plate when funnel is noted on plan.

2.3 FLOOR DRAINS IN FLOORS ABOVE GRADE

A. Mechanical Equipment Rooms: Josam No. 300-37A cast iron floor drain with L.P.S. outlet, 1910 deep seal P-traps with cleanout. Use shallow trap where necessary. Polished brass strainer. When funnels are called for on drawings provide a series #510-Q-11, 8" Dia. grate. Field welded funnels on grates will be unacceptable.

B. Toilet Rooms and Showers Miscellaneous Drains: Josam No. 300-36AK cast floor drain with I.P.S. outlet, 1910 deep seal P-trap with cleanout and Nikaloy strainer. Use shallow trap where necessary, provided flashing clamp areas where membrane occurs.

C. Flush Rim Floor Drain (F.R.F.D.): Josam No. 9850 cast iron drain with porcelain enamel inside. Double drainage flange and weepholes, clamping device, 3/4" I.P.S. flushing connections; flushing rim top with hinge grate. Trap to be Duriron P-trap, acid-proof. Provide solid hinged Nikaloy cover with integral strainer for all animal rooms. For all dog runs provide hinged Nikaloy perforated strainer only. Dog runs are located on 1st Floor West.

D. Fume Hood Exhaust Duct Drips: Josam V-232-FC cast iron drip drain with open top and anti-splash dome strainer. Provide clamping flange and clamping device.

E. Demineralizer Floor Sink Josam No. 9424-52-C lacquered cast iron, with full grate and clamping device, double drainage flange.

F. Acid Resisting: Duriron 5501-CF with Duriron P-trap. Where funnel is called for on the drawings, provide a Durcomet 100 funnel and strainer plate.

2.4 CLEANOUTS

A. Cleanouts, placed in accessible locations, shall be provided in all drainage lines where indicated on the drawings and where necessary to permit rodding out of the entire drainage system. Cleanouts shall be provided at the base of each soil or waste stack and at the base of each downspout riser.

B. Cleanout plugs and tees for bell and spigot piping shall have a cast iron body and a Minneapolis pattern cast brass plug. On threaded piping, cleanouts shall consist of a Minneapolis pattern cast brass plug screwed into a suitable fitting. Cleanouts on piping installed in inaccessible furred spaces above inaccessible ceiling or below floors on grade shall be provided with extensions to bring cover flush with finished wall or floor.

C. Cleanouts on acid-proof piping shall be of acid-proof material. See list below for type of frame and cover to be provided in the wall or floor.

D. All cleanouts shall be Zurn Manufacturing Company of the following figure numbers. Products as manufactured by Josam, Jay R. Smith, Blake or Wade are acceptable.

1. Finished Floors of Asphalt, Vinyl, Rubber or Other Composition: ZN-1325-5, bronze plug cleanout with nickel bronze round frame and round recessed cover.

2. Finished Floors of Terrazzo or Cement: ZN-1325 bronze plug cleanout with ZN-1385-2 nickel bronze round frame and round cover.

3. Finished Floors with Ceramic or Quarry Tile Finishes: ZN-1325-1 bronze plug cleanout with nickel bronze square frame and round cover.

4. Unfinished Floors and Traffic Areas: ZN-1326-10 bronze plug cleanout with cast iron frame, heavy duty grate and anchorage lugs.

5. Walls: Wall cleanout plugs in finished walls shall be Fig. ZN-1329-20 and square access covers shall be Fig. No. ZN-1375-1. Wall cleanouts in unfinished walls shall be Fig. ZN-1370 cleanout plug and housing with secured round access cover.

6. Ceilings: Cleanouts shall be provided with full size cleanout pipe with a brass coupling and a Fig. No. ZN-1329-20 polished nickel, bronze plug.

7. Carpeted Rooms: Z-1323 bronze brass countersunk plug, round brass scoriated cover flush with concrete floor. Carpeting shall be continuous over cleanout and shall be marked by a single chrome-plated round head screw protruding through the carpet and screwed through the center of the brass cover.

All exposed cleanout covers shall be chromium plated in walls and shall be nickel bronze in floors.

2.5 INDIRECT WASTE CONNECTION

A. Funnel drain connections receiving the discharge from indirect wastes shall be connected to the inlet side of trap on floor drain or to a separate trap. Indirect wastes shall be provided with a fixed air gap arrangement in connection to trap or shall be provided with a funnel drain connection.

2.6 ROOF JACKETS

A. Vent stacks from sewer, soil, waste and drain lines shall be extended at least 12" above roof, and shall be encased in frostproof jackets, Moore, Sure Seal or equal, each having an air space of at least 1" between the outside

surface of pipe and inside surface of frost jacket. The top of the frost jacket shall be designed as to permit the insertion therein of a testing plug of such form that it can be readily seen until removed, and said plug shall be removed at once after a final inspection has been made and approved by Engineer. Vent pipe shall be cast iron where same passes through roof slab.

B. Roof jackets shall be constructed of 16 oz. copper for all pipes sizes 6" and smaller, and 20 oz. copper for all pipes larger than 6".

C. Acid-proof, frost-proof, type roof jackets shall be constructed of 6 pound sheet lead.

2.7 BACKWATER VALVE. Backwater valves in sub-drainage piping connecting to storm sewer in building - floors on grade: Josam No. 1106, cast iron backwater valve with hub inlet and spigot outlet, extensions to floor level, caulked with cast iron bolted access cover, brass check valve with brass revolving flap and brass seat.

Drainage piping from fresh air intake plenums, where indicated on drawings. Shall include a Josam Series 1190 check valve with brags backwater flap valve.

2.8 MANHOLES AND CATCH BASINS

A. Furnish and install such units where shown and as detailed on drawings as part of the storm and sanitary sewer systems.

B. The manholes shall be of Cretex Companies, Inc., or equal, manufactured of prefabricated reinforced poured concrete ring type and of 4'-0" diameter. The top sections where shown shall be of concentric or eccentric reducer, 48" diameter to 27" diameter.

C. The catch basins shall be similar to the above manhole requirements, but shall be as detailed on the drawings.

D. Manhole and catch basin frames and covers shall be as specified on the detail plans. Frames to be fastened by bolts and grouting. Catch basins greater than 4' depth and all manholes shall have aluminum steps.

2.9 SUMP PUMPS - ELEVATOR PITS

A. Elevator Pits

1. Furnish and install where shown and detailed on the drawings in each of two elevator sumps a complete package duplex sump pump each to be an Enpo-Cornell Model 150-ABR, 1/2 HP, 120 volt, 60/1 phase, all bronze casting. Each unit shall pump 30 gpm against 23 feet of head. The Electrical Contractor will provide an electrical outlet in each of the two sumps. Concrete basin by General Contractor. Vented cover and frame by Mechanical Contractor.

2. Mechanical Contractor shall provide a submersible float switch mounted on pump discharge. Switch is to be used to signal high water level in sump by operation of a remote alarm (Enpo-Cornell Model 63-196 also by Mechanical Contractor). Wiring between switch and alarm by Mechanical Contractor. See plans for alarm location. Provide on each pump discharge pipe, a union, check valve and gate valve. Weil, Pacific & Chicago are approved equal.

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes providing and installing of porous drain pipe at foundation and other basement areas of building as indicated on Sheets M-2 and M-4. Work includes performing all labor and furnishing piping materials, porous surround, excavation, and other related requirements.

PART 2: PRODUCTS AND INSTALLATION

2.1 MATERIALS

A. Porous Drain Pipe: Porous concrete drain pipe, extra strength, with Y's, tees and other shapes required, 6" inside diameter, to be as manufactured by Waker Porouswall Pipe Company, Little Ferry, New Jersey, from a mixture of Portland cement, water, trap rock, and sand. Drain pipe to have tongue and groove solid concrete interlocking joints and have a minimum infiltration rate of two gallons per lineal foot.

B. Perforated Drain Pipe: 4" perforated drain lines at Mayo Garage roof and Diehl Hall roof, areas below grade. Pipe shall meet or exceed commercial standard CS-228-61 and conform to Federal Spec. No. WW-P-00380 and applicable PVC fittings. Pipe shall come in 10'-0" lengths as manufactured by Ralph Jones Co. Inc.

C. Drain Pipe Porous Surround: For all drain pipe work, provide a surround of materials consisting of crushed rock or gravel, well-graded between 3/4" and #8 sieve. Aggregate shall meet classification as given under ASTM D-1863-64.

2.2 INSTALLATIONS

A. Contractor to excavate as required to providing a minimum 6" clear distance around drain pipe for porous surround.

B. All porous drain pipe shall be set in a surround of specified crushed rock not less than 6" thick at top and sides, except at foundation where porous surround must extend to foundation. Drain pipe to be laid in accordance with invert elevations given on Sheets M-2 and M-4.

2.3 TESTS

A. Contractor to provide one material analysis test of drain pipe surround. Tests to be taken by independent testing laboratory.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary to connect the Roof and Area Drainage Systems and other related systems.
- C. Related work specified elsewhere:
1. Basic Methods and Materials: Section 15100.
 2. Pipe and Pipe Fittings: Section 15110.
 3. Mechanical Supporting Devices: Section 15140.
 4. Mechanical Systems Insulation: Section 15160.

PART 2: PRODUCTS AND INSTALLATION

2.1 GENERAL

- A. All roof and area drains furnished and installed under this contract shall be as manufactured by Josam, Zurn, Blake, Jay R. Smith, or Wade. Drains shall be of type, material and construction indicated.
- B. Roof flashing furnished under the General Contract. When vertical downspouts are more than one story in height and swing joints or offsets are not possible, furnish and install a Josam Series 1810 or approved equal expansion joint.
- C. The drains scheduled herein are to types as designated and sized on the drawings. Refer to architectural drawings for exact locations and elevations of all drains.

2.2 ROOF DRAINS

- A. Josam Series 4110 cast iron roof drain with large sump and caulked outlet. Large dome strainer, deck clamp, flashing clamp and gravel stop. See architectural detail

2.3 AREA DRAINS

- A. Area Drains 2, 4, 6, 19, 20, 21, 23, 30 and 31. Josam Series 060, with 9" diameter top with ductile iron grate, cast iron drain body with double drainage flange and weep holes. Round slotted ballast guard (field cut barrel to vary elevation) wrap barrel with bronze screen. Flashing clamp and caulked outlet. See detail 5/M-105.

B. Area Drains 1, 3, 5, 17 and 18. Josam Series 4090 cast iron drain with large sump and flange, 5" or 6" bottom outlet as indicated on drawings, removable loose set square brass grate in square brass frame supported by adjustable threaded rods for varying deck thickness, removable perforated filter and concrete perforated forming ring. See detail 6/M-105.

C. Area Drains 26, 27, 28 and 29. Josam Series 4090 as above except frame and grate shall be ductile iron.

D. Area Drains 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16. Josam Series 4090 same as Item B above for installation in brick paver area as per drawing detail 7/M-105.

E. For slab-on-grade, areaways, outdoor air and relief air plenums, Josam Series 110 with ductile iron grate, cast iron drain body, with double drainage flange and weep holes and caulked outlet.

F. Tree Well drains. Josam Series 0750 used as tree well drain, cast iron body caulked outlet, with waterproofing flange and adjustable brass square head with brass strainer. See drawing detail 8/M-105.

G. Curb Line Area Drain: Neenah No. R-3901-A frame and grate, heavy duty, of high strength gray iron, 8" outlet. See drawing detail 9/M-105.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the furnishing of all equipment, materials and performing all labor necessary to connect the plumbing fixtures, trim and other related systems.
- C. Related work specified elsewhere:
1. Basic Methods and Materials: Section 15100.
 2. Pipe and Pipe Fittings: Section 15110.
 3. Valves: Section 15120.
 4. Piping Specialties: Section 15130.
 5. Mechanical Supporting Devices: Section 15140.
 6. Mechanical Systems Insulation: Section 15160.

PART 2: PRODUCTS AND INSTALLATION

2.1 GENERAL

- A. Furnish and install fixtures and trim of first grade quality and finish, free from flaws and scratches. All fixtures shall have ground backs groups of fixtures shall be matched. Fixtures and trim are to be furnished as listed and shown under catalog numbers, unless otherwise noted and described.
- B. The following fixtures are taken mainly from the American-Standard, Elkay, Duriron Company, Inc., catalogs and are used to designate type of fixtures desired. Fixtures of similar type and grade may be used in place of those specified, all subject to Engineer's approval. Crane, Kohler, Haws, Watrous, Just, Carlton, Halsey-Taylor and Speakman are approved.
- C. All faucets, loose key stops, and flexible tube risers listed shall be Chicago Faucet Company.
- D. Flush valves shall be Sloan, Delaney or Watrous.
- E. Toilet seats shall be Church, Beneke, Olsonite, or Sperzel.
- F. Trim of similar type and grade may be used in place of those specified, all subject to Engineer's approval.

2.2 FINISH OF TRIMMINGS

A. All exposed flush, waste and supply pipes at the fixtures shall be chromium plated brass pipe, iron pipe size. The faucets, stops, valves, pop-up wastes, traps, flush valves, etc., shall be heavy cast brass, chromium plated. All chromium plate shall be applied over a nickel plated base.

2.3 FIXTURE SUPPORTS

A. Fixtures hung from partitions adjacent to pipe spaces shall be supported with carriers.

B. Fixtures hung from partitions, finished one side only, are to be supported as the type of fixture may demand, either with bolts extending directly from the fixture or from bolts extending from the fixture hanger, entirely through the partition. Bolts shall be welded to a steel plate, set plumb, on the opposite side of the partition and securely anchored. End of bolts or rods shall have C.P. cap nuts.

C. Fixtures hung from partitions finished both sides, the fixture shall be hung in a like manner mentioned above, except that anchor plates shall be placed within the partition and securely anchored. End of bolts or rods shall have C.P. cap nuts.

D.. Anchor bolts for supporting plumbing fixtures shall be the sole responsibility of the Mechanical Contractor. He shall furnish the bolts and/or anchorage and shall be solely responsible for the correct location of the bolts. All anchors are to be placed as the walls are being laid up to avoid drilling.

E. All anchor holes in the fixtures are to be utilized.

F. Carriers listed are as manufactured by Josam. Units as manufactured by Zurn or Wade will be acceptable.

2.4 CLEANING

A. After fixtures and trim are installed, place suitable guards on fixtures and trim to prevent use and protect from paint and plaster during construction. Prior to final inspection, clean off all labels and remove any construction dirt, rust, paint and plaster.

2.5 FIXTURE ROUGH-IN

A. Roughing-in for waste, vent and supply connections at the various fixtures shall be as follows:

<u>Fixture</u>	<u>Waste</u>	<u>Vent</u>	<u>H.W.</u>	<u>C.W.</u>
Water closet	4"	2"	-	1-1/2"
Urinal	2"	1-1/2"	-	1-1/4"
Lavatory	1-1/2"	1-1/2"	1/2"	1/2"
Service sink	3"	1-1/2"	3/4"	3/4"

<u>Fixture</u>	<u>Waste</u>	<u>Vent</u>	<u>H.W.</u>	<u>C.W.</u>
Sinks	1-1/2"	1-1/2"	1/2"	1/2"
Eyewash	1-1/2"	1-1/2"	-	1/2"
Drinking fountain	1-1/4"	1-1/4"	-	1/2"
Shower-emergency	-	-	-	1"
Scrub-up sinks	2"	1-1/2"	1/2"	1/2"

2.6 FIXTURE MOUNTING HEIGHTS

- A. Fixture mounting heights shall be as shown on the architectural drawings.
- B. Note special rough-in heights for handicapped.

2.7 PLUMBING FIXTURE SCHEDULE

- A. The fixtures listed herein refer to fixture numbers noted on the drawings.

Item F-1 Water Closet

<u>Bowl:</u>	American-Standard 2502.011	Siphon jet action; elongated bowl, wall hung, 1-1/2" top spud, vitreous china.
<u>Valve:</u>	Sloan 115-F-Y1-YV	Chrome plated, with vacuum breaker, inlet opposite handle 38" above floor, 1" screwdriver angle stop, wall flange, 1-1/2" spud nut and flange, two wall bumpers.
<u>Seat:</u>	Church 5320.403	Black solid plastic, open front, with self-sustaining hinge for elongated bowl.
<u>Support:</u>	Josam C100/M-150	Carrier shall be furnished with block base or short foot supports to support fixture free and independent of finished wall. Carrier shall also be furnished with integral stack fitting with auxiliary inlets and vent connections as required and carrier lugs with china caps.

Item F-1A Water Closet - Handicapped

Same as F-1 water closet except mounting height floor to rim shall be 18".

Item F-1B Water Closet

<u>Bowl and Tank:</u>	American-Standard 2093.292	Siphon jet action, elongated bowl, close coupled tank, wall hung, vitreous china, aquaguard liner.
<u>Seat:</u>	Church 5320.403	Black solid plastic, open front, with self-sustaining hinge for elongated bowl.
<u>Supply:</u>	American-Standard 3405.016	3/8" chrome plated angle stop with deep escutcheon, flexible riser, wheel handle and chrome plated.

Item FIB - (continued)

Support: Josam Same as F-1.
C100/M-150

Item F-IC Water Closet - Bedpan Flusher

Bowl: American-Standard Siphon jet action, elongated bowl wall hung, 1-1/2"
2477.024 top spud, vitreous china.

Bedpan American-Standard Bedpan cleaner with deoseptic unit.
Cleanser 7586.027
Unit

Valve: Sloan Chrome plated with vacuum breaker, inlet opposite
115-F-Y1-YV handle 38" above floor, 1" screwdriver angle stop,
wall flange, 1-1/2" spud nut and flange, two
wall bumpers.

Seat: Church/American "Posturemold" black, open front, with self
Standard sustaining hinge for elongated bowl.
5321.088

Support: Josam Same as F-1.
C100/M-150

Item F-ID Water Closet - Children's Toilet

Bowl: American-Standard "Devoro" baby toilet bowl; siphon jet action
No 2272.011 toilet; round front bowl; 1-1/2" top spud
vitreous china; No 481310-100 bolt caps.

Valve: Sloan Chrome plated, with vacuum breaker; handle
115-F-Y1-YV opposite inlet; handle 38" above floor; 1"
screwdriver angle stop, wall flange; 1-1/2"
spud nut and flange; two wall bumpers.

Seat: Church/American- Black solid plastic open front seat with
Standard 509 brass hinge with check
5330.113

Item F-2 Urinal

Urinal: American-Standard Vitreous china blowout urinal with extended shields,
6530.18 integral flush spreader and trap, 1-1/4" top spud,
2" back outlet threaded connection, and supporting
bolts.

Valve: Sloan Chrome plated with vacuum breaker, 1" screwdriver
180-F-Q-YV stop, flush connection and coupling for 1-1/4" top
spud, wall and spud flanges.

Support: Josam Urinal carrier with hanger plate, fixture bolts
C-226 bearing plate steel pipe uprights, block bases
and chrome plated trim.

Item F-3 Lavatory

Lavatory: American-Standard 20 x 18 vitreous china, anti-splashback, front overflow, less soap depression, faucet holes 4" centers, left-hand hole for soap dispenser.
0361.055

Support: Cast iron wall hanger and lag screws through anchor holes for block walls. Hanger for stud wall shall be full back plate between studs fastened and lavatory attached with through going bolts.

Trim: Chicago Quatern Center set fitting with No. 1000 handles, 1802 3-3/4" spout, No. E12 softflo and coupling nuts; polished chromium plated.

Waste: American-Standard Lavatory drain, 4" tailpiece, 1-1/2" diameter 2412.013 and integral perforated grid.

Trap: American-Standard Adjustable "P" cast brass trap with tubing drain 4403.010 to wall, 1-1/2" inlet, 1-1/2" outlet, ground swivel joints, cleanout plug, slip inlet with brass coupling nut, escutcheon and chrome finish.

Supplies: Chicago 3/8" chrome plated angle stops with 3/8" I.P.S. #441LK chrome plated deep escutcheons, with 3/8" x 1/4" chrome plated reducers with rigid supplies.

Soap Dispenser: Bobrick Polyethylene jar concealed under left side of lavatory.
B-8294

Item F-3A Lavatory

Lavatory: American-Standard 16" x 14" enameled cast iron anti-splashback, front overflow, with soap depression.
5300.108

Support: Same as for F-3.

Trim: Chicago Faucet Concealed Combination lavatory fitting with rigid HC104-317 gooseneck spout, No. E-3 softflo aerator, and wrist blade handles, chrome plated.

Supplies: Chicago Same as F-3.
#441 LK

Waste: American-Standard Same as F-3.
2412.013

Trap: American-Standard Adjustable "P" cast brass trap with swivel 4419.016 E11 1-1/2" inlet and outlet ground swivel joint; cleanout plug; chrome finish.

Item F-3B Lavatory

Lavatory: American-Standard Same as F-3.
0361.055

Item F-3B - (continued)

Support: Same as F-3.

Trim: Chicago Faucet HC 785-E3 Combination lavatory fitting with No. GNIA rigid Gooseneck spout, with No. E-3 softflo aerator and No. 317 wrist blade handles chrome plated.

Supplies: Chicago #441 LK Same as F-3.

Soap Dispenser: Bobrick B-8294 Same as F-3. Concealed under left side of lavatory.

Waste: American-Standard 2412.013 Same as F-3

Trap: American-Standard 4403.010 Same as F-3.

Item F-3C LAVATORY (Animal Rooms)

Lavatory: Elkay CHS-1916-LF 19" x 16" overall rectangular 18 gauge type 304 stainless steel, 6" high splash back, wall-hung, underside sound deadened.

Support: Wall hanger and stainless steel bracket. Lag screws through anchor holes for block walls. Hanger for stud walls shall include full back plate between studs.

Trim: Chicago Faucet HC-631-R modified Combination sink fitting with integral stop arms with GNIA rigid gooseneck spout No. E-3 softflo aerator modified with No. 369 lever handles indexed hot and cold.

Waste: Elkay L-8 2" perforated grid strainer with 1-1/2" O.D. tailpiece chrome plated brass.

Trap: American-Standard 4403.010 Same as F-3.

Item F-3D Lavatory (Exam Rms)

Lavatory: American-Standard 0372.029 18" x 15-7/8" vitreous china, anti splashback, front overflow, less soap depression, left hand hole for soap dispenser.

Support: Same as F-3.

Trim: Chicago Faucet HC 785-E-3 Combination lavatory fitting with No. GNIA rigid gooseneck spout with NO. E-3 softflow aerator and No. 317 wrist blade handles, chrome plated.

Waste: American-Standard 2412.013 Same as F-3.

Item F-3D Lavatory (Exam Rms) (continued)

Trap: American-Standard 4419.016 Same as F-3A

Supplies: Chicago Faucet 441-LK Same as F-3

Soap Dispenser: Bobrick M-8294 Same as F-3.

Item F-3E Lavatory (Exam Room)

Lavatory: American-Standard 0361.055 Same as F-3. Less hole for soap dispenser.

Support: Same as F-3.

Trim: Chicago Faucet HC 745-V0 Knee action double valve with vitreous enamel iron wall bracket and No. 1002 stedi-flo valves polished chrome plated and No. 699 straightway stops.

Supplies: 3/8" O.D. rigid chrome plated supply pipe with wall flange.

Waste: American -Standard 2412.013 Same as F-3.

Trap: American-Standard 4403.010 Same as F-3.

Item-F-3F Lavatory

Lavatory: American-Standard 0493.015 22 x 19 vitreous china self-rimming lavatory; faucet holes 4" centers; double front overflows, template and sealant for countertop installation. Left side to be drilled for soap dispenser.

Trim: Chicago Faucet 1802 Quatern fitting with No. 1000 Handles, 3-3/4" spout, No. E12 softflo.

Waste: American-Standard 2412.013 Lavatory drain; 4" tailpiece; 1-1/2" diameter; integral perforated grid.

Trap: American-Standard 4403.010 Same as F-3.

Supplies: Chicago Faucet 441LK Same as F-3.

Soap Dispenser: Bobrick 8294 Same as F-3.

Item F-3G Lavatory

Lavatory: American-Standard 5300.108 Same as F-3A.

Support: Same as F-3.

Trim: Chicago Faucet HC 104-950 Concealed combination lavatory fitting with NO. E12 aerator; No. 950 handles; coupling nuts, less tailpieces, polished chromium plated.

Waste: American-Standard 2412.013 Same as F-3.

Trap: American-Standard 4419.016 Same as F-3A.

Supply: Chicago Faucet 441LK Same as F-3.

Item F-4 Drinking Fountain (Countertop)

Fountain: Halsey Taylor 10000 Self-rimming, countertop, 16 gauge type 304 stainless steel, NO. 4 satin finish fountain, 13-1/4" diameter.

Trim: Halsey Taylor 3041 Single-stream angle jet projector; combination self-closing push-button type; integral automatic stream control; hood guard; chromium-plated brass; 3/8" I.P.S. connection with 3/8" I.P.S. flexible tube riser with loose key stop.

Waste: Removable grid strainer plate with 1-1/4" tailpiece.

Trap: Adjustable cast brass "P" trap with tubing drain to wall; 1-1/4" inlet and outlet; ground swivel joints; slip inlet with brass coupling nut; cleanout plug. All drain piping to be concealed.

Remote Chiller: Halsey Taylor SJ10A1 Unit shall deliver 9.5 G.P.H. of 50° water at 90° ambient and 80° inlet water. Cabinet shall be one-piece, spot welded, unitized construction. Compressor shall be hermetically sealed, with start capacity. System controlled by primary and secondary thermostats. Cooler shall be certified by A.R.I. Mechanical Contractor to provide all the necessary piping and fittings between the chiller and fountain.

Ventilating Panel: Halsey Taylor 6033 32" x 26" ventilating panel bar-reinforced with prime coat finish.

Item F-4A Electric Water Cooler - (Recessed)

Electric Water Halsey Taylor RC8A Unit shall deliver 8 G.P.H. of 50° water at 90° ambient and 80° inlet water. Top shall be stainless steel, anti-splash design, projector shall be forged brass two-stream; separate valve and diaphragm automatic stream regulator shall be mounted with in cabinet. Compressor shall be hermetically sealed with start capacitor; system controlled by primary and secondary protection thermostats. All stainless steel.

Supply: 3/8" I.P.S. connection with 3/8" I.P.S. flexible tube riser with loose key stop.

Waste Removable grid strainer plate; 1-1/4" O.D. slip connection with 1-1/4" tailpiece.

Trap: American-Standard 4418.018 Adjustable "P" cast brass trap with swivel Ell, 1-1/4" inlet and outlet; ground swivel joint; cleanout; chrome finish. All drain piping to be concealed.

Item F-4B Electric Water Cooler - (Wall Hung)

Electric Water Cooler Halsey Taylor WC7A Unit shall deliver 7 G.P.H. of 50° water at 90° ambient and 80° inlet water; all stainless top and cabinet; two stream mound building projector; right and left hand operation; separate valve and diaphragm automatic stream regulator shall be mounted within cabinet. Compressor shall be hermetically sealed with start capacitor; system controlled by primary and secondary protection thermostats.

Supply: Same as F-4A.

Waste: Same as F-4A

Trap: Same as F-4A.

Item F-5 Janitor Receptor

Receptor: Concrete receptor to be furnished by General Contractor. Floor drain shall be furnished by Mechanical Contractor as specified in Section 15260 for on-grade or above grade installations.

Trim: Chicago 897 Quatern combination sink fitting with vacuum breaker, 3/4" hose thread on spout, No. 369 handles with adjustable wall brace, pail hook and No. 4 1/2" flanged female adjustable arms with integral stops. Polished chromium plated. Center line of faucet to be mounted 48" above floor.

Item F-5A Janitor Receptor

Receptor:

Same as F-5.

Trim: Chicago Faucet
Co. No. 512
(modified)

Wall mounted quatern mixing faucet with vacuum breaker and 1/2" L.P.S. female shanks with integral check stops. Valve inlets on 8" center to center. No. 80 self-closing valve with insulated handle, hold down ring and rubber bound sprayhead; 3/8" I.P.S. Female inlet; No. 83 60" flexible stainless steel hose 3/8" L.P.S. male inlet and outlet. and Hose valve storage hook.

Item-F-6 Sink

Sink: Elkay
LR3322

33" x 22" two compartment, 18 gauge, type 302, self-rim stainless steel sink; 4 faucet holes. Undercoating.

Trim: Chicago Faucet
1102

Classic top mount deck sink fitting with No. L8-8" swing spout; NO. E3 softflow; No. 1000 handles; self-closing thumb control spray with 4 feet of hose. Inlet shanks on 8" centers.

Supplies: Chicago Faucet
442-LK

1/2" I.P. female inlet and outlet angle stops with lock shield cap and No. 293-6 loose key handle. Polished chromium plated.

Waste: Elkay LK-35
Dearborn 100-17

In the left bowl, provide Elkay No. LK-35 standard duo strainer; fits 3-1/2" opening; 4-1/2" top diameter; stainless conical basket with neoprene stopper; C.P. brass; 1-1/2" O.D. tailpiece; Dearborn No. 100-17 1-1/2" 17 gauge disposer kit.

Trap: American-Standard
4403.010

Adjustable "P" cast brass trap with tubing drain to wall; 1-1/2" inlet and outlet; ground swivel joint; cleanout plug; slip inlet; escutcheon; chrome finish.

Disposer: Waste King
3000

1/2 H.P., 115 volt, single phase, 60 cycle

Item F-6A Sink

Sink: Elkay
LR2522

25" x 22" single compartment, 18 gauge, type 302, self-rim stainless steel sink; 4 faucet holes; undercoating.

Trim: Chicago Faucet
Co No 1102

Same as F-6

Supplies: Chicago Faucet
Co. No 442-LK

Same as F-6.

Item F-6A - (continued)

Waste: Elkay LK-35 Standard duo strainer; fits 3-1/2" opening; 4-1/2" top diameter; stainless conical basket with neoprene stopper; C.P. brass; 1-1/2" O.D. tailpiece.

Trap: American-Standard 4403.010 Same as F-6.

Item F-6B Sink

Sink: Elkay LR-1720 17" x 20" single compartment; 18 gauge, type 302, self-rim stainless steel sink; 3 faucet holes; undercoating.

Trim: Chicago Faucet Co. No. HC785-E3 Quatern combination lavatory fitting with No. GNIA-E3 rigid gooseneck spout with No. E-3 softflo outlet.

Supplies: Chicago Faucet Co. No. 442-LK Same as F-6

Waste: Elkay LK-35 Same as F-6A

Trap: American-Standard 4403.010 Same as F-6

Item F-6C Sink

Sink: Elkay EWS 2520-LF 25" x 19-1/2" surgeons scrub-up sink No. 14 gauge stainless steel, type 304. 2 faucet holes; undercoating.

Trim: Chicago Faucet Co. No HC631-R Quatern combination sink fitting with No. 317 4" wrist blade handles; No. GN-1A-E3 rigid gooseneck spout with E3 softflo; No. "R" integral stop arms; polished chromium plated.

Waste: Elkay LK-24-R (modified) S. S. strainer - brass body, roto handle. Handle to be modified so length to be flush with edge of sink.

Trap: American-Standard 4403.010 Same as F-6

Item F-6D Sink

Sink: American-Standard 7655.186 24" x 22" vitreous china pack sink for exposed arms.

Item F-6D - (continued)

Trim: Chicago Faucet Co. No HC631-R (modified) Quatern combination sink fitting with No. 369 lever handles indexed for hot and cold water; No. GN-1A-E3 Rigid gooseneck spout with No. E3 softflo; No. "R" integral stop arms. Polished chromium plated.

Waste: American-Standard 7713.019 Grid drain; 3-1/2" outlet; 1-1/2" tailpiece.

Trap: American-Standard 4419.016 Adjustable P-trap; 1-1/2" inlet and outlet; cast swivel elbow with inside pipe threads.

Carrier: Josam C400-K Single carrier with white enameled arms; leveling and securing screws; square steel pipe uprights and heavy duty plate bases for securing to floor.

Item F-6E Dwyer Unit

Dwyer Unit General Contractor to furnish unit complete with sink, trim, crumb-cup strainer and tailpiece.

Piping Mechanical Contractor to provide waste, vent and water piping.

Supplies: Chicago Faucet 442-LK Same as F-6

Trap: American-Standard 4403.010 Same as F-6

Item F-6F Sink

Sink: Elkay LR1517 15" x 17-1/2" single compartment, 18 gauge, type 302; self-rim stainless steel sink, 1 faucet hole; undercoating.

Trim: Chicago Faucet LC929-GN2B-E3-2 (modified) Double sink fitting with No. GN2B-E3-2 rigid gooseneck spout with No. E3 softflo; No. 317 wrist blade handles.

Supplies: Chicago Faucet Co. No 442-LK Same as F-6

Waste: Elkay LK-35 Same as F-6A

Trap: American-Standard 4403.010 Same as F-6

Item F-7 Shower

Receptor: Furnished by General Contractor. Floor drain shall be furnished and installed by Mechanical Contractor as follows: Josam No. 300-36AK cast iron floor drain with I.P.S. outlet, 1910 deep seal "P" trap with cleanout, flashing clamp and nikaloy strainer.

Trim Powers Hydroguard, Model 425-2255 top outlet for concealed piping. Built-in shut-off valve, liquid-filled thermostatic element, poppet-type mixing valve, screwed-end inlet strainer check stops and 1/2" pipe connections.
Series 420

Shower Head and Volume Control: Powers Shower safety set for concealed piping, self-cleaning shower head with ball joint, separate and spray adjustment complete with arm and flange. All exposed parts polished chrome plated.
Type 55

Provide Powers Type 33 volume control between Hydroguard and Shower head.

Item F-8 Surgical Scrub Station

Scrub Station: Watrous Single position, one-piece heavy gauge stainless steel construction, complete with shower head, solenoid water control valve, water hammer arrestor, soap reservoir and soap dispenser; low voltage touch-on, touch-off, water control switch; touch-on 5 second automatic off surgical soap control switch, non-scald thermostatic water control valve.
W-2011

Supplies: Chicago Faucet 1/2" chrome plated straight stops on 1/2" hot and cold water supply piping.
45LK

Trap: 2" cast brass "P" trap with cleanout; chrome finish.

Carrier: Watrous Chair carrier support.
W-13

Item F-8A Surgical Scrub Station

Scrub Station: Watrous Two position, one-piece heavy gauge stainless steel construction, complete with removable Perspec divider panel, shower heads solenoid water control valves, water hammer arrestor, soap reservoir and soap dispenser; low voltage touch-up, touch-off water control switches; touch-on 5 second automatic off surgical control switches; non-scald thermostatic water control valve.
W-2012

Supplies: Chicago 1/2" chrome plated straight stops on 1/2" hot and cold water supply piping.
45LK

Item F-8A - (continued)

Trap: 2 - 2" cast brass "P" traps with cleanouts, chrome finish.

Carrier: Watrous Chair carrier support.
W-13

Item F-8B Surgical Scrub Station

Scrub Station: Amsco Three position, one-piece heavy stainless steel construction, complete with removable perspex divider panel, showerheads, solenoid water control valves, water hammer arrestor; soap reservoir and soap dispenser; low voltage touch-on, touch-off water control switches; touch-on 5 second automatic off surgical control switches; non-scauld thermostatic water control valve.
Model CE-11
or
Market Forge
SS10-3

Supplies: Chicago 1/2" chrome plated straight stops on 1/2" hot and cold water supply piping.
45LK

Trap: 3 - 2" cast brass "P" traps with cleanouts, chrome finish.

Support: Integral support brackets.

Item F-9 Emergency Shower and Eyewash

Emergency Shower

Trim: Speakman Wall mounted lifesaver emergency shower complete with 8" diameter deluge shower head with 1" inlet and 1" I.P.S. self-closing valve with chain pull ring, wall flange and interconnecting fittings.
SE231

Eye/Face Wash

Trim: Speakman Wall mounted aerated eye/face wash complete with mounting brackets; stay-open ball valve activated by push handle; stainless steel bowl; strainer and 1-1/2" O.D. tailpiece.
SE400

Supply: Chicago Faucet 1/2" I.P. female inlet and outlet angle stop with lock shield cap and No. 293-6 loose key handle. Polished chromium plated.
442-LK

Trap: American-Standard Adjustable "P" cast brass trap with tubing drain to wall; 1-1/2" inlet and outlet; ground swivel joint; cleanout plug; slip inlet; escutcheon; chrome finish.
4403.044

Item F-10 Flushing Device-Flush Rim Floor Drains

Trim: N.C.G. Shut-off valve box assembly with N.C.G. No. 480222-64, 1" ball valve for cold water with copper tube extensions. Valve box shall be 18 gauge sheet steel with 18 gauge steel cover with satin chromed finish. Centerline of cold water supply 42" above floor. Handle of valve to be indexed for "water flushing."

Item F-10A Flushing Device-Flush Rim Floor Drains

Trim: N.C.G. Shut-off valve box assembly with N.C.G. No. 480223-64, 1-1/4" ball valve for cold water with copper tube extensions. Valve box shall be 18 gauge sheet steel with 18 gauge steel cover with satin chromed finish. Centerline of cold water supply 42" above floor. Handle of valve to be indexed for "water flushing".

Item F-10B Flushing Device-Flush Rim Floor Drains

Trim: N.C.G. No. Shut-off valve box assembly with NCG. No. 480224-64, 1-1/2" ball valve for cold water with copper tube extensions. Valve box shall be 18 gauge steel cover with satin chromed finish. Centerline of cold water supply 42" above floor. Handle of valve to be indexed for "Water Flushing".

Item F-11 Mixing Faucet

Trim: Chicago Faucet Combination service sink fitting with vacuum breaker; 3/4" hose thread on spout; No. 369 897 handles; wall brace, pail hook; No. "R" 1/2" flanged female adjustable arms with integral stops. Polished chromium plated.

Item F-11A Single Faucet-Lasser Unit

Trim: Chicago Faucet Single sink fitting with 892 1/2" vacuum breaker LC1300 less E7X-T. Centerline of supply 40" above floor. (modified)

Filter: Cuno Water filter with cartridge for 1/2" piping. IMI-40069-01

Standpipe: Josam 3" diameter x 7" high brass standpipe threaded to 35L3 fit into 3" P-trap.

Trap: Josam Cast iron deep seal "P" trap with 3" I.P.S. female 1913 top inlet and female side outlet. Trap to be concealed in stud space of wall. Access panel for trap to be furnished by the General Contractor. Centerline of waste above floor 16".

Item F-11B Single Faucet

Trim: Chicago Faucet
952-633

Inside sill faucet with vacuum breaker; 3/4" hose thread outlet with lock shield cap; No. 633 four-arm metal cross handle indexed for cold water; inlet 3/4" flanged female I.P.S. polished chromium plated.

Item F-12 Hose Stations

Hose Station: El-Mikro-Spray
Model C-3

Unit shall consist of head assembly with injector body and mounting plate; check valve, vacuum breaker; inner co-axial hose, fluted ring nut; reservoir assembly; product strainer assembly; nozzle - 3/4" FH, hose hanger; 50 feet of 5/8" hose 16" wide x 17" high heavy gauge stainless steel mounting plate; interconnecting piping from reservoir to head assembly. All items mentioned above shall be a complete package supplied by one manufacturer.

Mixing Faucet: Chicago Faucet
767-8
(modified)

Classic built-in two valve with No. 633 handles less shower head, shower arm and wall flange. Provide wall flanges for handles and piping from valve body to reservoir assembly.

Item F-13 Thermostatic Mixing Valve

Valve: Lawler Series
66

Valve No. 66-50 having a capacity of 18 gpm with a pressure drop of 5 P.S.I. across the valve. Valve shall be complete with union end angle stops with checks and strainers; temperature adjustment knob with temperature setting of 110°F., thermometers on the mixed water outlet and incoming hot water piping. Shut-off valves on inlet and outlet piping; shut-off valves on recirculating piping before and after circulating pump and check valve on recirculating line.

Recirculating Pump :

See Section 15220.

Item F-13A Thermostatic Mixing Valve-Radiology Dept.

Valve Powers Series
440-1500.
Calumet WRP

Fotoguard for exposed piping complete with vernier controls; integral volume control; union strainers with checkstops, thermometer shut-off valves. See riser diagram for detail. Polished chrome plated.

Filters: Cuno
E1028DC

Superlife water filters with cartridges for 1/2" piping.

Item F-13A Thermostatic Mixing Valve-Radiology Dept. (continued)

Hose: Chicago Faucet Co. No 860-SB Eight foot flexible stainless steel hose 3/8" male I.P.S. inlet with 1/2" I.P.S. male adapter; self-closing valve with insulated handle, hold down ring and plain end bent spout; No. 853 wall hook.

Piping: Exposed piping to be chromium plated.

Item F-14 Clinical Service Sink

Clinic Service Sink : American-Standard 9504.010 20" x 28" clinic service sink; siphon jet flushing action, flushing rim; vitreous china; 1-1/2" brass top spud; 4" floor outlet. Stainless steel bolt cover plates.

Flush Valve: Sloan Royal 117H0(1") Quiet exposed service sink flush valve with 1" offset, chrome plated, metal oscillating non-hold open handle; 1" I.P.S. screw driver bak-chek angle stop with protective cap; adjustable tail-piece, vacuum breaker flush connection and spud coupling for 1-1/2" top spud; wall and spud flanges. Centerline of valve 38" above floor.

Trim Chicago Faucet Co. NO. 814 Quatern double service sink fitting with No. 319 6" wrist blade handles. No. "R" integral stop arms; No. EX2 2" extension pieces stationary mixing spout with plain outlet, pail hooks and wall brace below spout attaching to flush pipe strap for 1-1/2" O.D. flush pipe.

Waste: American-Standard 7847.015 Cast metal loose strainer

Rim Guards: American-Standard 7832.017 Stainless steel spring type rim guards for front and sides.

Item F-15 Aspirator - Procto Rooms

Aspirator: Kohler K-13837 (modified) Concealed aspirator with horizontal ejector for 3/8" hose; control valve with four arm handle and 3/8" I.P.S supply. 1/2" I.P.S. vacuum breaker (modified) to be located within cabinet; 2" O.D. Tub-receptor with open bonnet inlet connection and 1-1/2" O.D. outlet tailpiece.

Trap: Kohler K-9007 1-1/2" cast brass adjustable P-trap with cleanout 10" long I.P.S. nipple and flange.

Cabinet:
(recessed) 20" wide x 22" high x 4" deep inside white baked enamel finish 18 gauge steel recessed cabinet with sound insulated door hinge and handle. Provide drilling in door for hose.

Item F-16 Indirect Waste - Coulter Counter

- Trap Josam No. Brass primer valve with automatic vacuum breaker
Primer: 1465 For installation in cold water service to a plumbing fixture and connection to P-trap.

- Air Gap: Josam No. Cast iron fitting with air gaps, threaded inlet
1800-1 and outlet. Provide 1" to 1/4" threaded bushing for 1" threaded inlet on air gap.

- Primer Connection: Josam No. Cast iron body male inlet; female outlet, 1/2"
1462 I.P.S. primer connection.

- Trap: Josam No. Cast iron deep seal "P" trap with female top inlet
1912 female side outlet and bottom cleanout with cast iron plug.

Item F-17 Floor Sink

- Floor Sink: American-Standard 6" deep floor sink with Removable flat strainer,
7764.095 acid-resisting enameled cast iron 4-3/4" outlet for 4" caulk drain; No. 7767.015 enameled cast iron full grate.

- Trap: Josam No. 4" cast iron deep seal trap with female top inlet,
1910 female side outlet with cleanout.

Item F-17A Floor Sink

- Floor Sink: American-Standard 6"deep floor sink with removable flat strainer,
7764.038 acid-resisting enamel cast iron 2-1/2" outlet for 2" caulk drain.

- Trap: 2" cast iron soil P-trap.

Item 18 Disposal Unit

- Disposal Unit : GARB-EL Series Free standing 7-1/2 H.P. unit enclosed with a
AL73-S - 7-1/2 H.P. stainless steel top and sides, pre-plumbed and pre-wired; case hardened steel hammers, large hopper, automatic feed. Provide stainless steel cover over hopper and neoprene edging around counter-top of disposer. Unit to be complete with spray unit, vacuum breaker and interlocking piping.

- Trap: Josam No. 4" cast iron deep seal trap with female top inlet,
1910 female side outlet with clean. Provide 2" vent piping and install discharge piping as recommended by manufacturer.

- Piping: Provide 1" laboratory cold water piping to unit.

Item F-19 Trench Sprays

Spray
Nozzle:

Spraying Systems Co. Veejet Nozzle No. H 1/4U2530, type 316 stainless steel. Flat spray pattern, 32° spray angle, 4.2 GPM at 80 PSI, 1/4" n.p.t. Nozzles shall be mounted in 1/4" x 1/4" SS stamped flange adjustable joint (Spraying Systems Co.) Mount all adjustable joint and nozzle combinations 1-1/2" from trench bottom to center line. Provide type 316 stainless steel pipe and tees for nozzle extensions. See Drawing Detail.

Globe
Valve:

1" globe valve, chrome plated exposed on wall.

Piping:

Piping exposed on wall to be chrome plated.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the furnishing, installation and connection of all laboratory fixtures and trim as located on the drawings and scheduled herein including all piping, sleeves, valves, stops, sinks, and sink and laboratory fixtures and trim furnished under other sections or furnished by the Owner.
- C. Related work specified elsewhere:
1. Laboratory Casework: Section 11610 and 11620.
 2. Basic Materials and Methods: Section 15100.
 3. Mechanical Systems Insulation: Section 15160.
 4. Plumbing Fixtures and Trim: Section 15300.
- D. Connected but not furnished or installed under this section:
1. All fixtures identified herein with "LX" and "LXFH" numbers. The trim, traps, supplies, rough-in and final connections to the fixtures, however, shall be provided and installed by Mechanical Contractor as scheduled herein.
 2. All fixtures furnished by the Owner as identified on the drawings.

PART 2: PRODUCTS

2.1 LABORATORY FIXTURES

- A. The fixtures schedules refer to fixture numbers noted on the drawings.
- B. All sink supplies shall be supplied with loose key stops.
- C. This Contractor will furnish and install composition sinks and seal sinks to underside of table top with an acid-proof, waterproof compound, Johns-Manville Company "Vorseal", or approved equal. All supports for sinks in metal cabinets will be furnished by the General Contractor. This Contractor shall provide the General Contractor with dimensional data for support of sinks in metal cabinets.
- D. Exposed water piping at fixtures shall be iron pipe size, chromium plated brass pipe.

E. Sinks, composition material shall be Durcon 2A as manufactured by Duriron Company, Inc., Kemresin by Kewaunee Manufacturing Company, or approved equal. Durcon numbers are scheduled.

F. Where stainless steel sinks are specified they shall have underside sound deadened, and for counter installations shall be self rim type.

G. Stainless steel sinks shall be furnished with holes to receive trim as herein specified.

2.2 SCHEDULE OF LABORATORY FIXTURES

Item L-1A

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR2222
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 7-1/2"D
Trim: Type 'A' (see Item 2.3 Laboratory Trim following)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece. 316 stainless.
Trap: Kimax 6700, 2" x 1-1/2" swivel "P" trap with 6655 adapter coupling

Item L-2A

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR2222
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 7-1/2"D
Trim: Type 'A' (see Item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece. Cast brass tubing to trap and wall, chrome plated.
Trap: Josam H-32 cast aluminum sediment interceptor

Item L-3B

Type of Fixture: Sink, double compartment
Manufacturer's No: Elkay MDLR 4322-10
Material: Stainless steel type 316, 18 gauge
Size: 43"L x 22"W x 10"D overall
Trim: Type 'B' (see item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece each compartment
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.
Provide continuous waste.

Item L-4A

Type of fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1922
Material: Stainless steel type 316, 18 gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'A' (see item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Item L-5B

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MDLR2522-10
Material: Stainless steel type 316, 18 gauge
Size: 25"L x 22"W x 10"D
Trim: Type 'B' (see item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece. Cast brass tubing to trap and wall. Chrome plated
Trap: Josam H-32 cast aluminum sediment interceptor

Item L-6C

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR1720
Material: Stainless steel type 316, 18 gauge
Size: 17"L x 20"W x 7-1/2"D
Trim: Type 'C' (see item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-7D

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR1922
Material: Stainless steel type 316, 18 gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'D' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-8A

Type of Fixtures: Sink, single compartment
Manufacturer's No: Elkay MDLR1722-10
Material: Stainless steel type 316, 18 gauge
Size: 17"L x 22"W x 10"D
Trim: Type 'A' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-9A

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MDLR2222-10
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 10"D
Trim: Type 'A' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Item L-10E

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MDLR2222-10
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 10"D
Trim: Type 'E' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-11F

Type of Fixture: Sink, single compartment with drainboard
Manufacturer's No: Elkay MW-NSF-8130-54R
Material: Stainless steel type 316 14 gauge
Size: 30"L x 18"W x 12"D
Trim: Type 'F' (See item 2.3)
Waste: Elkay LK-372 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-12G

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 25
Material: Composition
Size: 18"L x 15"W x 8"D
Trim: Type 'G' (See item 2.3)
Waste: Durcon No. SO-3 sink outlet, with Kimax 6728-1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling

Item L-13H

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon NO. 35
Material: Composition
Size: 21"L x 18"W x 10"D
Trim: Type 'H' (See item 2.3)
Waste: Durcon No. SO-3 sink outlet with Kimax 6728-1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-14 I

Type of Fixture: Sink single compartment
Manufacturer's No: Durcon No. 35
Material: Composition
Size: 21"L x 18"W x 10"D
Trim: Type I (See item 2.3)
Waste: Durcon No. SO-3 sink outlet with Kimax 6728-1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-15 I

Type of Fixture: Sink, single compartment

Manufacturer's No Durcon NO. 55

Material Composition

Size: 25"L x 15"W x 10"D

Trim: Type I (See item 2.3)

Waste: Durcon NO. SO-3 sink outlet with Kimax 6728-1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling

Item L-16J

Type of Fixture: Cup sink, oval

Manufacturer's No Durcon CS4

Material: Composition

Size: 3" x 6"

Trim: Type J (See item 2.3)

Waste: Kimax NO. 6728-1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-17G

Type of Fixture: Sink, single compartment

Manufacturer's No: Elkay MDLR 2222-10

Material: Stainless steel Type 316, 18 gauge

Size: 22"L x 22"W x 10"D

Trim: Type 'G' (See item 2.3)

Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-18B

Type of Fixture: Sink, single compartment

Manufacturer's No: Durcon No. 30

Material: Composition

Size: 18"L x 15"W x 11"D

Trim: Type 'B' (See item 2.3)

Waste: Durcon No. SO-3 sink outlet with Kimax 6728-1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-19B

Type of Fixture: Sink, single compartment

Manufacturer's No Durcon No. 35

Material: Composition

Size: 21"L x 18"W x 10"D

Trim: Type 'B' (See item 2.3)

Waste: Durcon No. SO-3 sink outlet with Kimax 6728-1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-20J

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 3122
Material: Stainless steel type 316, 18 gauge
Size: 31"L x 22"W x 7-1/2"D
Trim: Type J (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-21S

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1922
Material: Stainless steel type 316, 18 gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'J' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-22K

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 2222
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 7-1/2"D
Trim: Type 'K' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-23L

Type of Fixture: Sink, two compartment
Manufacturer's No: Elkay MDLR 4322-10
Material: Stainless steel
Size: 43"L x 22"W x 10"D
Trim: Type 'L' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless, each compartment.
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.
Provide continuous waste.

Item L-24G

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1922
Material: Stainless steel type 316, 18 gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'G' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Item L-25M

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1922
Material: Stainless steel type 316, 18 gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'M' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-26C

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1922
Material: Stainless steel type 316, 18 Gauge
Size: 19"L x 22"W x 7-1/2"D
Trim: Type 'C' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-27G

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MLR 1517
Material: Stainless steel type 316, 18 gauge
Size: 15"L x 17"W x 7-1/2"D
Trim: Type 'G' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-28C

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 50
Material: Composition
Size: 24"L x 16"W x 8"D
Trim: Type 'C' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling

Item L-29C

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 61
Material: Composition
Size: 30"L x 18"W x 18"D
Trim: Type 'C' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-30P

Type of Fixture: Sink, double compartment
Manufacturer's No: Durcon 2-No. 25
Material: Composition
Size: 18"L x 15"W x 8"D each compartment 38"L x 16"W overall
Trim: Type 'P' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly each compartment
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.
Provide continuous waste.

Item L-31Q

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon NO. 25
Material: Composition
Size: 18"L x 15"W x 8"D
Trim: Type 'Q' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.
Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item L-32R

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 25
Material: Composition
Size: 18"L x 15"W x 8"D
Trim: Type 'R' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-33S

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 25
Material: Composition
Size: 18"L x 15"W x 8"D
Trim: Type 'S' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet, with Kimax 6728, 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling

Item L-34R

Type of Fixture: Sink, single compartment
Manufacturer's No: Durcon No. 25
Material: Composition
Size: 18L x 15"w x 8"D
Trim: Type 'R' (See item 2.3)
Waste: Durcon No. S0-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-35T

Type of Fixture: Sink, single compartment

Manufacturer's No: Durcon NO. 25

Material: Composition

Size: 18"L x 15"W x 8"D

Trim: Type 'T' (See item 2.3)

Waste: Durcon NO. SO-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-36C

Type of Fixture: Sink, single compartment

Manufacturer's No: Elkay MLR 1517

Material: Stainless steel type 316, 18 gauge

Size: 15"L x 17"W x 7-1/2"D

Trim: Type 'C' (See item 2.3)

Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless.

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Item L-37U

Type of Fixture: Sink, double compartment

Manufacturer's No: Elkay MLR 3722

Material: Stainless steel type 316, 18 gauge

Size: 37"L x 22"W x 7-1/2"D

Trim: Type 'U' (See item 2.3)

Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless. Each compartment

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling. Provide a continuous waste.

Item L-38G

Type of Fixture: Sink, single compartment

Manufacturer's No: Elkay, MLR 1517

Material: Stainless steel type 316, 18 gauge

Size: 15"L x 17"W x 7-1/2"D

Trim: Type 'G' (See item 2.3)

Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-39V

Type of Fixture: Sink, single compartment

Manufacturer's No: Durcon No. 50C

Material: Composition

Size: 24"L x 16"W x 8"D

Trim: Type 'V' (See item 2.3)

Waste: Durcon No. SO-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-40J

Type of Fixture: Trough
Manufacturer's No: Durcon Style. T-1, Section 3. Countersunk for
Drain outlet in center.
Material: Composition
Size: 5'-0"L x 7-5/8"W x 5"D
Trim: Type 'J' (See item 2.3)
Waste: Durcon NO. SO-3 sink outlet with Kimax 6728, 1-1/2" tailpiece assembly
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-41Z

Type of Fixture: Sink, single compartment with drainboard
Manufacturer's No: Elkay M 8100L
Material: Stainless steel type 316, 14 gauge
Size: 18"L x 20"W x 8"D
Trim: Type 'Z' (See item 2.10)
Waste: Elkay LK 372 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-42Z

Type of Fixture: Sink, single compartment with drainboard
Manufacturer's No: Elkay M 8100R
Material: Stainless steel type 316, 14 gauge
Size: 18"L x 20"W x 8"D
Trim: Type 'Z' (See item 2.3)
Waste: Elkay LK-372 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-43C

Type of Fixture: Sink, single compartment
Manufacturer's No: Elkay MDLR 2222-10
Material: Stainless steel type 316, 18 gauge
Size: 22"L x 22"W x 10"D
Trim: Type 'C' (See item 2.3)
Waste: Elkay LK-337 strainer with 1-1/2" tailpiece, 316 stainless
Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Item L-44

Type of Fixture: Hose Reel
Manufacturer's No: 2 - N.C.G. 669002-64
Type: Air, vacuum, oxygen, nitrous oxide
Mounting: Ceiling outlet-stainless steel face plate
Remarks: Outlets on each plate to be labeled.
"AIR" AND "VACUUM"
"OXYGEN" AND "NITROUS OXIDE"

Item L-45

Type of Fixture: Hose reel

Manufacturer's No: NCG 669008-64

Type: Two-vacuum

One-oxygen

One-nitrogen

Mounting: Ceiling outlet with stainless steel face plates

Remarks: Outlets on plate to be labeled.

"VACUUM" AND "VACUUM"

"OXYGEN" AND "NITROGEN"

Item L-46

Type of Fixture: Hose reel (ceiling outlet with hose assembly and reel type retractor kit)

Manufacturer's No: Ohio Medical Products 221 - 7805 - 885 DISS ceiling outlet.

Ohio 231 3209 - 815 upper hose assembly Ohio 221 - 5990 - 800 reel type retractor kit

Type: Nitrogen

Mounting: Ceiling outlet

Remarks: Outlet on plate to be labeled "Nitrogen"

Item L-XIB

Type of Fixture: Sink, double compartment

Manufacturer's No: See Section 11610.

Material: Stainless steel

Trim: Type 'B' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X2

Type of Fixture: Nourishment station, single compartment sink

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: See Section 11610

Waste: See Section 11610

Trap: American Standard 4403.010 1-1/2" adjustable cast brass P-trap, tubing drain to wall, cleanout plug

Supplies: Chicago Faucet No. 442-LK 1/2" polished chrome plated angle stops. Loose key handle

Item L-X3C

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'C' (See item 2.3)

Item L-X3C (continued)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies

Item L-X4

Type of Fixture: Photography sink single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: See Section 11610

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies

Item L-X5N

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'N' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling. Provide continuous waste.

Supplies: Chicago Faucet No. 445 LK 1/2" chrome plated angle stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X60

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'O' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling. Provide continuous waste.

Supplies: Chicago Faucet No. 445 LK 1/2" chrome plated angle stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies

Item L-X7R

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'R' (See item 2.3)

Item L-X7R (continued)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X8T

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'T' (See Section 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X9

Type of Fixture: Photo Processing Sink

Manufacturer's No See Section 11610

Trim: See Section 11610

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X10

Type of Fixture: Print washers and sink

Manufacturer's No See Section 11610

Trim: See Section 11610

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item LX-11

Type of Equipment: Glasswasher

Manufacturer's No: See Section 11610

Waste: 2" I.P.S. waste piping from unit to floor sink

Remarks: Glasswasher is complete with all component parts within unit. Mechanical Contractor is to provide air piping with pressure reducing valve set at at 50 psi, 180° hot water piping. Provide chrome plated straight stops on all supplies.

Item L-X12W

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'W' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45 LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X13X

Type of Fixture: Sink Double compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'X' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling. Provide continuous waste.

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X14Y

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'Y' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling. Provide continuous waste.

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X15AA

Type of Fixture: Sink, double compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'AA' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X16

Type of Equipment: Glasswasher

Manufacturer's No: See Section 11610

Item L-X16 (continued)

Waste: 2" I.P.S. waste piping from unit to 'P' trap

Trap: 2" cast iron 'P' trap, vented, with cleanout

Remarks: Glass washer is complete with all component parts within unit.

Mechanical Contractor is to provide air piping with pressure reducing valve set at 50 psi, 180° hot water piping and distilled water piping to unit.

Provide chrome plated straight stops on all supplies.

Item LX17

Type of Fixture: Bottle filling station

Manufacturer's No: See Section 11610

Waste: See Section 11610

Trap: Adjustable 'P' cast brass trap with tubing drain to wall, 1-1/2" inlet and outlet ground swivel joints, cleanout plug, slip inlet with brass coupling nut, escutcheon, chrome finish.

Remarks: Unit is complete with filler and manifold header and water fill valve. Mechanical Contractor is to provide cold water piping and stop on supply piping and make the necessary connections where required.

Item L-X18AA

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'AA' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item LX19

Type of Equipment: Cage washer

Manufacturer's No: See Section 11610

Waste: 3" galvanized waste piping from pump to 'P' trap.

Trap: 3" cast iron 'P' trap, vented with cleanout

Remarks: Cage washer is provided with pump, water and air connection.

Mechanical Contractor is to provide air piping with pressure reducing valve set at 30 psi, 180° hot water and cold water piping and make necessary connections where required. Provide chrome stops on all supplies.

Item L-X20BB

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'BB' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item L-X21CC

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'CC' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling

Supplies: Chicago Faucet No. 45LK 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item LX22

Type of Equipment: Print Washer

Manufacturer's No: See Section 11610

Trim: Mesur-flow with unit-gate valve and piping by Mechanical Contractor.

Waste: See Section 11610

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with No. 6655 adapter coupling.

Item LX23

Type of Equipment: Film processor

Manufacturer's No: See Section 11610

Trim: Thermostatic mixing valve and temperature gauge to be furnished with unit; shut-off valve, check valve and piping by Mechanical Contractor.

Filters: By Mechanical Contractor: Cuno superlife No. E1028 DC hot and cold water filters and cartridges.

Item LX24

Type of Equipment: Electron microscope-existing relocated.

Manufacturer's No: See Section 11610

Trim: Existing trim to be reused. Shut-off valves, copper chilled water supply and return piping by Mechanical Contractor. Valves to be located at chiller and microscope. Chiller by Owner. Mechanical Contractor to provide adapters or shoulders on copper piping for connections to hoses on chiller and microscope.

Waste: 3" floor drain with 1-1/2" vent.

Item LX25

Type of Equipment: Electron Microscope

Manufacturer's No: See Section 11610

Trim: Regulators, gauges and filters to be furnished with unit. The chiller to be furnished by Owner. Shut-off valve at chiller and microscope, copper chilled water supply and return piping by the Mechanical Contractor. Mechanical Contractor to provide adapters or shoulders on copper piping for connections to hoses on chiller and microscope.

Waste: 3" floor drain with 1-1/2 vent.

Item LX26

Type of Equipment: Photo processing sink

Manufacturer's No: None. Unit furnished by Owner.

Item LX26 - (continued)

Trim: Thermostatic mixing valve, faucets, strainer tailpiece, filters and other trim to be furnished with unit.

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with No. 6655 adapter coupling.

Item LX27

Type of Equipment: Animal necropsy table.

Manufacturer's No: See Section 11610

Trim: Waste disposer and trim to be furnished with unit.

Supply: 3/4" cold water and 1/2" hot water by Mechanical.

Waste: 2" cast brass adjustable P-trap with cleanout with 1-1/2" vent.

Stainless Steel Jacket: Stainless steel jacket for vent and water piping by General Contractor.

Item LX28

Type of Equipment: Ice maker

Manufacturer's No: See Section 11610

Trim: Shut-off valve and water piping by Mechanical Contractor.

Waste: 2" floor drain with funnel to receive ice maker waste.

Item LX-29DD

Type of Fixture: Sink, single compartment

Manufacturer's No: See Section 11610

Material: Stainless steel

Trim: Type 'DD' (See item 2.3)

Waste: See Section 11610

Trap: Kimax 6700 2" x 1-1/2" Swivel P-trap with 6655 adapter coupling.

Supplies: Chicago faucet No. 45KL 1/2" chrome plated straight stops with 1/2" I.P.S. chrome plated deep escutcheons with 1/2" chrome plated rigid supplies.

Item LXFH1

Type of Equipment: Fume Hood

Manufacturer's No: See section 11610

Sink: Item L31-Q

Fittings and Controls Chicago Faucet Gas, air, vacuum, steam: LC 962-CO-GA-986-E7 wall flange outlet, LC962-VO-SA with LC986-E7X-7 wall flange outlet with 937-2 black handle. all handles to be indexed for service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH2

Type of Equipment: Fume Hood

Manufacturer's No: See Section 11610

Sink: See Section 11610

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Item LXFH2 - (continued)

Fittings and Controls: Chicago Faucet

Water: Two LC 962-VO indexed for hot water and cold water modified for mixing water consisting of valve body, LC900GN2B-E7 spout and nozzle.

Gas, Air, Vacuum, Steam: LC962-VO-GA-986-E7 wall flange outlets. LC962-VO-GA with LC986-E7X-T wall flange outlet with 937-2 black handle. All handles to be indexed for service used.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH3

Type of Equipment: Fume hood

Manufacturer's No: See Section 11610

Sink: See Section 11610

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Fittings and Controls: Chicago Faucet

Water: Two LC962 VOA, each indexed cold water and two LC900-GN2B-E7 spout and nozzles

Gas, air, vacuum: LC962-VO-GA-986-E-7 wall flange outlet, indexed for service

Nitrogen: LC962-VO-GA-986-901 wall flange outlet, needle point cock, indexed for service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH4

Type of Equipment: Fume hood

Manufacturer's No: See Section 11610

Sink: See Section 11610

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adapter coupling.

Fittings and Controls: Chicago Faucet

Water: LC962VOA indexed for cold water and LC900-GN2B-E7 spout and nozzle

Gas, air, vacuum: LC962-VO-GA-986-E7 wall flange outlets, indexed as to service.

Nitrogen: LC962-VO-GA-987-F-901 wall flange outlet, two needle point cocks, indexed for service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH5

Type of Equipment: Fume hood

Manufacturer's No: See Section 11610

Sink: See Section 11610

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kiax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Fittings and Controls: Chicago Faucet

Water: LC962VOA indexed for cold water and LC900-GN2B-E7 spout and nozzle

Item LXFH5 - (continued)

Gas, air, vacuum: LC962-V0-GA-986-E7 wall flange outlets, indexed as to service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH6

Type of Equipment: Fume hood

Manufacturer's No: See Section 11610

Sink: See Section 11610

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Fittings and Controls: Chicago Faucet

Water: LC962-VOA indexed for cold water and LC900-GN2B-E7 spout and nozzle.

Gas, air, vacuum: Two sets of each, LC962-V0-GA-986-E7 wall flange outlets, indexed as to service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish.

Item LXFH7

Type of Equipment: Fume hood

Manufacturer's No: See Section 11610

Sink: Cup sink L-16

Waste: Kimax 6728, 1-1/2" tailpiece assembly

Trap: Kimax 6700, 2" x 1-1/2" swivel 'P' trap with 6655 adaptor coupling.

Fittings and Controls: Chicago Faucet

Water: LC962-VOA indexed for cold water and LC988-GN2B-E7 angle base spout and nozzle

Gas, air, vacuum: LC962-V0-GA-986-E7 wall flange outlets, indexed as to service.

Remarks: All fittings exposed within fume hoods shall be coated with aluminum bronze epoxy finish

2.3 LABORATORY TRIM

A. Index Buttons: All brass furnished shall be identified with a color coded plastic index button on the fixture handle as herein scheduled and noted under the particular fixture number that call for cross arm or wheel handles.

<u>Service</u>	<u>Lettering and Color</u>	<u>Button Color</u>
Cold water	CW-White	Green
Hot water	HW-White	Red
Gas	GAS-White	Blue
Air	AIR-White	Orange
Vacuum	VAC-White	Yellow
Distilled water	DW-Black	White
Steam	STEAM-White	Black
Oxygen	OXY-Black	Orange
Nitrogen	N-Black	Gray

B. Faucet trim shall be specialized laboratory design with three arm or four arm handles and plastic index buttons indicating the type of service. •Furnish deck type, wall type goosenecks where scheduled. All working parts that move in water including seat, lower stem, washer retained and nut shall be of monel metal to insure maximum resistance to corrosion and abrasion. Entire working unit shall be removable and interchangeable with any other faucet on laboratory equipment and shall be held in place by a cap nut, housing, conical packing and brass packing washer. Removable unit shall be readily convertible to self-closing type without disturbing permanent installation of the fixtures. All faucets shall be slow compression type and close with pressure. All faucets shall have female outlets so designed to take a standard 3/8" filter pump and/or an anti-splash spout and without the use of intermediate fittings. All sink faucets shall be furnished with Chicago Faucet, or equal, No. 441LK stops. All sink faucets shall be polished chrome plated unless otherwise specified.

C. Distilled water faucets shall be Chicago Faucet with heavy silver plating on inside and a Butler silver plating on outside, cross index handles, self-closing units.

D. All outlets, cocks and inlet shanks shall be furnished and installed with rough-in and final connections, as a portion of the mechanical contract, unless otherwise noted.

E. This Contractor shall check countertop material for installation of lab outlets as they vary from lab to lab.

F. Laboratory trim located on laboratory casework shall be as scheduled. For locations see drawings. Numbers listed are Chicago Faucet, or approved equal.

2.4 LABORATORY TRIM SCHEDULE

Item 'A'

Manufacturer's No. (Faucet): 786-GN2B-E3-2 combination hot and cold water mixing faucet with wrist blade handles, 10" tall rigid gooseneck and softflow aerator outlet with adaptor.

Item 'B'

Manufacturer's No. (Faucet): 786-L9-E3-2 combination hot and cold water mixing faucet with wrist blade handles, 9-1/2" tall swinging spout with softflow aerator outlet with adaptor.

Item 'C'

Manufacturer's No. (Faucet): LC 931-L7-E3-2 combination hot and cold water mixing faucet with four arm handles indexed as to service, 7-5/8" tall swinging spout with softflow aerator outlet with adaptor.

Item 'D'

Manufacturer's No. (Faucet): LC 946-L7-E3-2 combination hot and cold water mixing faucet with four arm handles indexed as to service, 7-5/8" swinging spout with softflow aerator outlet with adaptor.

Item 'E'

Manufacturer's No. (Faucet): 786-GN2B-H13-E3-2 combination hot and cold water mixing faucet with wrist blade handles, 13" tall rigid gooseneck spout with softflow aerator outlet with adaptor.

Item 'F'

Manufacturer's No. (Faucet): LC 970 back mounted single faucet for distilled water with four arm handle indexed as to service, 10" tall gooseneck with serrated nozzle outlet.

Manufacturer's No. (Faucet): 629-GN2A-E3-2 Single spout back mounted for cold water, 10" tall gooseneck modified swing spout with softflow aerator outlet with adaptor.

Manufacturer's No. (Pedal Valve): No. 625 Double pedal valve, mixing type, chrome plated finish.

Item 'G'

Manufacturer's No. (Faucet): LC929-GN2B-E3-2 combination hot and cold water mixing faucet with four arm handles indexed as to service with 10" tall gooseneck modified to swing and softflow aerator outlet with adaptor.

Manufacturer's No. (Faucet): LC969 single faucet for distilled water, with four arm handles indexed as to service, 10" tall rigid gooseneck and serrated nozzle outlet.

Item 'H'

Manufacturer's No. (Faucet): LC985-A-GN2B-E3-2 single faucet for hot and cold water, high turret with 10" tall gooseneck modified to swing and softflow aerator outlet with adaptor.

Manufacturer's No. (Valve) : No. 625 floor mounted double pedal valve indexed for hot and cold water service, chrome plated.

Item 'I'

Manufacturer's No. (Faucet): LC 931-GN2B-E3-2 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" high rigid gooseneck and softflow aerator outlet with adaptor.

Manufacturer's No. (Faucet): LC 969 single faucet for distilled water with four arm handle indexed as to service, 10" high rigid gooseneck and serrated nozzle outlet.

Item 'J'

Manufacturer's No. (Faucet): LC 927-GN2B-E7 single faucet for cold water with four arm handles indexed as to service, 10" high rigid gooseneck and serrated nozzle outlet.

Item 'K'

Manufacturer's No. (Faucet): LC 946-L9-317-E-3-2 combination hot and cold water mixing faucet with wrist blade handles, 9-1/2" swinging spout with softflow aerator outlet with adaptor.

Item 'L'

Manufacturer's No. (Faucet): LC 946-GN2B-317-E3-2 combination hot and cold water mixing faucet with wrist blade handles, 10" tall gooseneck modified with swinging spout, softflow aerator outlet with adaptor.

Item 'M'

Manufacturer's No. (Faucet): HC 786 combination hot and cold water mixing faucet with wrist blade handles, 10" tall rigid gooseneck with rose spray outlet.

Item 'N'

Manufacturer's No. (Faucet): LC 931-L7-E3 combination hot and cold water mixing faucet with four arm handles indexed as to service, 7-5/8" swing spout with softflow aerator outlet.

Manufacturer's No. (Faucet): LC 927-GN2B-E3-2 single faucet for cold water with four arm handles indexed as to service, 10" tall rigid gooseneck with softflow aerator outlet with adaptor.

Item 'O'

Manufacturer's No. (Faucet): LC 933-GN2B-E3-2 single faucet for cold water with four arm handle indexed as to service, 10" tall rigid gooseneck with softflow aerator outlet with adaptor.

Manufacturer's No. (Faucet) LC 953-S4-E3 combination hot and cold water mixing faucet with four arm handles indexed as to service, 4-5/8" swing spout with softflow aerator outlet.

Manufacturer's No. (Prerinse Unit): No. 510 pre-rinse fitting and wall mounted faucet for hot and cold water, lever handle, 1/2" x 24" riser with 36" flexible stainless steel hose.

Manufacturer's No. (Disposal Unit): In-sink-erator No. SS-150-5, 1-1/2 HP, 208 volt, 3 phase 120 volt solenoid volve, manual reversing switch and vacuum breaker supplied with unit.

Item 'P'

Manufacturer's No. (Faucet): LC 946-GN2B-E7 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" tall gooseneck modified swing spout with serrated nozzle outlet.

Item 'Q'

Manufacturer's No. (Faucet): LC 900-GN2B-E7, low base with 10" tall rigid gooseneck with serrated nozzle outlet.

Item 'Q' (continued)

Manufacturer's No. (Remote Control Valve): Two LC 962-V0 remote control valves for hot and cold water with four arm handles indexed as to service, modified for mixing water consisting of valve body.

Note: Fittings exposed in fume hoods shall be coated with aluminum bronze epoxy finish.

Item 'R'

Manufacturer's No. (Faucet): LC942-GN2B-E7 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" tall rigid gooseneck with serrated nozzle outlet.

Item 'S'

Manufacturer's No. (Faucet): LC 980-GN2B-E7, side outlet turret for cold water service with 10" tall rigid gooseneck spout with serrated nozzle outlet.

Manufacturer's No. (Knee Valve): No. 649 knee valves.

Item 'T'

Manufacturer's Model No. (Faucet): 728SS, combination hot and cold water sink fitting with lever handles, 4-5/8" swinging spout with softflow aerator outlet and metal soapdish.

Item 'U'

Manufacturer's Model No. (Faucet): Two LC 931-L7-E3, combination hot and cold water mixing faucet with four arm handles indexed as to service, 7-5/8" swing spout with softflow aerator outlet.

Item 'V'

Manufacturer's Model No. (Faucet): LC 931-L7-E3, combination hot and cold water mixing faucet with four arm handles indexed as to service, 7-5/8" swing spout with softflow aerator outlet.

Manufacturer's Model No. (Faucet): LC 969-GN2B-E7 single distilled water faucet with four arm handle indexed as to service, 10" tall rigid gooseneck spout with serrated nozzle outlet.

Item 'W'

Manufacturer's Model No. (Faucet): LC 942-GN2B-H-15-E7 combination hot and cold water mixing faucet with four arm handles indexed as to service, 15" tall rigid gooseneck spout with serrated nozzle outlet.

Item 'X'

Manufacturer's Model No. (Faucet): LC 942-GN2B-H15-E7 combination hot and cold water mixing faucet with four arm handles indexed as to service, 15" tall gooseneck modified swing spout with serrated nozzle outlet.

Item 'X' (continued)

Manufacturer's Model No. (Disposal): Insinerator No. SS-150-5 disposal unit. 1-1/2 HP, 208 volt, 3 phase solenoid valve 120 volt, manual reversing switch and vacuum breaker supplied with unit.

Item 'Y'

Manufacturer's Model No. (Faucet): LC 942-GN2B-E7 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" tall gooseneck modified swing spout with serrated nozzle outlet. Chicago Faucet No. LC 970 back mounted sink fitting with No. GN2B-E7 rigid gooseneck spout and No. E7 serrated nozzle.

Item 'Z'

Manufacturer's Model No. (Faucet): No. 175 HE combination hot and cold water service sink fitting with lever handles, adjustable wall brace and pail hook with 3/4" hose thread on spout. Integral stops.

Item 'AA'

Manufacturer's Model No. (Faucet): LC 942-GN2B-E3-2 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" tall rigid gooseneck with softflow aerator outlet with adaptor fitting.

Item 'BB'

Manufacturer's Model No. (Faucet): No. 200-GN2B-E3-2-LC204 combination hot and cold water mixing faucet with four arm handles indexed as to service, 10" tall rigid gooseneck with softflow aerator outlet with adaptor fitting. Provide self-closing thumb control spray with 4 feet of hose. Four hole drilling to be provided in sink with spray hole on left.

Manufacturer's Model No. (Disposal): Insinkerator No. SS-150-5 disposal unit.

Item 'CC'

Manufacturer's Model No. (Faucet): LC 929-GN2B-E3-HI3 combination hot and cold water mixing faucet with four arm handles indexed as to service, 13" tall rigid gooseneck spout with softflow aerator outlet.

Item 'DD'

Manufacturer's Model No. (Faucet): 786-E3 concealed fitting with No. 317, 4" wrist blade handles, No. GN2B-E3-2 rigid gooseneck spout with No. E-3 softflow aerator outlet and coupling nuts to slip 1/2" o.d. tubing on inlets.

The

The following items scheduled herein are for types of trim as designated on the drawings for all outlets for vacuum, air, gas, nitrogen, oxygen, and nitrous oxide:

Item G, A, V

Manufacturer's No: Chicago Faucet No. LC 980-907

Type: Gas, air, and vacuum.

Mounting: Turret - one side opening.

Item G1, A1, V1

Manufacturer's No: Chicago Faucet No. LC 981-907

Type: Gas, air and vacuum

Mounting: Turret - two side opening on 180°.

Item G2

Manufacturer's No: Chicago Faucet No. LC 982-907

Type: Gas

Mounting: Turret - two side openings on 90°.

Item G3, A3, V3

Manufacturer's No: Chicago No. LC 986-907

Type: Gas, air and vacuum

Mounting: Back mounted flange.

Item O, N, N20

Manufacturer's No: Chicago Faucet No. LC 980-901

Type: Oxygen, nitrogen, nitrous oxide

Mounting: Turret - one side opening.

Item O1

Manufacturer's No.: Chicago Faucet No. LC 986-901

Type: Oxygen

Mounting: Back mounted flange.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment and material, and performing all labor necessary to provide natural gas at all outlets shown.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipefitting: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.
6. Gas Outlets: Section 15300.

PART 2: PRODUCTS AND INSTALLATION

2.1 GAS SERVICE REQUIREMENT

A. The natural gas requirements for Unit B/C consist entirely of that required for laboratory outlets and boilout tanks. (Approximately 1025 CFH).

B. The natural gas requirements for Unit B/C will be met by a downstream connection from the existing service meter in Unit A as shown on the drawings.

C. The Contractor shall contact the Minneapolis Gas Company to make necessary arrangements and pay any costs relative to the proposed extension of service.

2.2 PRESSURE REGULATORS

A. The gas distribution pressure within the building shall be 3 psig with pressure regulators furnished and installed at the point of use as shown and scheduled on the plans. The piping of the reducing stations shall be as detailed.

B. Regulators for 3 psig inlet pressure and adjustable outlet pressure from 3" to 6" w.c. shall be Maxitrol with the following capacities:

<u>Capacity (Cu. Ft/Hr.)</u>	<u>Maxitrol Number</u>
0-105	R400S
106-240	R500S
241-405	R600S

C. Regulator housings shall be two piece rugged die cast aluminum construction with all internal parts corrosion resistant. Diaphragm shall be Buna-N. The regulators shall be the lock-up type so that reduced pressure is maintained even at no flow conditions. Each regulator shall be complete with a Maxitrol vent limiting orifice #12A02.

D. Each regulator shall have an attached plastic laminoid tag noting service, regulator number, capacity, inlet pressure, outlet pressure, and room numbers or areas served.

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment and material, and performing all labor necessary to provide compressed air at outlets shown.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100
2. Pipe and Pipe Fittings: Section 15110
3. Valves: Section 15120
4. Piping Specialties: Section 15130
5. Mechanical Supporting Devices: Section 15140
6. Laboratory Fixtures and Trims: Section 15310

PART 2: PRODUCTS AND INSTALLATION

2.1 MATERIALSA. Laboratory Compressed Air-Low Pressure

1. Low pressure laboratory compressed air (20#) shall be supplied to Unit 'B/C' from Unit 'A' existing duplex compressed air unit. The Mechanical Contractor shall extend 'B/C' system piping into Unit 'A' and make connections at the units as shown on Drawing Sheet M-65.

2. At present one of two existing refrigerated air dryers in Unit 'A' is piped to serve the low pressure (20#) air compressors. This dryer is also cross connected to serve a high pressure (100#) air compressor as a standby, in case its air dryer should be out of service. This air dryer shall be disconnected from the (20#) compressed air system and connected to the 100# compressed air system.

Two new refrigerated air dryers shall be provided for the low pressure (20#) compressed air system as hereinafter specified and as indicated on the drawings.

B. Dental Compressed Air-High Pressure

1. High pressure compressed air (100#) shall be supplied to Unit 'B/C' from unit 'A' existing duplex compressed air unit. The Mechanical Contractor

shall extend 'B/C' system piping into Unit 'A' and make connections at the units as shown on Drawing Sheet M-65.

C. Refrigerated Air Dryers

Two refrigerated air dryers shall be provided for the 20# low pressure laboratory compressed air system. Each refrigeration air dryers shall be installed in the air discharge line from the compressor, but ahead of the receiver. The dryers shall include a hermetically sealed non-cycling refrigeration unit, a pre-cooler heat exchanger, a hot gas bypass valve to permit load variations from 5-100% capacity without on-off compressor operation or freeze-ups and air blockage, and a moisture separator. The moisture separator shall be of the coalescing filter type capable of removing 98% of all particles of water and dirt to .04 microns from the effluent air.

1. Dryer instrumentation and equipment shall include panel-mounted refrigerant suction compound pressure-temperature gauges, outlet pressure gauge, Aquadex moisture indicator, safety pressure switch, power-on light and automatic trap.

2. Alarms and indicators shall be furnished to indicate high pressure drop across separator and low freon charge.

3. Dryer Operating Conditions

a. Ambient air conditions	85°F.
b. Outlet dew point at line pressure with inlet air	+35°F.
c. Air flow quantity (max.)	300 scfm
d. Inlet pressure	25 psig
e. Inlet air temperature	100° F.
f. Quantity	2
g. Electrical characteristics	460/3/60
h. Electrical class	NEMA 1
i. Maximum allowable dressing drop	4 psig

4. Dryers shall be Model R-II or approved equal. Hankinson, Pall Trinity, Zurn General and Ingersoll Rand with identical characteristics are acceptable. Provide condensate trap piped to floor drain. Provide washable type filter to protect the condenser. Provide type A vibration isolation for .35" static deflection.

Note: Omit condenser piping shown on Drawings if air cooled Model is provided.

D. Quick Disconnect Fittings

1. Quick disconnect fittings where shown on the drawings in equipment rooms and other areas noted as air outlets shall be Swagelok Quick-Connects with single end shut off. Each equipment room outlet shown shall consist of shut off valve, quick-connect fittings, drip leg and blowoff petcock.

E. Traps

1. At the base of compressed air risers, furnish and install Armstrong 1" No. 71 snap action ball float traps. Provide drip leg and gate valve in front of trap with drain valve on discharge side.

F. Air Operated Doors

1. Supply and install pressure regulator and gauge on air lines to automatic door operators.

G. Pressure Reducing Valves

1. Pressure reducing valves shall be installed as shown on the drawings. Provide pressure gauge on downstream side of pressure reducing valve and a strainer on the upstream side. Valves shall be Fisher or Watts Series 18.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment and material, and performing all labor necessary to provide vacuum at all outlets shown.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100
2. Pipe and Pipe Fittings: Section 15110
3. Valves: Section 15120
4. Piping Specialties: Section 15130
5. Mechanical Supporting Devices: Section 15140
6. Laboratory Fixtures and Trim: Section 15310

2.1 MATERIALSA. Clinical Vacuum Pumps

1. Furnish and install one (1) duplex vacuum unit, Size OV-6A as manufactured by the Nash Engineering Company. The Unit will be capable of passing fluids directly through the pumps to waste and shall include the following:

2. Two (2) Model MHC-80 single stage, positive displacement, non-pulsating, liquid seal, rotary vacuum pumps. The pumps shall have enclosed rotors with conical porting that facilitates adjustment of internal clearances.

3. Each vacuum pump shall have a capacity of 64 cfm at 25" Hg. Each pump shall be driven by a close coupled 5 hp, 1750 rpm, ODP motor powered by 480 volts, 3 phase, 60 cycles. Pumps shall be mounted on common steel base attached to horizontal receiver tank.

4. The pump manufacturer shall conduct operating tests to verify that actual performance is within five percent of nominal setting. Certified test data for each vacuum pump shall be made available to the Owner at no charge.

5. For each pump, provide and install a discharge separator-silencer, seal water line strainer, 120 volt solenoid valve, anti-siphon fitting and vacuum switch.

6. Electrical controls shall provide alternating control for the two vacuum pumps. Included in the control equipment shall be two (2) vacuum switches; high and low set, shall through suitable relays, sequence vacuum pump operation: Upon closure of low set switch, vacuum pump #1 will start. Continued rise in pressure in system will close high set pressure switch and start vacuum pump #2. Provide a manual transfer switch to alternate the lead vacuum pump.

7. Provide all controls, magnetic starters with protection on each leg, relays and terminal strip mounted in a NEMA 1A enclosure for the two units. Control voltage shall be 120 volt, 60 cycle. Provide all interwiring required.

8. The electrical contractor will provide the disconnects at the motor control center and power wiring to the panel location.

9. Provide one (1) welded steel vacuum control tank, 24" diameter x 60" long, ASME construction, horizontal, galvanized inside and out equipped with vacuum gauge. Gauge glass, tank supports, and all necessary provisions for pipe connections. Provide type "B-J" isolation for .75" static deflection below tank support legs.

10. Sieman Hinsch equipment is approved as equal.

B. .

B. Laboratory Vacuum System

1. Laboratory vacuum shall be supplied to Unit 'B/C' from Unit 'A' existing duplex vacuum unit. The Mechanical Contractor shall extend 'B/C' system piping into Unit 'A' and make connections at the units as shown on the drawings.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing and install all equipment, materials and performing all labor necessary for a complete oxygen piping system, nitrogen piping system, nitrous oxide piping system, and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Mechanical Supporting Devices: Section 15140.
5. Ceiling Outlets: Section 15310.

D. Furnished by Owner:

1. Flow meters, nebulizers, portable equipment, etc.

PART 2: PRODUCTS AND INSTALLATION

2.1 GENERAL

A. All equipment and parts shall be the products of a reputable, experienced and recognized manufacturer of hospital oxygen, nitrogen and nitrous oxide service equipment and shall be single make if possible. Such equipment shall be supplied by or through a reputable established organization regularly engaged in supplying these gases and furnishing necessary service for central clinical service systems and providing engineering services for the installation of clinical service systems. Products shall be National Cylinder Gas, Ohio Chemical, Puritan-Bennett Corporation or approved equal.

B. The workmanship shall be first class in every respect and shall be done by workmen fully instructed and qualified for the special class of work required on the installation of oxygen and other type gases service equipment.

C. The entire oxygen distribution system and other type gas systems and all parts thereof shall be in strict accordance with all prevailing codes,

regulations and laws covering such installations and in accord with the best standard practices. The recommendations as set forth in the latest editions of pamphlet No. 56F of the National Fire Protection Association shall be adhered to in all respects.

D. All new and existing gas cylinders shall be individually bracketed to the wall with easily removeable clamp and chain.

2.2 STATION OUTLETS

A. Ceiling outlets shall be NCG Series 669000-64 or approved equal. Recessed base reels for oxygen, vacuum, air, and nitrous oxide, housed in steel outlet box, with No. 4 finish stainless steel cover. See architectural drawings for arrangements and outlet locations. Each base reel for each service shall be operable independently of any other reel. Nitrogen ceiling outlets shall have an exposed hose reel with retractor kit assembly.

1. See Section 15310 for outlet schedule.

2. Mount hose reel units rigidly from structure above with 4-3/8" diameter extension studs and 4 anti-sway bars.

B. Wall outlets shall be NCG, Series 378 recessed, or approved equal, for oxygen, vacuum, and nitrous oxide, housed in steel outlet box with chrome plated cover. Outlet shall be rigidly attached to box and box securely fastened to wall.

For oxygen provide: 237800-64-1/2" top inlet

For vacuum provide: 237805-64-1/2" top inlet

For nitrous oxide provide: 237806-64-1/2" top inlet

1. Where two or more outlet boxes are indicated side by side, they shall be located no less than 8" on center apart unless specifically called out otherwise in architectural elevations.

2.3 NITROUS OXIDE GAS MANIFOLD

A. Furnish and install where shown on the plans and indicated in the following schedule, supply units to consist of completely automatic manifold control, including self-shifting to reserve cylinders when supply cylinders are exhausted. The controls shall incorporate pressure switches for the purpose of actuating designed signal systems when supply service is exhausted. No manual resetting of the control unit shall be required. Connections between leveled valves shall be of high pressure flexible copper tubing equipped with fittings and valves.

B. Manifold Schedule

<u>Service</u>	<u>Supply Cylinders Quantity</u>	<u>Reserve Cylinders Quantity</u>	<u>Delivery Pressure PSI</u>	<u>Manifold Location</u>
Nitrous Oxide	4	4	50	1st Floor

C. For the manifold as specified in B, above, furnish and install an audible and visual alarm system to indicate abnormal line pressure, and reserve supply with

pressure monitoring gauges. Panel shall be located in Data Center in basement Unit 'A'. The Electrical Contractor shall provide the necessary 120 volt electrical circuit. Necessary wiring for visual and audible alarm systems shall be by Mechanical Contractor. Panel shall be equal to Chemetron No. 180241-64 concealed with stainless steel cover. Mechanical Contractor shall be responsible for providing 24 volt transformer, switches and controls for proper operation of the unit. Submit complete piping and wiring installation drawings for approval. Provide adjacent to the alarm panel NCG pressure gauge for nitrous oxide. Unit shall be NCG 480951-64, with 1-1/2" back inlet, and plastic protective dial face. Provide 1/4" tubing between nitrous oxide line (with shut-off cock) and the gauge. Gauge shall be fully recessed with stainless steel cover plate indicating gauge usage.

D. Mechanical Contractor shall supply and install pressure electric switches on the nitrous oxide system in the following locations:

a) On each floor where nitrous oxide is to be used. P-E switch should be located on branch piping at service core in which riser is located.

b) On manifold (P.E. switch supplied as part of manifold).

The Mechanical Contractor shall wire between all P.E. switches and the new alarm panel located in Data Center in basement Unit 'A'. See drawing Sheet M-65 for room location.

2.4 OXYGEN AND NITROGEN SYSTEMS

A. OXYGEN:

(1) System for Unit 'B/C' shall be interconnected with existing system in Unit 'A' in existing Room A102. Connection shall be made at the discharge from the manifold as shown on the drawings.

The existing Oxygen room is being made smaller and will necessitate changes to the manifold to accomplish the relocation of cylinders in the new room configuration. No new cylinders will be added to the system. All oxygen system changes required in this room electrical or mechanical, shall be the responsibility of the Mechanical Contractor.

(2) The Mechanical Contractor shall supply and install pressure electric switches on the oxygen system in the following locations:

a) On each floor where oxygen is to be used. P.E. switch should be located on branch piping at service core in which riser is located.

The Mechanical Contractor shall wire between all P.E. switches and the existing alarm panel located in Data Center in basement Unit 'A'.

B. NITROGEN:

(1) System for Unit 'B/C' shall be interconnected with existing system in Unit 'A' in existing Room A-69. Connection shall be made at the discharge from the manifold as shown on the drawings.

The existing Nitrogen Room is being made larger. The following cylinder additions should be made to the system.

<u>Service</u>	<u>Supply Cylinder Quantity</u>	<u>Reserve Cylinder Quantity</u>	<u>Delivery Pressure PSI</u>
Nitrogen	3	3	160

Changes shall be made to the manifold to accommodate the new cylinders and to satisfy the new room configuration. All N2 system changes required in this room, Electrical or Mechanical, shall be the responsibility of the Mechanical Contractor.

(2) The Mechanical Contractor shall supply and install pressure electric switches on the nitrogen system in the following locations:

(a) On each floor where nitrogen is to be used. P.E. switch should be located on branch piping at service core in which riser is located.

The Mechanical Contractor shall wire between all P.E. switches and the existing alarm panel located in Data Center in Basement Unit 'A'. See drawing sheet M-65 for room location.

2.5 OXYGEN, NITROUS OXIDE, VACUUM AND NITROGEN, ALARM AND PRESSURE GAUGES

A. Install where shown on plan Detail 33/A13-5 (3 required at operating rooms), NCG consolidated alarm systems as manufactured by Chemetron to indicate abnormal oxygen line pressure, abnormal nitrous oxide line pressure, abnormal nitrogen line pressure, abnormal vacuum line pressure. Unit shall have visible and audible alarm and be supplied with pressure monitoring gauges. Unit shall be U.L. label, fully recessed in the wall, with stainless steel cover Model No. 181030-64. Unit shall receive pressures downstream from operating room shut off valve boxes. The Electrical Contractor will provide a 115 volt circuit at the individual units. Wiring and piping shall be by Mechanical Contractor and shall be as per manufacturer's recommendations. Submit complete installation drawings for approval.

2.6 IDENTIFICATION OF EQUIPMENT AND ZONE VALVES

A. Each and every part of the oxygen, nitrous oxide, nitrogen and vacuum distribution system shall be properly and permanently identified as covered by approval manuals. Outlets, valves, valve boxes and similar equipment shall be labeled by imprinting or tagging. Instructions shall be given to the painting contractor for painting all exposed pipes, boxes, etc., and for necessary stenciling.

B. Each zone control valve cabinet and individual room valve shall be marked in substance: CAUTION - OXYGEN VALVE - DO NOT CLOSE EXCEPT IN EMERGENCY - THIS VALVE CONTROLS SUPPLY OF OXYGEN TO ROOMS (include proper room number). The same shall be for nitrous oxide and other gas systems as shown on the drawings.

2.7 ZONE SHUT-OFF VALVE BOXES

A. Zone shut-off valves as specified in Section 15120 shall be installed in a box with pull ring type frangible window, with identification plate plainly denoting room or rooms served. Box shall be 18 gauge. Valve service is

specified on valve handle along with color-code.

For one service: NCG - 480001-64 (1/2")

For two services: NCG - 480004-64 (1/2")

For four services: NCG - 480020-64 (1/2")

2.8 "J" TRACK

A. A "J" track is to be furnished by the General Contractor in each of three operating rooms. "J" track will be supplied complete with terminal box and manifold. Mechanical Contractor is to extend oxygen, nitrous oxide and vacuum to the manifold and make final connections.

2.9 NITROGEN PRESSURE REGULATOR AND RELIEF VALVE

A. Furnish and install pressure regulators to reduce the nitrogen pressure from 160 psi. Regulators shall be Airco, or approved equal with capacity and discharge pressures as indicated on the drawings. The seat mechanism and filter shall be exposed by use of hand tool only. Provide type "T" adjustment adjusting screw. Provide and install on the low side of the regulator a reseatable spring loaded adjustable relief set to relieve at 10 psig higher than discharge pressure indicated for the respective valve.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment, material and performing all labor necessary for the distilled water system.

C. Related work specified elsewhere.

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Mechanical Supporting Devices: Section 15140.
5. Laboratory Fixtures and Trim: Section 15310.
6. Compressed Air System: Section 15410.
7. Steam Heating System: Section 15600.

PART 2: PRODUCTS AND INSTALLATION

2.1 DISTILLED WATER SYSTEM

A. The present distilled water needs of Unit B/C will be served by the addition of a 1500 gallon storage tank to be provided on the 15th floor of Unit B/C, and by the interconnection with Unit 'A' system equipment in the existing 10th Floor Mechanical Room. Space is provided in Unit B/C for a future still and its associated demineralizer.

2.2 DISTILLED WATER STORAGE TANK

A. The storage tank shall be so designed that when connected to the water-distilling apparatus with borosilicate glass pipe, it will receive the distillate produced and maintain in under controlled conditions of maximum purity. Tank shall be Barnstead or Vaponics, Inc.

B. The tank shall be a tin-lined, 1/16" thick, steel box type rectangular tank measuring 8'-0" wide, 6'-6" deep and 4'-0" in height for a storage capacity of 1,500 gallons. The lining shall extend over the exterior top lip of the tank, and all joints shall be sealed with pure tin. Tank interior shall be finished in aluminum bronze. Tank shall be complete with removable tin lined cover, gauge glass, draw-off faucet, threaded tappings for inlet and outlet, drain and tappings for level monitoring.

1. First level monitor closest to the top shall be used at this time for the indicating device for transfer pump operation. The monitor shall start and stop the new transfer pump in Unit 'A', to pump distilled water from Unit 'A' 10th Floor storage tank to Unit B/C 15th Floor storage tank. This monitor shall also open an automatic valve on the distilled water line from the 10th Floor tank.

2. The second level monitor tapping shall be used for the indicating device to signal alarm. The alarm device shall be supplied and installed by this Contractor in the Basement Equipment Room where designated by the University.

3. The low level monitor on the existing 10th Floor storage tank in Unit 'A' shall be wired to shut down the new transfer pump to Unit B/C in the event of a low distilled water condition, in the 10th Floor tank.

4. All wiring shall be provided by this Contractor for proper operation of system.

5. The piping at the existing 10th Floor storage tank in Unit 'A' shall be manifolded to accept the new transfer pump. See Drawing detail.

C. The tank shall be supplied with air filters to protect the distilled water in storage from airborne contamination by removing dust, mist, bacteria, and all particulate matter down to 0.2 micron in size, and gases including carbon dioxide from the air entering the tank to replace the distilled water drawn off.

D. The storage tank shall be mounted on the floor with factory-installed floor stand, especially designed for use with the tanks. Legs shall be adjustable.

2.3 DISTILLED WATER TRANSFER PUMP

A. The transfer pump shall be a Barnstead Size 'D', designed to deliver 6 GPM at a 120 foot head, 1-1/2 HP, 480 volt, 60 cycle, 3 phase. The pump shall be type 316 stainless steel complete with teflon seals. Pump by Cherry-Burrell or Vaponics, Inc. is equal and approved. Provide type B-J vibration isolation for 1-1/2" static deflection.

B. Provide shock absorber at transfer pump as indicated on the drawings, and necessary stainless steel companion flanges and hardware for adapting to beaded process glass pipe.

2.4 PRESSURE REDUCING VALVES

A. Supply and install stainless steel pressure reducing valves in the distilled water piping system as shown on the drawings. Valves shall be individually supported separate from the glass piping system. Valves shall be Cash-Acme type G-60 with type 316 stainless steel body and trim. Maximum inlet pressure 100 psi, minimum outlet pressures 10-50 psi.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment, materials and performing all labor necessary to connect the dental oral evacuation systems and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.

PART 2: PRODUCTS AND INSTALLATION

2.1 CENTRAL ORAL EVACUATION SYSTEM

A. This Contractor shall extend the existing central oral evacuation piping system from Unit 'A' into Unit B/C terminated as indicated on the drawings. No system outlets will be required under this contract.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes a wet standpipe and sprinkler pipe system as shown on the drawings and as specified below. The entire sprinkler layout shall conform to the reflected ceiling plan as shown on the drawings. Ceiling contractor, architectural representatives and sprinkler contractor shall coordinate all ceiling sprinkler layout before any piping, as sprinklers shall conform to the exact ceiling pattern. Submit ceiling plan marked as shop drawing plans for approval. The sprinkler heads as laid out and installed must meet or exceed NFPA requirements.

C. It is the intent of these specifications to meet the requirements of the "Sprinkler Alternative" as described in Section 1807 of the Uniform Building Code. The existing fire pump in Unit 'A' shall be cross connected for standby use in Unit 'B/C'. On the same basis the new fire pump in 'B/C' will be standby for Unit 'A'.

The existing 8" valve header with test connections shall be useable by Unit 'B/C' fire pump. See drawing detail.

A new jockey pump will be added to serve the new system in Unit B/C.

An on-site 15000 gallons of water storage will be provided, available automatically if the City main supply is lost.

D. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100
2. Piping Specialties: Section 15130
3. Mechanical Supporting Devices: Section 15140

2.1 PIPE AND PIPE FITTINGS

A. This contractor shall make connections to water service at a point inside of building wall. Work to begin at 8" flanged outlet.

B. Standpipe and Sprinkler Fire Protection Piping

1. Pipe - Seamless standard weight steel pipe.
2. Fittings - 250 psi extra heavy cast iron or welded fittings for floors 10 and below. (All piping shall be welded in stairwell shafts)

with the exception of the hook up to sprinkler flow control valve cabinet, Fire Department valve cabinet, and main riser drain line. See Drawing details.

- 175 psi extra heavy cast iron or welded fittings for floors 11 and above. (All piping shall be welded in stairwell shafts) with the above exceptions.

3. Joints - Screwed, welded or approved grooved pipe method suitable for pressures as noted above.

- Screwed or couplings approved specifically for use in sprinkler systems.

C. All underground water piping shall be #150 Class A-22 mechanical joint for sprinkler and 250# for standpipe. All ellis and tees shall be braced as noted by NFPA and brace rods painted to prevent corrosion.

2.2 VALVES

A. Fire department siamese:

1. One required for "standpipe and sprinkler" system, so identified. For the north side of building, the valves shall be Allenco Fig. 276, Elkart Fig. 166 flush type, or equal. Valves shall be 2-1/2" x 2-1/2" x 6' brass with threads to Minneapolis Fire Department specifications and finish shall be hard-coat Architectural Class 1, AA-A42, Alcoa Duranodic, Kaiser Kalcolor, Reynolds Reynocolor, to match window frame.

B. Fire department valves in stairwells shall be Allenco Fig. 170 U, Elkart Fig. U-25, or equal, angle valve with cap and chain. Valve shall be UL approved 300# for floors 10 and below, 175# for floors 11 and above, cast brass with satin trim and red enamel hand wheel. Outlet threads to Minneapolis Fire Department specifications. Valves shall be mounted in cabinets as detailed on the drawings. Cabinets shall be Elkart series 1600, Allenco Fig. 280 AL, or equal, modified recessed cabinet 11" deep with flush trim and double strength glass, hinged door panel, steel prime coated. See drawing A-11-1 for detail.

C. Roof hydrant shall be Elkhart #153 exposed type with polished brass finish. Male outlets, size 2-1/2 x 2-1/2" x 6" with caps and chains less clapper valves. Escutcheon lettered "WALL HYDRANT". Outlet connections to Minneapolis Fire Department specifications.

D. All shut off valves shall be UL labelled OS and Y or Butterfly 300# MWP on discharge side of fire pump. All other valves shall have 175# MWP. Where valves are called out on Drawings to be supervised they shall be provided with tamper switches. These shall be wired by electrical contractor into fire alarm system.

E. Check valves shall be UL approved 300# MWP with soft seat. Fire department check valve shall be equipped with 1/2" ball check. Ball drips shall be piped to floor drain.

F. Furnish and install one eight (8) inch detector check Hersey Model DC, 8" with 2" all bronze disc bypass meter and shut-off valves.

G. Furnish and install a deluge valve, o.s. and y valve, or approved butterfly valve etc., per NFPA 214, for cooling tower sprinkler system. Provide necessary heat detectors in cooling tower to activate valve. Piping on leaving side of valve shall be filled with moisture free compressed air. One deluge valve assembly required for each cooling tower cell as shown on the drawings. All wiring necessary to the deluge cooling tower sprinkler system shall be by this Contractor.

2.3 SPRINKLER CONTROL VALVE CABINET

Cabinet shall be 2'-8" wide x 4'-0" high x 11" deep recessed furnished and installed by the General Contractor. See Architectural Detail Sheet A-11-1. This Contractor shall furnish and install within the cabinet a 3" butterfly valve (gear driven), a 2" main drain valve, a 1" inspectors test valve, 1" sight glass and 3" flow switch, all as shown on Drawing Detail Sheet M-46. On certain floors where shell space occurs adjacent stairwells, the sprinkler control valve cabinet will not be built by the General Contractor. In this case this Contractor shall furnish and install the required piping and valves based on a future installation of a similar sized cabinet. Valves shall be rough brass. A 12" wide x 36" high x 11" deep space shall be left available inside the cabinet for a fire extinguisher to be provided by Owner. Wiring of flow switch to building fire alarm system shall be by Electrical Contractor.

2.4 DRAINAGE

A. On the sprinkler system all branch lines, cross mains, feed mains, and risers shall pitch to drainage points so that systems will drain by gravity to the riser or at low points with drains provided where 5 gallons or more are trapped and where shown on the drawings by an angle drain valve.

B. Provide standard inspector's test connections discharging to 2" main riser drain. Two (2) inch system drains shall be run to 2" main riser drain that discharges into opening provided in Basement.

2.5 SPRINKLERS

A. Sprinklers shall be spray type 165°F. temperature rating, except that sprinklers installed in the vicinity of sterilizers shall be of high rating as required.

B. Sprinklers mounted in ceilings shall be "Stargard" semi-recessed, chrome plated.

C. Sprinklers mounted in exposed areas without ceilings or shell space shall be "Stargard" sprinkler, or approved equal, standard brass finish.

D. Sprinklers installed in the cooling towers shall be specifically designed for this purpose.

E. Sprinkler cabinet shall be provided with 48 sprinklers and 4 sprinkler wrenches for emergency use. Stock of sprinklers shall include a proportionate number of all types and ratings installed. This cabinet shall be located under the direction of the University.

F. This Contractor to provide two sprinkler stoppers for semi-recessed head with necessary handle length to service all ceilings. Provide also two stoppers for upright heads with necessary handle length to service all heads.

2.6 ALARMS

A. Flow alarm valves shall be installed within the systems as indicated on the drawings. Wiring shall be by electrical contractor. A 1" test valve shall be set in each system loop so that opening of the test valve will activate the alarm. The discharge to be equal to one sprinkler head flow.

2.7 INSTALLATION

A. The sprinkler work shall conform to NFPA standards, the City of Minneapolis, and the insurance company having jurisdiction: All work required for respective systems shall be performed by workmen skilled in this trade. All work shall be neat and piped in a workmanlike manner. Piping shall be run in strata provided with no interference with other trades.

B. All required permits for sprinkler system, fire lateral and related work shall be obtained and paid for by this contractor.

C. Submit three copies of working drawings stamped by NFPA (approved) to Architect/Engineer for approval. Submit all supporting hydraulic calculations for the complete sprinkler system and the deluge system serving cooling towers. Submit all equipment and trim for approval with shop drawings. If hydraulic calculations submitted indicate a smaller main size, a proposed credit to the Owner should also be included.

2.8 FIRE PUMP

A. Furnish and install one Aurora Peerless or approved equal Model 5-481-11B-UL listed, FM approved horizontal centrifugal fire pump designed to deliver 1000 gpm at a total discharge head of 347 feet when driven by a Cummins or approved equal Model V-504-F diesel engine rated at 171 HP. at 3300 RPM, at 90° ambient temp. The pump shall deliver no less than 150% of rated capacity at a pressure not less than 65% of the rated pressure. Shut-off pressure shall not exceed 120% of the rated pressure. Provide Type B-J vibration isolation for .75" static deflection.

B. The pump shall be a horizontal split case type. Discharge Flange on Pump to be 250 psi.

C. The pump unit shall be listed and approved and meet all requirements of the National Fire Protection Associates Pamphlet #20. Fuel piping and plumbing for unit shall conform to NFPA pamphlets #20, 30 and 31.

D. Accessories.

- 1 - Relief valve elbow
- 1 - open overflow cone
- 1 - Eccentric suction reducer, 8 x 6
- 1 - 8 x 8 x 4 discharge tee

- 1 - 4" main relief valve
- 1 - 3-1/2" dial compound press-Vac. gauge (suction)
- 1 - 3-1/2" dial press. gauge (discharge)
- 1 - 1/2" automatic air release valve, 300# MWP
- 1 - 6" x 8" concentric discharge increaser
- 1 - Fuel system (including filters, condensate drains etc. and integral pump) less fuel tank (fuel tank provided under Section 15570 Day Tanks).
- 1 - Set of flexible fuel oil connections on fuel supply and fuel return
- 1 - Flexible exhaust connection
- 1 - Residential type muffler
- 1 - Battery Rack
- 1 - Set of dual batteries cables and straps
- 1 - Capacity plate

E. Control Equipment

1. Furnish and install in connection with Engine driven fire pump unit specified a controller completely assembled, wired and tested at the factory. The assembly shall be specifically approved for fire pump purposes by NFPA, U.L. and F.M. agencies and shall be Master controller Bulletin 174.

2. The controller shall be marked "Fire Pump Controller."

3. Controller shall function to automatically start an engine driven fire pump from the water pressure control switch included in the controller. The main control switch shall be furnished with a TEST position for starting the engine by dropping the pressure to the water pressure control switch. Normal stopping of the engine shall be manually initiated by operating a "STOP" pushbutton on the outside of the controller enclosure.

4. Controller shall be furnished in a free standing enclosure constructed of heavy gauge metal with baked-on fire engine red finish.

5. Controller shall provide a pilot light and common alarm bell, which operate in event of each of the following:

- Low Engine Oil Pressure
- High Engine Jacket Water Temperature
- Failure to Start Automatically
- A.C. Power Failure (local alarm does not operate)
- Battery Failure #1
- Battery Failure #2
- Overspeed Shutdown

Provisions shall be included for the possible connection of remote signals which correspond to the individual pilot lamps in the controller.

6. All alarm and signals shall be operable under manual as well as automatic conditions.

7. The controller shall include a built-in battery charger that has been specifically approved for fire pump service under the latest requirements of NFPA 20. The chargers shall have automatic overload protection. Individual voltmeters and ammeters shall be provided for each battery.

8. A pressure Recorder shall be provided and provisions must be included for starting the engine on Power Failure after an adjustable time delay of 0 to 5 minutes.

9. Controller shall be a MASTER Model DCFR-359 or approved equal.

10. An adjustable solid state timing device shall prevent this pump from starting simultaneously with existing fire pump.

11. Engine shall come equipped with a Kim hotstart or equal jacket water heater capable of maintaining the temperature at 120°F. Heater shall be 2500 watt, 208 volt, 1 phase.

12. All control wiring between controller and engine driven fire pump shall be by Mechanical Contractor.

13. This Contractor shall make a 1/2" brass pipe connection to controller from system side of fire pump.

14. Pressure controllers inside New engine driven fire pump controller and inside existing motor driven fire pump controller shall be set up so that the motor driven unit comes on the line first and if it cannot maintain system pressure the engine driven unit will come on the line. Maintain 5 psi difference between controller set points.

F. Tests

1. The pump shall be hydrostatically tested to twice the working pressure, but in no case less than 250# per square inch.

2. The pump unit shall be given a complete performance test and characteristic curves prepared from the test results shall be furnished to the Architect/Engineer for approval.

G. Jockey Pump

1. Furnish and install an Aurora Model 300T5 IIDC red jacket vertical pump for 5 GPM at 350 foot head and operating at 3600 RPM direct connected to a 3 HP 3 phase 60 cycle, 460 volt open drip proof motor. Turbine vane pumps are not acceptable.

2. Furnish with this pump the following accessories:

a) Pressuretrol of the mercoid type.

H. All wiring shall be by this Contractor.

2.9 ON-SITE WATER STORAGE SYSTEM

A. Storage Tank

Provide and install a 22,000 gallon ASME coded pressure vessel designed for 200 pis working pressure. Tank shall be as manufactured by R. L. Faubion Co. and shall be 10 foot diameter by 38 feet long. Constructed of 1" steel plate

70,000 psi tensile, and prime coated on exterior with 2 coats rust inhibiting paint. Concrete piers to support tank will be provided by the general contractor as per Drawing Detail Sheet M-46. Mechanical Contractor shall supply and install steel saddles and steel bands anchored to saddles as shown. Tank interior shall be lined with an epoxy coating equal to Plasite 7155. Tank shall be supplied with manhole flanged bolted and gasketed and with the following flanged connections located as per Drawing Detail:

- 8" Pump suction
 - 2" Drain
 - 4" Water fill
 - 2" Vent for relieving air under filling conditions
 - 1/2" Gauge port (Press. gauge-6" dial 0-250 psi.
 - 1/2" Safety valve (Quincy Model 3022-200) 1-1/2" Compressed air inlet
 - 1/2" Conn. for air compressor pressure sense line
 - 1/2" conn. for low air press. alarm
 - Supply and install pressure-electric switch
- 2 1-1/2" conn. for gauge glass and tricock assembly and McDonnell Miller No. 194 low water alarm.

B. Air Compressor

1. Provide and install a Quincy Model D350L air cooled, base mounted two stage motor driven air compressor, pressure lubricated with 10 H.P. motor 860 RPM, Electric characteristics 480/3/60, capacity 34.5 cfm at 200 psi. Air compressor electric motor and U-belt drive with belt guard, shall all be supplied on a structural steel base. Supply complete with pressure switch and loadless start for automatic operation. Accessories shall include; Quincy intake silencer No. 4469, filter, and flexible stainless steel discharge piping, 1-1/2", No. 6841. Provide type B-J vibration isolation for .75" static deflection.

2. Mechanical Contractor shall do all necessary control wiring for a properly operating system. Electrical Contractor will wire all alarms as mentioned above to the central fire alarm system.

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PART 1: GENERAL

1.2 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment, material and performing all labor necessary for the fuel oil system serving emergency generators and an engine driven fire pump.

C. The fuel handling system shall consist of two fuel oil storage tanks, oil lines, pumps, valves, gauges and accessories.

D. Related Work Specified Elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.

PART 2: PRODUCTS AND INSTALLATION

2.1 FUEL OIL STORAGE TANKS

A. Each underground fuel oil storage tank shall be U.L. approved, 5'-4" diameter by 18'-0" long, 3000 gallons capacity. Tank material and thickness shall be 7 gauge steel. Tank tappings shall be as indicated on drawing detail. Provide an 18" diameter manhole in top of tank. Tank exteriors shall be painted with two coats of Koppers Bitumastic #50 with final coat applied when tank is in place. Tank interiors shall be epoxy resin coated to minimize metal contact and corrosion.

B. Acceptable tank fabricators are Brown-Minneapolis, Wheeler, and Arrow Tank. Owens/Corning fiberglass tanks with tappings and manholes are considered equal to above.

C. Immediately upon setting tanks, notify University to fill with oil conforming to U. S. Commercial Standard CS12-48, Grade No. 2. This cost of oil shall be at University's expense.

2.2 TANK ACCESSORIES

A. Tanks shall be provided with openings in the top for oil suction and return, 4" filling terminated with waterproof lock type fill cap, 2" vent with screened

vent cap raised above grade, and 2" watertight grade level sounding line with watertight lock type cap all terminated where shown on the drawing plans. See drawing detail for elevations of fill, vent, and sounding line with respect to grade. Where concrete pads are shown for on grade installation of fill and sounding caps they shall be supplied and installed by Mechanical Contractor.

B. Provide the following for each tank:

1. Fill Cap: A.Y. McDonald Model 969
2. Vent Cap: A.Y. McDonald Model 834
3. Sounding Line: A.Y. McDonald Model 969
4. Calibrated sounding stick sized to tank diameter.

2.3 FUEL OIL PIPING

A. All underground pipe and fittings shall be double wrapped with 3M tape No. 471.

B. Gate valves in both suction and return lines at entrance to building tagged "Oil Valves - close only in emergency".

C. Provide fusible link syphon breaker at high point of suction line, see drawings for exact location. Syphon breaker valve shall be Preferred Utilities Co. Type T.

D. All underground piping shall be installed with swing joints.

2.4 FUEL TANK GAUGES

Large model Levelometer remote reading hydrostatic gauge with integral hand operated air pump shall be provided for each tank, calibrated in gallons for exact dimensions of oil storage tank. Gauge wall mounted where shown with gauge air lines run inside protective 2" PVC pipe from tank to gauge.

2.5 FUEL OIL PUMPS

A. Pumps shall be Viking heavy-duty direct drive units, series 195. Pump and motor mount on a formed steel base isolated with Type 'A' isolation with .35" deflection. See drawing sheet M-105 for pump schedule. H.P. listed are required for pumping 100 SSU viscosity liquid. Pumps shall be complete with ductile iron pump gears, mechanical seals, automatic pressure lubrication system and integral safety relief valve.

2.6 FUEL OIL DAY TANKS

A. Day tanks shall be Simplex or approved equal modified less pump. This Contractor shall supply and install a 100 gallon day tank for each emergency generator and a 275 gallon day tank for the engine driven fire pump. Day tank shall be heavy gauge steel construction tank and top, complete with heavy-duty float switch, and all components completely enclosed under a protective lift-off cover. Tank shall be all welded construction, rust

proofed and finish painted outside. Tank interior shall be completely epoxy coated. Tank shall be supplied with sight glass with hand valves and guard and a fuel strainer at the tank inlet. Tank shall include a control panel with a "press to test" button and wired circuit to test all components including float switch, supply lines, valving and remote oil transfer pump. All necessary wiring shall be provided by this contractor including that necessary to tie the remote oil pumps into the day tank control system such that pump operation is controlled from the day tank float switch to maintain the proper oil level in the tank. Each day tank shall be supplied with high and low level fuel alarms with integral wiring to terminal block. This Contractor shall wire from this terminal block to an alarm bell in the basement equipment room located where directed by the University. Wiring and alarm bell shall be by this Contractor.

B. A pipe stand shall be provided for day tanks per Drawing Detail 14/M-105. A pipe stand adapter shall be provided by tank manufacturer.

C. Each day tank shall set in a fabricated drip tank as detailed on Drawing MI05. Tank shall be 16 gauge galvanized soldered watertight and finished inside and out with 2 coats of epoxy paint. Provide angle iron bracing as required and detailed. Each drip tank shall be supplied with a high level fuel alarm with necessary wiring to an alarm bell in the basement equipment room. Wiring and alarm bell shall be by this Contractor.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary to connect the steam heating systems and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.
6. Vibration Isolation: Section 15150.
7. Mechanical Systems Insulation: Section 15160.

D. Furnished but not installed under this section:

1. Steam coils

PART 2: PRODUCTS AND INSTALLATION

2.1 HUMIDIFIERS

A. Furnish and install in built-up air handling units packaged air handling unit and ductwork where shown on the drawings. Humidifiers shall be of a type which discharge clean, dry steam without drip or objectionable noise. Humidifier design shall utilize a steam jacketed valve and separating chambers, an asbestos muffler and an insulated stainless steel steam jacketed distribution manifold for this purpose. Each humidifier shall be furnished with a normally closed, full modulating direct acting pneumatic valve, a .045" perforated strainer, an inverted bucket type steam trap, and stainless steel discharge manifolds suitably sized to traverse plenum and equipped with internal stainless steel silencing screen. Each humidifier shall be accurately sized according to pounds of steam required per hour and 12 psi inlet steam pressure, for built-up and packaged air handling unit humidifiers and 5 psi inlet steam pressure for booster humidifiers in Ductwork. Humidifier shall be Armstrong Series 30 or approved equal.

B. On all multiple manifold installations in built-up air handling unit housings the humidifier supplier shall furnish a normally open temperature switch which shall be installed as shown on the drawings and will be wired under temperature control.

C. See drawings for humidifier schedule.

2.2 STEAM COILS

A. Preheat coils for built-up air handling units S-1C through S-8C, S-13C through S-18C shall be wing Model VIFB. Capacities shall be based on 4psi coil inlet pressure. Maximum face velocity shall be 800 F.P.M. and number of rows shall be as scheduled on the Drawings.

1. Each heating coil shall consist of built-in series of vertical finned heating elements and by-passes with interlocked dampers controlled by pneumatic damper motor and air stream thermostat. Dampers shall be constructed and arranged so as to completely enclose and isolate the heating coil passes when no temperature rise is required.

2. Finned heating elements shall be fabricated of 5/8" O.D. seamless copper tubes with rectangular aluminum fins. Each tube shall be individually secured to steam and return headers by a brazed joint. Finned elements shall be factory tested at 200 psig steam and 1,000 pounds hydrostatic pressure.

3. The coil shall be prepitched and casings shall be constructed of 14 gauge galvanized and painted with rust inhibitive paint. Dampers shall be constructed of 16 gauge cold rolled steel with baked enamel finish. The volume of air passing through the coil shall not vary more than $\pm 5\%$, regardless of the position of the internal dampers.

4. See drawings for schedule.

B. Preheat coils for air handling unit S-9C shall be Wing model IFB with horizontal finned heating elements and by-passes.

1. All remaining coil characteristics shall be identical to paragraph 'A' above.

2. See drawings for schedule.

2.3 PRESSURE REDUCING AND RELIEF VALVES

A. Furnish and install pressure reducing valves and pressure relief valves of capacities indicated in the schedule on the drawings. Pressure reducing valve assemblies shall include strainer, unions or flanges, PRV, three valve by-pass and pressure gauges on high and low side of assembly location.

B. Pressure reducing valves shall be of the single seated dead-end service type, pilot operated reducing valves. Valves shall be Fischer 92B or Spence ED pilot type valves with stainless steel seats and discs. Valves shall be 300 pound cast steel construction. Downstream control line shall be connected at least 50 pipe diameters from valve if possible.

C. Relief valves:

1. Relief valve for the low pressure steam reducing stations shall be Crane-Cochrane Series 1000, or approved equal, multipoint pressure relief-to-atmosphere valve. Relief valve shall have horizontal handwheel, adjustable with drain tapping, drip funnel and piping extended to floor drain. The valve shall be of 0-25 psig set pressure construction 350°F. Valve shall be constructed with cast iron body 20# springs and bronze and alloy steel trim.

2. Relief valves for medium pressure steam reducing stations shall be Kunkle Series 250 for appropriate pressure, Lunkenheimer, Clarke Reliance, forged coppered alloy body with bronze trim. Furnish and install safety valve discharge elbow with nipple and drain piping to drain.

3. All relief valves shall be set for a pop pressure 5 psig higher than normal operating pressure on the downstream side of reducing valves. The relief valves shall have a capacity equal to or greater than the combined maximum capacities for each system. Valves shall be sized for 10% accumulation.

4. Furnish and install exhaust head on Cochrane valve at the top of each exhaust vent. Exhaust head shall be constructed of cast iron or steel welded construction with flange connection, inner cylinder, baffle, coupling, and drain line to extend to roof drain.

D. Noise Suppressor

1. Noise suppressors for the low pressure steam reducing stations shall be Spence Model B, or approved equal, of the dissipative reactive type. In lieu of Model B noise suppressors, Spence Mutholeplates may be used located as shown on the drawings. Noise level measured 10 feet from the reducing station shall not exceed 85 decibels.

2. Construction shall be welded steel shell, deflector assembly and acoustic packing is of corrosion resistant material, 300 lbs. inlet and outlet.

3. Suppressors shall be flanged.

E. Steam Flow Meter and Recorder

In locations where shown on the drawings provide steam flow metering. Meters shall be Bailey Meter Co. specification No. M-22-1. Provide orifice and flanges, meter valves, reservoirs, settling chambers nipples and reloader with 24 hour chart, surface mounted type. Equipment shall be installed by this Contractor with necessary 1/2" O.D. copper tubing, unions, valves, connectors, all as per manufacturers recommendations. Start up service shall be provided by equipment manufacturer. Equipment provided shall include a mounted transmitter suitable for interface with the existing Honeywell Delta 2000 system in "Unit A".

See drawings for meter schedule.

2.4 CABINET UNIT HEATER

- A. Types and capacities as shown and scheduled. Capacities based on 2 psig steam and 60°F entering air. Nesbitt or equal Modine, McQuay, Airtherm, Dunham Bush, or Trane. See drawings for schedule.
- B. Heating elements of copper tube expanded into aluminum fins, with tubes bonded to headers, supported in the cabinets with brackets arranged to allow free movement and adjustable for pitch. Elements tested at not less than 150 psig. Provide throw away 1" thick glass filters except where noted otherwise.
- C. Fans driven from a three-speed motor 120/60/1 electric characteristics.
- D. Cabinets No. 16 gauge steel, prime coat finish over rust preventive. Access cover to disconnect switch with tamper-proof operator.
- E. Recessed units shall have full lap frames. Units shall be inverted air flow with front inlet and outlet grilles.
- F. Fan speed and air capacities shall not exceed the values listed on the drawings and all units shall have a Class II or less AMCA sound measurement classification.

2.6 UNIT HEATERS

A. Furnish and install Trane, McQuay, Carrier, Modine or Herman Nelson unit heaters. Units shall be propeller type; either horizontal or vertical projection as shown on the drawings. Heater capacity shall be as noted on the drawings when using two (2) psig steam and 60 degrees F. entering air. Unit heaters shall have throw and radius of diffusion sufficient to cover the areas served. See drawings for schedule.

1. Motors shall be 120-60-1 with thermal overload. Units shall be complete with off-on switches and thermostat. Control wiring by this contractor.

2.7 REHEAT COILS

A. Reheat Coils shall be Trane type N or NS, McQuay type 8J or 8SOR, or Westinghouse type HM, and shall be installed in the ductwork as shown, and shall be of the steam distributing type with fins securely bonded to the tubes.

1. Fin thickness shall be .012 inch. Coils shall be pitched within the casings and tested tight with a hydrostatic pressure of 150 psig.

2. Coils shall be with fin spacing as required based on four (4) psig steam entering coil.

3. See drawings for schedule.

2.8 FLASH TANKS

Furnish and install flash tanks where shown on the drawings and in accordance with the details shown. Tanks shall be of size indicated on the

drawings with tapings for inlet, outlet, vent and drain connections. Tanks shall be constructed of standard steel pipe Schedule 30 with flanged or welded ends.

Tanks shall be supported by angle iron brackets on the wall or from the ceiling or by a floor stand. Tanks shall be all welded construction, rust proofed and finish painted outside.

2.9 CONDENSATE RECEIVER

Furnish and install Condensate receiver where shown on the drawings and as detailed. Tank shall be 4'-0" diameter x 11'-0" long with tapings and guage glass as shown on the drawings. Tank shall be constructed by ASME specifications for a non code tank for 125# W.P.

Tank shall be supported on a floor stand as detailed on the drawings. Tank shall be all welded construction, rust proofed and finish painted outside. Submit shop drawings for approval.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary to connect the hot water heating systems and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves: Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.
6. Vibration Isolation: Section 15150.
7. Mechanical Systems Insulation: Section 15160.
8. Chemical Treatment: Section 15990.

D. Furnished but not installed under this section:

1. Hot water reheat coils.

E. Installed but not furnished under this section:

1. Chemical treatment equipment.

PART 2: PRODUCTS AND INSTALLATION

2.1 CONVERTORS

A. Furnish and install steam in the shell and water in the tube instantaneous heater having cast iron heads, 3/4" O.D. copper tube, steel tube sheets and steel tube supports. Unit shall be Bell & Gossett Type SU, Patterson-Kelly, Bernstrom and Dunham Bush Type DS, or Taco Type S.

B. Convertors shall be constructed in accordance with ASME code for unfired pressure vessels for a working pressure of at least 125 psig. Water velocity shall not exceed 5 feet per second and the heating surface shall be based on

a scale factor of 0.001. Capacity of units shall be as scheduled herein for heaters with 2 psig steam.

C. This Contractor shall furnish and install saddles and remaining framework as shown on the drawings for mounting convertors.

D. See drawings for Convertor Schedule.

2.2 BOOSTER PUMPS

A. Furnish and install forced hot water circulating pumps having a leakproof mechanical seal, John Crane specifically for water service from 40°F to 210°F. Pumps shall be Allis-Chalmers, Chicago Pump Company, Peerless, Armstrong, Aurora, Ingersoll-Rand, Bell & Gossett, Taco Dunham Bush and Thrush.

B. Pumps shall be flexible coupled (Falk or Lovejoy), single suction, centrifugal pump with cast iron casing, bronze impeller and stainless steel shaft. Provide coupling guard.

C. Base-mounted motor and pumps shall be complete with steel base plate. Certified pump curves shall be furnished with shop drawings. Special emphasis is placed on flat head characteristics of pump operation. Pump impeller diameter shall not be less than 90% of the maximum diameter to promote quiet operation.

D. Pumps shall have grease lubricated ball bearings. Piping to pumps shall be properly installed and aligned to prevent any distortion of the pump casing under all operating conditions. Pump characteristics shall be as scheduled on the drawings.

E. In line booster pumps shall be supported independent of system piping.

F. All motors shall be 1750 RPM unless otherwise noted.

G. Each pump shall be furnished with an extra mechanical seal.

2.3 REHEAT COILS - HOT WATER

A. Furnish and install all non-ferrous tube and fin extended surface hot water reheat coils. Coils shall be McQuay, Dunham-Bush, Trane or Recold, with flanges for mounting in ductwork.

B. Coils shall be one or two rows deep, with 5/8" O.D. tubes ARI. rated 8 fins per inch maximum, with at least 17 square feet of external fin surface per square foot of face area per row. The majority of the coils shall be single tube serpentine or header type and shall be used as required to meet capacity and pressure drop requirements based on 55°F entering air. Coils shall be of nominal face dimensions and of minimum face area as indicated in the schedules and they shall have capacities as indicated when using water from 195°F to 165°F.

C. Coils shall be tested for 150 psig working pressure with copper return bends brazed into tubes on both ends with copper to IPS adapters brazed to the supply and return leads. Casing for coils that are both shorter than 19"

tube length and not higher than 13" may be built of 20 gauge galvanized iron with 1" wide flanges.

D. Water friction shall not exceed 8.0 feet of head in each coil. This Contractor shall tag all reheat coils and distribute them near the correct location for installation in the duct system as covered under Section 15800. This Contractor shall furnish complete information to the Ventilation Contractor regarding proper setting of the coils in the duct system.

2.4 FINNED TUBE RADIATION

A. Furnish and install where shown on the drawings, Sterling, Standard, Dunham Bush, Webster, Nesbitt or Vulcan finned tube radiation. All radiation shall be IBR rated and approved. Element length indicated on the drawings are minimum finned element lengths.

B. The heating elements shall be constructed of steel tubes and steel fins with fins of 20 gauge thickness securely bonded to pipe. All elements shall be installed on slide cradle hangers to eliminate all expansion noise. Wall hangers shall be of 12 gauge steel with side plates of 14 gauge steel. Hangers shall be bonderized and prime-coated. This Contractor shall furnish and install hangers for all finned tube radiation whether he provides enclosure or not.

C. The various heating elements and covers are indicated on the plans by alphabetical letters.

1. Selection of finned tube radiation is based on 195°F water entering and 165°F water leaving with 65°F entering air.

D. See drawings for radiation schedule.

2.5 CONVECTORS

A. Furnish and install where shown on the drawings Sterling, Airtherm, Trane hot water heating convectors. Front panels shall be constructed from 16 gauge sheet steel, bonderized and prime-coated, secured by key operated locks. Cabinets shall be fully recessed type, with wall guard and access doors.

B. Heating coils shall be copper tube with aluminum fins encased in a steel frame. Air vent assembly consisting of a manual air vent, copper tubing reducing coupling to connect with a copper air chamber. See piping detail on drawings.

C. All units shall be selected on 195 degrees F. water entering and 165 degrees F. water leaving with 65 degrees F. entering air. 6" D. with an output of 2.0 MBH.

D. See drawings for Convector Schedule.

2.7 CABINET UNIT HEATERS

A. Furnish and install cabinet unit heaters as shown on drawings. Numbers listed below refer to Trane catalog. Units manufactured by Airtherm, Nesbitt, Dunham Bush, McQuay and Modine are approved equal.

B. Hot water ratings for unit heaters shall be based on 195°F entering water and 165°F water leaving with 65°F entering air. See piping Detail on Drawings.

C. These cabinet units shall be constructed of 16 gauge steel fronts with directional louver type integral grilles, bonderized parts and gray prime finish. Provide copper coil with aluminum fins. Motors shall be three speed and shall be for 120 volts, single phase, 60 cycle and cabinet type unit. RPM shall not exceed those listed. All motors shall be provided with overload protection built into windings. Provide throw-away 1" thick glass fiber filters except where noted otherwise. Filters shall be replaced before building is turned over to Owner.

D. Provide high temperature belts in inverted units. Fronts on recessed or ceiling hung models shall have four side overlap. Recessed units on outside walls shall be backed by 1" thick 3 lb./cu. ft. density glass fiber insulation cut to fit the masonry opening.

E. Ceiling mounted cabinet unit heater shall have rubber grommets for isolation in hangers.

F. Wall mounted or concealed units shall be mounted above the base or as noted on architectural or mechanical drawings.

G. Units shall be complete with starters with thermal overload protection.

H. See drawings for Cabinet Unit Heater Schedule, and piping detail.

2.7 PROPELLER UNIT HEATERS

A. Furnish and install horizontal type unit heaters where shown on the drawings. Unit heaters as manufactured by Nesbitt, Trane, Modine, Webster, Westinghouse, McQuay, Dunham Bush, or Airtherm are approved.

B. Unit heaters shall have copper tubes, non-ferrous fins and cast headers. Fans shall be quiet operating and direct drive with 120 volts, 60 cycles, single phase motors with overload protection. Outlet shall have adjustable multi-blade louvers, two-way deflection.

C. Heaters shall have the capacities listed on the drawings. Units shall be sized for 195°F entering water and 165°F leaving water with 65°F air inlet temperatures.

D. See details on the drawings for piping of unit heaters.

E. Units shall be complete with starters with thermal overload protection.

F. See drawings for Propeller Unit Heater Schedule

2.8 HYDRONIC SYSTEMS ACCESSORIES (Radiation, Reheat, Radiant Panel, Heat Recovery and Chilled Water Systems)

A. Expansion Tanks

1. Closed expansion tanks shall be constructed according to ASME codes

and bear label of the same. Construction shall be black steel. Tanks as manufactured by Bell & Gossett and Bremen.

2. All tanks shall be complete with gauge glass with guards and cocks, overflow, drain valve, air charging valve, fill, system connection and opening for float.

3. Furnish and install McDonnell Miller Series 69 float switch set at one quarter level to indicate a remote low level light. Wiring by Mechanical Contractor with 120-60-1 characteristics. Low level alarm lights shall be brought to a central location in Unit B/C Basement Mechanical Room where directed by Architect/Engineer.

4. See drawings schedule for sizes of tanks.

B. Air Separator

1. Furnish and install as shown on the drawings Bell & Gossett Rolairtrol, Thrush, Armstrong or Taco air eliminator complete with strainer. Install unit for easy access for strainer clearing and provide blow down valve piped to floor drain. Unit sizes shall be as scheduled on the drawings.

C. Provide and install ASME pressure relief valves for radiation, reheat radiant panel, heat recovery and chilled water systems. Pipe relief valve discharge to nearest floor drain.

2.9 HEAT RECOVERY SYSTEMS

A. This contractor shall furnish and install a 50% ethylene glycol mixture heat recovery system for air handling units S-1C, S-14C and S-18C. The system shall be complete with air to water coils, piping, controls, valves, insulation, pumps, air separator, tanks, and fill, etc., complete as detailed on the drawings. System fill of 50% glycol mixture shall be by this Contractor.

1. Coils shall be the same as specified in Section 15900 for cooling coils, except provided continuous aluminum fins in lieu of copper. See schedule on drawings for size.

2. Pumps: Pumps shall be close-coupled, vertical split case centrifugal pump, having a leak proof mechanical seal with cast iron casing, bronze impellor stainless steel shaft and heavy duty motor.

a. Pumps shall be base mounted as shown on plans, complete with certified pump curves furnished with shop drawings. Special emphasis is placed on flat head characteristics of pump operation. Pump impeller diameter shall not be less than 90 percent of the maximum diameter to promote quiet operation.

b. Pump characteristics shall be as scheduled on the drawings.

c. Pumps shall be Bell and Gossett, Taco, Thrush, Ingersoll Rand, Aurora, Chicago and Allis-Chalmers.

3. Expansion tank and accessories shall be the same as specified in Article 2.8 above and sized on the drawings.

4. Thermometers and pressure gauges shall be the same as specified in Section 15130 and located as shown on the drawings.

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PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes the furnishing of all equipment and materials, and performing all labor necessary to connect the radiator coolant systems and other related systems.
- C. Related work specified elsewhere:
1. Basic Methods and Materials: Section 15100.
 2. Pipe and Pipe Fittings: Section 15110.
 3. Valves: Section 15120.
 4. Piping Specialties: Section 15130.
 5. Mechanical Supporting Devices: Section 15140.
 6. Vibration Isolation: Section 15150.
 7. Mechanical Systems Insulation: Section 15160.
- D. Installed but not furnished under this section:
1. Temperature control valves.

PART 2: PRODUCTS AND INSTALLATION

2.1 HEAT EXCHANGERS

- A. Furnish and install a fixed bundle, shell and tube, single pass, water-to-glycol heat exchangers having cast iron heads, 3/8" O.D. tubes Admiralty brass, brass tube supports and brass shell. Unit shall be Perfex Type "W". Bell and Gossett, Patterson-Kelley and Taco are approved as equal.
- B. Heat exchangers shall be constructed in accordance with ASME code for unfired pressure vessels for a working pressure of at least 125 psig. Water velocity shall not exceed 5 feet per second and the heating surface shall be based on a scale factor of 0.001. Capacity of each unit shall be as scheduled below for 1-pass heaters.

	<u>Tube Side</u>		<u>Shell Side</u>	
	System 1	System 2 & 3	System 1	System 2 & 3
1. Circuit	Engine	Engine	Radiator	Radiator
2. Fluid	Water	water	50% glycol/ water	50% glycol/ water
3. GPM	411	380	180	160
4. Temp. in °F	200	200	145.0	145.0
5. Temp. out °F	192.2	192.7	165.0	164.2
6. Max Press. drop psi	5.0	2.3	10.0	8.7

C. This Contractor shall furnish and install saddles and additional framework as required to mount heat exchangers.

2.2 RADIATORS

A. Furnish and install air cooled, finned tube radiators having 1/2" O.D. copper tubes, aluminum fins, fixed pitch propeller fan and TEFC motor. All sheet metal parts shall be hot-dipped galvanized. Unit shall be Perfex Model RHX. 80-3 System 1, 65-4 Systems 2 and 3. Equivalent equipment manufactured by McQuay, Trane or Carrier is approved as equal.

B. Radiators shall be constructed for a working pressure of at least 125 psig. Capacity shall be as scheduled below.

	<u>System 1</u>	<u>System 2 and 3</u>
1. Number of Fans/Blades	1/4	1/4
2. Fan Dia. - inches	84	84
3. Fan RPM	336	300
4. Fan Capacity - SCFM	46,600	43,400
5. Motor HP	7-1/2	5
6. Fluid in Tubes	50% ethylene glycol	50% ethylene glycol
7. GPM	180	160
8. Temperature in - °F	165.0	164.2
9. Temperature out - °F	145.0	145.0
10. Maximum Pressure Drop - Water - psi	2.0	6.0
11 Ambient Temp - °F	110°	110°

C. This Contractor shall install radiators on roof framing provided by the General Contractor. Additional intermediate supports as required and shown shall be provided by this Contractor. Radiators shall be mounted on Type 'C' isolation with 1" deflection. Radiator coolant piping shall be tied into the roof mounted radiators with flexible connections.

2.3 RADIATOR COOLANT SYSTEMS ACCESSORIES

A. Expansion Tanks:

1. Closed expansion tanks shall be constructed according to ASME Codes and bear label of the same. Construction shall be black steel.

2. All tanks shall be complete with gauge glass with guards and cocks, overflow, drain valve, fill, system connection and opening for float. Glycol mixture shall be provided by this Contractor.

3. Furnish and install McDonnell Miller Series 69 float switch set at one quarter level to indicate a remote low level light. Wiring by Mechanical Contractor with 120-60-1 characteristics.

4. See drawings for schedule and sizes of tanks.

B. Air Separators:

1. Furnish and install as shown and scheduled on the drawings, a Bell & Gossett, Thrush or Taco air eliminator complete with strainer. Install unit with easy access for strainer cleaning and provide blow down valve piped to floor drain.

C. Surge Tanks:

1. Furnish and install where shown on the drawings a 20 gallon black steel surge tanks by the same manufacturer as the heat exchanger.

2. Surge Tanks shall be complete with gauge glass and 14 psig radiator cap. Provide openings for inlet, drain and fill connections, all as detailed on the drawings. Provide with factory prime and finish coat.

Provide and install ASME pressure relief valves for radiator coolant systems. Pipe relief valve discharge to nearest floor drain.

2.4 PUMPS

A. Furnish and install, split-case, centrifugal pumps having leak proof mechanical seals, cast iron casings, bronze impellers, stainless steel shafts and heavy duty motors.

B. Pumps shall be base mounted as shown on the plans. They shall be complete with pump curves furnished with the shop drawings. Special emphasis is placed on flat head characteristics of pump operation. Pump impeller diameter shall not be less than 85% of the maximum diameter to promote quiet operation.

C. Pump characteristics shall be as scheduled on the drawings.

D. Pumps shall be Bell and Gossett, Taco, Thrush, Ingersoll Rand, Aurora, Chicago or Allis-Chalmers.

2.5 CONTROLS

A. Typical for each of 3 radiator coolant systems serving engine driven emergency generators. The radiator coolant circulating system pump (50% glycol/water) will be interlocked with the emergency generator by the Electrical Contractor.

An aquastat with a wide range adjustable differential shall cycle the fans on the roof mounted radiator cooler. This aquastat shall be located inside the building in the 15th Floor Mechanical Room.

This Contractor shall supply necessary controls and do all control wiring.

2.6 GLYCOL MIXING AND FILL SYSTEM

This system shall serve as the means of filling all glycol/water systems from the one location. See Drawing Detail Sheet M-72.

A. Tank

1. Provide a 50 gallon heavy gauge, free-standing translucent polyethylene tank. The tank shall have a removable cover, a 3/4" drain valve and a 3/4" outlet valve. Graduations on the tank side shall be provided for reading liquid level.

2. The tank shall sit on a welded steel frame.

3. The tank shall have an electric agitator with stainless steel shaft and impeller. Agitator motor shall be 1/4 HP, 115 volt, 60 Hz, single phase.

4. Provide a liquid level switch on the tank to shut the pump off automatically when the tank is near empty.

5. The tank, stand and agitator shall be furnished as a package by Mogul, or approved equal.

6. All piping, valves, strainers, control wiring etc., necessary to make the system function properly shall be the responsibility of this Contractor.

B. Pump

1. Furnish and install an in-line centrifugal pump having leak proof mechanical seals, cast iron casing and bronze impeller.

2. Pump shall be capable of pumping 5 GPM against 49' of head at 1750 RPM with a 1 HP motor.

3. Pump shall be Bell and Gossett series 60 - 1-1/2A, bronze fitted, Thrush, Taco or Armstrong.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary to connect the ventilation and air conditioning systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100
2. Mechanical Supporting Devices: Section 15140.
3. Vibration Isolation: Section 15150.
4. Mechanical Systems Insulation: Section 15160.

D. Installed but not furnished under this section:

1. Water Reheat Coils
2. Steam Coils.
3. Cooling Coils
4. Sound traps for sound-isolated rooms.

PART 2: PRODUCTS AND INSTALLATION

2.1 SHEET METAL WORK

A. All ducts and built-up fan and coil housings where shown on the drawings shall be constructed from zinc-coated iron or steel sheets unless listed otherwise, and they shall conform accurately to the dimensions indicated on the drawings. All ducts shall be installed in accordance with the recommendations of the latest edition of ASHRAE Guide and Data Book (Systems and Equipment) Air Duct Design. Gauges of metal and reinforcing shall be in accordance with their Table 10, which has been partially reproduced on the drawings for the Contractor's convenience. All joints on supply air duct work shall be sealed with 3M Brand Sealer EC-800, or approved equal, with application, according to manufacturer's recommended procedure. Relief air and exhaust air ducts at the

point of entering or leaving the building, ductwork containing duct humidifiers, and all fresh air duct work and any point where moisture can collect, shall be soldered absolutely watertight.

B. Flat areas of duct over 18" in either dimension shall be cross broken. Cross breaking is not required if the ducts are insulated.

C. All ductwork shall be run substantially as shown on the drawings. However, where conflicts occur with other trades, the Architect/Engineer reserves the right to require the contractor to make minor changes in duct locations. Whenever possible, ducts shall be run close to beams or floor slabs above, and where two or more ducts cross each other they must be arranged in such a manner as to get the greatest possible clearances underneath. This Contractor shall avoid running ductwork in the plumbing or electrical strata. This Contractor shall not cover service panels or electrical outlets.

D. Where sound insulation is specified and/or shown for ducts, they shall be constructed so the sizes shown on the drawings are the dimensions inside the insulation. A reduction in duct area because of the installation of sound insulation will not be permitted.

E. All horizontal ductwork shall be securely anchored to the building construction in a manner to be free from vibration and swaying under all conditions of operation. Hangers for ducts smaller than 30" x 15" shall be supported with trapeze hangers, consisting of galvanized steel straps metal screwed to the duct in accordance with the following schedule.

<u>STRAP SIZE</u>	<u>DUCT SIZE</u>	<u>HANGER SPACING</u>
18 ga. x 1" W	Up to 17" x 11"	8'-0" o.c.
18 ga. x 1" W	18" x 12" to 30" x 15"	6'-0" o.c.

Ductwork larger than 30" x 15" shall be supported with trapeze hangers consisting of rods and angles. Rivets or bolts shall be used for attaching hangers to ductwork.

F. All vertical duct risers that pass through floors shall have supporting angles that shall be securely fastened to ducts with rivets (no screws) attached to the ducts with the angles supported on adjoining floor or beam construction in an approved manner. Angles shall be galvanized and shall be placed on at least two sides of the duct.

<u>ANGLE SIZE</u>	<u>DUCT SIZE</u>
1-1/2" x 1-1/2" x 1/8"	36" x 18"
2" x 2" x 1/8"	48" x 24"
2" x 2" x 3/16"	Larger than 48" x 24"

G. The minimum duct size shall be 6" x 6". Curved elbows shall have a centerline radius equal to 1-1/2 times the width of the duct. Where space conditions prevent the curved elbows specified above and/or where square turns are indicated on the drawings, the contractor shall use multi-type turning vanes, such as "Ducturns"

or he may construct the vanes to conform with the following requirements. Changes in size throughout shall be of perfect rectangular cross section. Vanes shall be well-braced and rough or raw edges shall be avoided to prevent objectionable noise, they shall be double thickness type and shall be the same gauge as the duct in which they are installed. Vanes shall be pre-assembled on runners before being installed in the elbow. Vanes shall conform to the following table:

<u>DUCT WIDTH INCHES</u>	<u>VANE SPACING INCHES</u>	<u>INSIDE BLADE RADIUS INCHES</u>	<u>OUTSIDE BLADE RADIUS INCHES</u>	<u>RUNNER WIDTH INCHES</u>
Up to 25"	1-1/2 centers	2	1	5
Above 25"	3-1/4 centers	4-1/2	2-1/4	9

H. All branch take-offs, from the main shall be of the "divertor" type.

I. All ventilation air which is conveyed below grade in earth shall be run through either round reinforced concrete pipe or extra heavy vitrified clay pipe or transite materials, all of which shall be code approved. Concrete pipe shall be that as manufactured by Cretex Company. Tile pipe shall be that as manufactured by Red Wing Pottery and Tile Company. Transite pipe shall be that as manufactured by the Johns-Manville Manufacturing Company. Only round concrete pipes will be acceptable for sizes 15" and over in diameter. All underground ductwork shall be installed in accordance with Manual #4 of the National Air Heating and Air Conditioning Association. Transite ducts shall be jointed by the use of mechanical joints. Tile and concrete pipes shall be jointed with a plastic sealing compound with all joints encased in 2" of concrete. Sheet metal joints and transitions shall be encased in concrete.

J. Exhaust Ductwork serving kitchen areas shall be No. 18 gauge black steel braced with angle iron and not cross broken, with all joints welded. Pitch horizontal ductwork up towards riser. Provide bolted access cleanouts every 10 feet on horizontal ductwork. Provide a bolted access cleanout at the base of a vertical rise, and every 20 feet on the vertical duct. All cleanouts shall be located on a vertical surface.

K. All weather louvers in outside walls will be furnished and installed under the general construction work section of these specifications. This contractor shall make watertight connections to louver frames for all weather louvers. At fresh air intakes provide soldered drain pans with threaded drain connections to collect any waste water entering through louvers or accumulating from melting snow. Extend pan drains to floor drains.

Contractor shall blank-off all unused weather louvers areas with sheet metal and insulate blanked-off section as per Section 15160.

L. Acoustical Vanes: Where indicated on the drawings, furnish and install acoustical type turning vanes. These shall be Sono-Turn, as manufactured by Sound Control products. or Acoustiturn as manufactured by Air Filter Corporation. Acoustical type turning vanes shall be commercially manufactured with published sound attenuating data available. Field or shop fabricated items are not acceptable.

M. Backdraft dampers shall be constructed of rolled aluminum leaves, 26 gauge, attached to steel rods supported in a steel frame. Dampers shall be provided with position indicators. Each leaf of the shutter shall be edged with a neoprene strip tightly folded into the metal to prevent "rattling". All leaves shall be linked together to operate as a unit.

N. Provide protective rubber or armafex type bumpers on all hangers and corners of ducts that could be dangerous to maintenance personnel.

2.2 VOLUME, AIR FLOW DEVICES AND BALANCING DAMPERS

A. This Contractor shall furnish and install the required air devices necessary to produce the specified air volumes without excess air resistance or noise.

Butterfly dampers shall be installed at all branch take-offs or in trunk ducts at branch take-off locations, except for any flat or square take-offs for supply air branches which shall have volume extractors with operators accessible from outside the ductwork. Dampers shall be reinforced to prevent vibration, and shall be equipped with approved damper rods, quadrants and locking devices. Quadrants shall be marked to indicate damper position. Where ducts are insulated, quadrants shall be set to finish flush with insulation. Up to and including 3 square feet duct area, use one butterfly damper, from 3 square feet duct area up to and including 6 square feet duct area use two butterfly dampers each with locking quadrant. Over 6 square feet duct area use opposed blade dampers with standard channel welded frame and oilite brass bearings. Maximum blade width shall be 6". Splitter dampers shall be used only for conditions described on symbol sheet Drawing M-1 and where specifically shown on drawings.

B. Each fume hood and canopy hood shall have an opposed blade balancing damper installed in the exhaust ductwork.

1. All automatic dampers, volume dampers, splitters and fire dampers installed in corrosion resistant ductwork shall have blades and rods cleaned and degreased and primed with one (1) coat of Placite 7103 Primer and finishing with two (2) coats (5 mils each) of Placite 7122. Degreasing and coating of all dampers shall be by this contractor.

2.3 SHEET METAL DUCTWORK FOR FUME HOODS

A. All ductwork used for fume hood exhaust, unless otherwise noted, shall be constructed of corrosion resistant sheet metal, equal to H. H. Robertson Company "Galbestos". These ducts shall be protected on both sides with:

1. Asbestos felt bonded to steel core with a metallic adhesive.

2. Asphaltic application and impregnation of the asbestos felt.

3. Corrosion-proof coating of approved bituminous compound applied by hot rollers at a minimum temperature of 380 degrees F. This application shall weigh not less than 7 lbs. per 100 sq.ft. of surface.

4. All above coatings shall withstand temperatures as high as 150 degrees F. without running.

5. Galbestos shall be handled and formed into shape, in accordance with the manufacturer's printed instructions. Ducts shall be substantially fabricated and shall be air tight to prevent leakage or infiltration. All longitudinal and traverse joints are to be made up with Pittsburgh seams and slip and drive connections and sealed with Everplastic asphaltic compound.

6. All shop and field seams shall be fully sealed with Everplastic asphaltic compound before assembly. Any cracks or breaks occurring in fabrication or in erection shall be sealed by application of Everplastic to the affected parts. See access panel detail on drawings.

7. All ducts shall be supported by metal rod hangers, with the ducts resting on angle irons fastened in place and firmly secured.

8. Make connections to fume hood exhaust fan inlets and from fan outlets extend ductwork through roof as shown and detailed on the drawings.

9. The exception to the above for using "Galbestos" type ductwork shall be that the exposed duct connections to the fume hood penetrating the ceiling and from the fume hood fan outlet to the roof outlet shall be 22 gauge, type 316 stainless steel with 2B finish.

B. Exhaust ductwork for radioactive fume hoods from the hood to the absolute filter shall be constructed from 22 gauge, type 316 stainless steel with No. 2B finish. All components of this system shall be impervious and inorganic material.

C. This Contractor has the option of using type 316 stainless steel with No. 2B finish, ductwork for all fume exhaust systems in lieu of "Galbestos".

D. All fume hood ductwork gauge and fabrication shall be according to ASTM specifications for medium pressure ductwork.

2.4 ACCESS DOORS, PANELS AND CLEANOUTS

A. Where reheat coils, motorized dampers, smoke dampers, fire dampers, control equipment, etc., are installed in ducts, provide access panels made air tight with gasketed edges. Access panels shall be as detailed on the drawings. Provide access doors between obstructions at each change of direction and/or not more than 20'-0" o.c. on horizontal ducts and at the bottom of each duct riser. Access doors shall be sized in accordance with equipment maintenance and duct cleaning requirements of the system. Additional access panels beyond those on the drawings shall be installed to fulfill this spacing requirement. Use Ventlok sponge rubber gasketing material. The panels shall be double wall construction with 1" of rigid insulation fill and shall be attached to the duct with cam latches. Omit access panel insulation and double wall construction if ducts are not specified to be insulated. For other than reheat coils the access panels shall be of adequate size to permit maintenance of the equipment. For reheat coils the access panels shall be installed on the side of the duct so that the coil and valves can be serviced through one ceiling access panel. The duct panel shall be at the air inlet side for coil cleaning and shall be sized as follows:

Reheat Coil Depth

6" to 15"
15" to 21"
21" and above

Access Panel Size

10" W. x (coil depth -2") D.
12" W. x (coil depth -2") D.
18" W. x (coil depth -2") D.

Normally coil access panels shall be installed on the sides of ducts. However, where pipes, conduit, etc., interfere with easy access, panels may be installed on the bottom of the duct. The Contractor shall secure the Architect's permission before using bottom mounted panels.

B. See paragraph 2.11 C. for access panels at fire and motorized smoke dampers.

2.5 FLEXIBLE DUCT CONNECTIONS

A. Install flexible connections at connections between all fan suction and discharge openings, ventilating machines and sheet metal ducts or housings. These connections shall be made of fire resistant, waterproof duct fabric, closely woven glass fabric, double-coated with neoprene material, 30 oz. weight, similar to "Ventglass", as manufactured by Ventfabrics.

B. This contractor shall use 1" x 1" x 1/2" angles to clamp the duct fabric to the rectangular ductwork, fan suction and discharge openings and ventilating machines, using 5/16" stove bolts or rivets on approximately 6" centers. Use #14 gauge, 1" wide bands to bolt fabric to round openings. Joints shall not be located at corners of ducts and must be lapped joints and completely airtight. All connections shall be a minimum of 6" wide and shall be made with slack in the fabric.

2.6 SOUND ATTENUATING FAN ENCLOSURES AND FAN DISCHARGE PLENUMS

A. This Contractor shall construct acoustical enclosures for supply fan discharge plenums as indicated on the drawings. They shall be assembled from Soundmetal Panels, by Koppers Company, IAC Noishield panels by Industrial Acoustics Company, Keene Vibrasonics, Rink Corporation, United Sheet Metal Co. or Dualite Acoustapanel by Buensod. Supply fan discharge plenum shall be four sided.

B. Panels shall be 4" nominal thickness, fabricated with 22 gauge galvanized steel or aluminum perforated sheets on the interior and 18 gauge galvanized steel or aluminum sheets on the exterior. Edges of panels shall be sealed with channel frames or extrusions for structural stability. Sound retarding and absorbing fill shall be incombustible, inert, mildew resistant and vermin proof. Panels shall have a maximum "U" factor of .14 BTU per hour per square foot per degree F.

C. Plenum design shall have combustion requirements that do not exceed the following:

1. Flame Spread - not over 25
2. Smoke Developed - not over 50

D. Openings for fan, ducts and access shall be cut and framed by this Contractor. Panel connections and erection shall be in accordance with the manufacturer's recommendations. Supply fan discharge plenums shall be capable of withstanding a positive internal pressure of 4 inches.

E. Panels and doors shall have the following minimum transmission loss characteristics.

Frequency (CPS)	125	250	500	1000	2000	4000
Attenuation (DB)	23	30	42	52	60	61

Acoustical and absorption coefficients shall be compatible with the above sound transmission class.

F. The supply fan discharge plenum structure shall be supported from adjoining fan housing. Bottom panels shall be supported free from the floor with vibration eliminators as scheduled on the Drawings.

2.7 NOISE ATTENUATORS

A. This Contractor shall furnish and install sound attenuators of types as scheduled on the drawings. Units shall be as manufactured by Koppers Company Inc. or Industrial Acoustics or approved equal. The attenuators shall be constructed of 22 gauge galvanized steel sheets with an acoustical filler of 435# fiberglass. Units shall be Industrial Acoustics low static pressure resistance type "L" and be 5 feet long minimum except as noted otherwise.

B. Attenuators shall have the following minimum transmission loss characteristics.

Frequency (CPS)	106	212	425	850	1700	3400	6000
Attenuation(DB)	8	13	19	29	37	29	21

2.8 FLEXIBLE DUCT

A. Flexible insulated ducts shall be a factory assembled unit, with spin-on fitting with integral volume damper with locking quadrant device for connection to the branch duct and a downstream coupler specifically designed to lock in to the coupler collar furnished on the air diffusers or registers. This collar must be verified with units furnished with the ceiling system.

B. The duct shall consist of a galvanized or vinyl coated spring steel wire helix or resilient steel band and woven fiberglass mesh liner, 1" insulation and a factory sealed vapor barrier. The product shall bear UL Class I air duct label as tested under UL 181 and required by NFPA 90A.

1. Flame Spread - not over 25
2. Smoke Developed - not over 50

C. Flexible duct assembly shall have a thermal conductivity "K" factor of 0.25 at 75 degrees F. mean. Assemblies shall be constructed for conveying air at 250 degrees F. at a maximum velocity of 2400 F.P.M. and 1-1/2 inches of maximum internal positive static pressure and 1/2" maximum negative pressure.

D. Assemblies shall consist of insulated duct lengths of 5'-0", with no splices in a run of duct with 45 degrees total bends the maximum that are allowed in the 5'-0" run. The assembly shall have a minimum straight run acoustical attenuation of the following:

Frequency (CPS)	125	250	500	1000	2000	4000
Attenuation (DB)	15	18	17	18	14	9

E. Flexible insulated ducts assembly shall be Owens-Corning Fiberglass, XLC, Glass Flex Type OC-41, wiremold 49-K Thermaflex Type M-KA, H. K. Porter Co., or Genflex.

2.8 EQUIPMENT

A. Centrifugal Fans: Fans shall be Trane or approved equal. These fans shall be AMCA rated and certified, non-power overloading, airfoil blade, backward curved fans in Class II Construction, for all supply and return-relief fans and shall be AMCA rated Class I non overloading, backward curved for general exhaust fans unless otherwise noted. Fans shall have 1-1/4" tapping in bottom of scroll, with plug for drainage. Fans shall be arrangement 3 and fans under 36" shall be convertible.

1. Each fan shall be equipped with two or more heavy duty grease lubricated anti-friction bearings. Class II fans shall have precision built spherical roller bearings and Class I fans shall have self-aligning pillow block ball bearings.

2. All fan wheels, shafts and the interior and exterior of fan housing shall be cleaned of rust, mill scale, etc. degreased then given a primer coat of red lead or zinc chromate, and then sprayed with two (2) coats of chlorinated rubber base paint to prevent corrosion. All of this work shall be done at the factory.

3. Adjustable inlet vanes shall be provided on all fans as scheduled. Inlet vanes shall have positive control linkage and be individually supported at both ends by a precision bronze bearing. Vanes on double inlet fans shall be interconnected to operate in unison. The control arm shall be suitable for manual or automatic operation.

4. Scroll bypass dampers shall be provided on all fans as scheduled. This bypass damper shall be mounted on the scroll and have opposed airfoil blades. Blades and frame shall have extruded vinyl seals to provide positive sealing. The control arm shall be suitable for manual or automatic operation.

5. Provide split housings on centrifugal fans as noted on drawing schedule.

6. AMCA certified test curves shall be provided on all centrifugal fans which will be required to operate at an initial condition different from its ultimate future requirement. Test shall be run at initial and final CFM and static pressure conditions.

B. Propeller Fans: Propeller fans shall be Trane, Champion, Greenheck, Acme, Chicago Blower, American Standard, Barry, York, Carrier or Peerless, and shall be direct or belt-driven as noted. Units shall be complete with mounting panel, three (3) or more blade propellers, steel hub, blade guard, terminal box, ball bearing motor and belt guard. Fans shall be rated and certified per AMCA standards. This Contractor shall furnish all sheet metal, blank-off necessary for satisfactory installations and operation of these fans.

C. Fume Hood Exhaust Industrial Fans: Fume hood exhaust fans shall be Buffalo type "V" or "MW", Barry Series 600 Sturtevant series 400M, having not more than six (6) radial blades, and open type wheel. Fan housings shall be cast iron or

steel plate construction with frictionless self-aligning, resilient mounted, pillow type bearings. No oilite type bearings are to be used. All hood exhaust fans shall be arrangement 9 and shall have 1-1/4" tapping in bottom of scroll, with plug for drainage. The entire interior of the hood exhaust fans, including fan wheels and shafts, shall be coated with six (6) coats of baked phenolic (approximately 5 mils thick), Plasite, Heresite, or approved equal

D. Utility Blower Fan Sets: Utility sets as scheduled shall be Trane, Champion, Chicago Blower, American Standard, Barry, York, Carrier or Peerless. Units shall be standard built together, motor and fan mounted on a common base with hood. Fan wheels, in general, shall be backward curved, certified non overloading, except where noted. Provide scroll drain tapping with plug. Fans shall be equipped with frictionless self-aligning, resilient mounted, pillow type bearings. No oilite type bearings shall be used. Fans shall be rated and certified per AMCA.

E. Terminal Booster Supply Fans: These fans shall be Cook, Aerovent, Penn, or approved equal, centri-vane inline centrifugal fan. Motor shall be out of the air stream. Fan units shall be belt drive or direct drive as scheduled on the drawings with direct drive units having external disconnect. Fan housing, fan wheel and supports shall be aluminum. Isolation mounts shall be extruded rubber.

F. All fans shall be equipped with a bolted on scroll access panel, rolled to fit the scroll curvature and made of metal same gauge as the scroll. Panels shall be fitted with asbestos gaskets and made airtight.

G. Belt Guards: All fans shall be furnished with variable speed drives and installed with guards to enclose all belts, drive shafts and rotating equipment. These guards are to be constructed of 20 gauge galvanized steel with 16 gauge 3/4" diamond mesh screen or expanded metal. The mesh screen or expanded metal shall be spot or stitch welded to the frame. The guard shall be supported on brackets from the floor or fan base. Openings shall be provided in guards to permit tachometer readings for both motor and driven unit. Guards shall comply with the requirements of the Minnesota Industrial Commission and be designed for easy removal for belt replacement.

H. Packaged Air Handling Units: This Contractor shall furnish and install all package air handling units. These units shall be draw-through type and contain components as scheduled herein. Units shall be Trane, Carrier, York, McQuay, Dunham Bush, Westinghouse or approved equal, low pressure type or medium pressure type when indicated.

1. The casing shall be of sectional construction, enclosing fans, bearings, cooling coil and drain pan and in certain cases the heating coil. See Section 15830 for roll filter requirements. Units shall be constructed of heavy gauge furniture steel, suitably reinforced. Exterior shall be smooth construction with removable side panels for access and inspection. Access doors shall be airtight, yet easily removable. Casings shall be designed so coils can be removed. Casings and all accessories shall be given a protective enamel paint finish. Unit shall be medium pressure type.

2. Fans shall be double width, double inlet, multi-blade centrifugal type and shall be statically and dynamically balanced at the factory. Fans shall be installed on proper sized one-piece hollow or solid shafts. Bearings

shall be self-aligning resilient mounted, pillow block type bearings externally mounted. No oilite type bearings are acceptable. Fans shall have "AMCA" seal. Motor shall be mounted on slide rail base with V-belts, belt guard, and adjustable sheave. Motors shall have a service factor of 1.4.

a. Packaged air handling units having internal bearings are satisfactory providing:

(1) Single fan units have three (3) bearings and split shaft similar to a double inlet fan with a shaft extension and adequate access panels to service bearings and replace shaft is necessary.

(2) Two fan units shall have similar service and replacement capability.

3. Casing unit panels and coil panels shall be insulated with 1" blanket fiber glass type insulation, with neoprene coating on air side to eliminate wear. Drain pans shall be complete with seamless 1/2" cellular foam-in place insulation.

4. Heating coils for all units except units S-10C, S-11C, S-12C, S-19C, S-20C, S-21C, S-22C and S24C shall be same as specified in Section 15600, Article 2.2. Heating coils for these units shall be Trane Type NS, steam distributing type coil, with 1" copper condensing tubes and continuous aluminum fins. See the Drawing Schedule for those units with one or two heating coils.

5. Cooling coils where scheduled, same as specified in Section 15900, Article 2.4. Unit S-24C shall have no cooling coil.

6. Medium capacity filter box. Provide as scheduled. Casing shall be designed for attaching on fan unit casing on one end and duct attachment to other end. Unit shall be designed to hold 2" throw away filters. Provide full size access doors on filter inlet side.

1. Belt Drives: All fans shall be equipped with V-belt drives, adjustable motor sheaves and belts. See fan schedule for units requiring 2 sets of drives, sheaves and belts. Drives shall be as manufactured by Allis-Chalmers Company, Browning Manufacturing Company, and Gates Rubber Company. All pulleys shall be carefully and accurately balanced for static and dynamic accuracy. The number of belts and grooves for each unit shall be based on a 150% overload rating. The overloading rating shall be applied to motor nameplate horsepowers for each fan, not brake horsepower. Pitch diameter of pulleys are not given, but driven speed must be maintained as closely as possible where regular stock size pulleys are used with 1750 RPM motors. Variable speed sheaves shall be selected so the pitch diameter at design conditions is midway between the minimum and maximum for the particular sheave. All drives shall be supplied with at least the minimum number of belts as outlined below.

0 - 1-1/2 HP -- 1 belt
2 - 7-1/2 HP -- 2 belts

All drives above 7-1/2 HP shall be supplied with number of belts as recommended by the drive manufacturer. The belts shall be furnished in matched and sealed sets.

J. Air Blender: Provide Air Blenders as manufactured by R. M. Products Company and as shown and scheduled on the drawings. Air blenders shall be factory built and tested, and shall be installed in strict accordance with manufacturer's recommendations, and as shown on the drawings. Blenders shall be fabricated of heavy gauge aluminum, all welded construction, with necessary cross bracing to withstand system pressures with no vibration noise. Units shall be completely fixed devices that shall be capable of providing air temperature within 6°F of theoretical mixed air temperature.

K. In addition to the fume hood exhaust fans as previously specified, other exhaust fans, as scheduled, shall be coated with corrosion resistant coatings. These fans shall have the entire interior, including fan wheels, shafts, and fan section housing enclosure coated with three (3) coats of baked Phenolic, Plasite, or Heresite.

2.9 REGISTERS, GRILLES, DIFFUSERS AND CONTROL DEVICES

A. This Contractor shall furnish and install all registers, grilles, diffusers and such air distribution accessories indicated, shown and/or tabulated on the drawings, that are necessary to effect uniform distribution of air. All registers, grilles and diffusers furnished by the Mechanical Contractor shall have prime and finish coat as selected by the Architect. Draw all air outlet and return devices tight to ceilings and/or walls to eliminate dirt streaking using extra screws if necessary to secure a tight fit. This contractor shall refer to architectural drawings for type of ceilings and be responsible for proper type of frame for type of ceiling or wall. The various grilles, registers and diffusers are indicated on the plans by alphabetical letters, according to the following schedule. Registers, grilles, diffusers and control devices by Waterloo-Anemostat, Carnes & Krueger and Titus are approved as equal to Tuttle & Bailey as specified.

B. Linear supply diffusers, with no alphabetical notation, but noted on plans as 1-way, 2-way, etc. are furnished and installed with the ceiling suspension system. This contractor shall make air flow adjustment and connections to supply air distribution system with flexible duct.

C. Type 'B' ceiling panels used as 10" x 9" supply, relief, return and exhaust. These units are furnished and installed with the ceiling suspension system. This contractor shall make air flow adjustment and connection to return and/or exhaust air distribution system. When a panel is used for supply air the General Contractor shall insert a pattern controller into the panel, see Architectural Detail on Sheet 10/A4-14. This Contractor shall make connection to supply air distribution system with flexible round duct. See Architectural Drawing A4-14.

D. Type 'C'. Same as Type 'B' except 10" x 16" size. See Architectural Drawing A4-14.

E. Type 'D'. Same as Type 'B' except 10" x 23" size. See Architectural Drawing A4-14.

F. Type 'E'. Same as Type 'B' except for grille location in panel. See Architectural Sheet A4-14.

G. Type 'F' same as Type 'C' except for grille location in panel. See Architectural Sheet A4-14.

H. Type 'G'. Linear return and/or exhaust register, 1-slot. These units are furnished and installed with the ceiling suspension system. This Contractor shall make air flow adjustment and connections to return and/or exhaust air distribution system with flexible duct.

I. Type 'H'. Same as Type 'G', except 2-slot.

J. Type 'J'. Ceiling supply registers. These shall be Tuttle and Bailey Model NT 607, aluminum with vertical face bars 1/2" centers, removable key operated opposed blade dampers and 5/8" margin. Front bars shall be adjustable. Color selected by Architect.

K. Type 'K'. Sidewall supply registers. These shall be Tuttle and Bailey Model NT 647 and 45B frame, aluminum with horizontal rear bars and vertical face bars and removable key operated opposed blade dampers. Front and rear bars shall be adjustable. Color selected by Architect.

L. Type 'L'. Sidewall return and exhaust registers. These shall be Tuttle and Bailey Model NT 77D and 45B frame, aluminum, with horizontal face bars set at 35 degrees through 45 degrees and removable key operated opposed blade dampers. Registers shall be mounted with bars angled upward when at or above eye level. Color selected by Architect.

M. Type 'M'. Unitary Panels. These shall be Multi-Vent as manufactured by Dynamics Corporation of America, Series MVART unitary panels complete with air valves, enclosures and distribution face plate made of steel with white baked enamel finish. All panels shall be suitable for installation in operating room ceilings, with necessary clip angles (by Mechanical) as per Architectural Details Sheet A49. Operating Rooms are 1-283, 1-292 and 1-297.

N. Type 'N'. Unitary Panels. These shall be Multi-Vent as manufactured by Dynamics Corporation of America, Series MVART unitary panels, complete with air valves, enclosures and distribution face plate made of steel with white baked enamel finish. All panels shall be suitable for installation in lay-in-type ceilings.

O. Type 'N-I'. Unitary Panels. These shall be Multi-Vent as manufactured by Dynamics Corporation of America, Series MVAR Unitary panels complete with air valves, enclosures and distribution face plate made of steel with white baked enamel finish. All panels shall be suitable for installation in plaster ceilings.

I. Trim strips shall be provided as required for installation as shown on the drawings. The face plates shall be removable with chain-linked hinges.

P. Type 'O'. Round drum type supply diffuser. These shall be Krueger, Type A, or approved equal, round drum diffuser. Units shall be constructed from non-flammable plastic, with cut-off guard and adjustable deflection. Color selected by Architect.

Q. Type 'P'. Ceiling exhaust and/or return air register. Same as Type 'L' except with horizontal face bars set at 0 degrees.

R. Type 'Q'. Ceiling Grilles. Same as Type 'L', except with horizontal face bars set at 0 degrees, and no opposed blade damper. Where heavy duty grilles

are indicated in floor, use Tuttle & Bailey Model T-70G, steel with 0° deflection.

R. Type 'R'. Ceiling Supply Registers. These shall be Tuttle and Bailey Model AN47-1 through AN47-4 and 45B frame, aluminum with adjustable vertical face bars and removable key operated opposed blade dampers. Color selected by Architect.

T. Type 'S'. Linear Supply Diffuser. These units are furnished and installed with the metal panel ceiling suspension system. This Contractor shall furnish and install air plenum above diffuser and make air flow adjustment and connections to supply air distribution system with flexible duct.

U. Type 'T'. Linear Supply Diffusers. These shall be Tuttle and Bailey Imperial line 6000 Series with No. B2 frame, extruded aluminum linear air diffuser. Units shall have plaster frames and key operated opposed blade dampers. Units shall have complete adjustment for vertical and horizontal air flow. Color shall be special, with color chips furnished by Architect.

V. Type 'U'. Filtered Return Grille. These shall be Tuttle and Bailey Model A110DFB aluminum with horizontal face bar set at 45°. Register shall be mounted with bars angled upward for splash protection when room is hosed down.

W. Type 'V'. Linear Return Grille. These shall be Tuttle and Bailey Imperialine Series 6000 extruded aluminum linear air diffuser. Units shall have plaster frames and key operated opposed blade dampers.

X. Type 'W'. Sidewall grilles for Vestibules 90 and 93 shall be Tuttle and Bailey Imperialine 4000, 1/2" space 0 degrees deflecting grille only and no frame. See Architectural Drawing A-71 for installation detail.

Y. Branch take-off device for butted duct connection, butted registers, etc., shall be Tuttle and Bailey "Vectrols".

2.10 DUCT SLEEVES

A. Furnish and install sleeves at all locations where ducts pass through walls, floors, or partitions not fire rated. Sleeves shall be fabricated of 16 gauge galvanized iron with angle iron stiffeners as required to prevent bending.

B. Sleeves shall be 1/2" larger in dimension than the duct passing through and shall be 1/2" larger than through-going insulated duct.

C. Sleeves passing through finished walls, ceilings and partitions shall be set flush with finished surface. Sleeves through floors in exposed and concealed areas shall be extended 1/2" above the finished floors.

D. Seal the space between the duct and sleeve with plastic caulking such as Presstite or Duragum. Sleeves shall be set and maintained in place by this Contractor during the progress of the work.

E. Where ducts pass through fire partitions the ducts and sleeves shall be constructed per Paragraph 2.11.

2.11 AUTOMATIC FIRE DAMPERS

A. Furnish and install fire dampers in all ducts where shown on the drawings, where required by the City of Minneapolis, where required by NFPA Pamphlet 90-A and Minnesota Building Code and as indicated below:

1. Where horizontal duct pierces fire partition.
2. At the junction of each branch duct with main vertical duct at utility core wall.
3. At each point where a vertical duct pierces a floor.

B. All fire dampers shall bear UL label and shall be constructed and installed in accordance with NFPA Pamphlet 90-A and as detailed on the drawings. Steel sleeves as shown shall be attached to walls and floors and to the fire damper.

C. All dampers shall have approved damper position indicators so that damper position can be determined without removing the access panel. Access panels with glass insert will be acceptable in lieu of damper position indicator. Glass used shall have essentially the same fire rating as a metal panel.

D. Fire doors shall meet all description as listed above, but shall be rated 3 hours.

E. Fire dampers and fire doors shall be Air Balance, Advanced Air, Ruskin and Air Stream, United Sheet Metal Co., Tuttle & Bailey or approved equal.

2.12 CANOPY HOODS

Canopy hoods will be furnished and installed by General Contractor. Mechanical Contractor shall make duct connections as shown and detailed on the drawings.

2.13 EXHAUST OR FRESH AIR INTAKE ROOF VENTILATOR

Ventilators as shown on the drawings and as scheduled shall be Acme "Skymaster Trimline" low silhouette. Unit shall be Model X for exhaust air use (1 to 1 ratio of hood perimeter opening to throat area) and Model N for intake air use (2 to 1 ratio of hood perimeter opening to throat area). Unit shall be constructed of aluminum with extruded channels for rigidity. Supply with zinc chromate primer for field painting by General Contractor. Unit shall have ginged hood and 1/2" mesh galvanized bird schrren. A heavy coating of asphaltic base mastic compound shall be sprayed on underside of hood and base for condensation protection.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary for air filtration systems and related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Ventilation and Air Conditioning: Section 15800.

PART 2: PRODUCTS AND INSTALLATION

2.1 AIR FILTERS AND AIR HANDLING UNITS

A. Air filters shall be as manufactured by the American Air Filter Company, Inc., Cambridge Filter Corporation, Farr, Mine Safety Appliance, or Continental Air Filter Company. All units shall be similar to physical dimensions to permit satisfactory installation and servicing in the space allocated on the plans. The Electrical Contractor will provide a separate electrical circuit terminating in a junction box near each air supply unit. All wiring from the junction box, including the necessary fused disconnect switches and other materials and labor necessary to complete the power wiring and control circuits for the filter assembly shall be furnished and installed by the Mechanical Contractor. On roll type filters, an auxiliary switch shall be provided by the Mechanical Contractor to permit manual operation of the filter drive motor when the unit supply fan is not operating. For sizes see drawing schedule.

B. Roll Type Prefilters. These shall be American Air Filter Company's Roll-O-Matic, Type H, Model G horizontal and Type V Model J, Verticals, Cambridge Filter Corporation Type Var or Har, Farr, Mine Safety Appliance, Continental Conomac Type VA or Type ELA, automatic renewable media type air filter, complete with casing, top and bottom media covers, 1/6 HP motor and external drive mechanism, timer, screens, rolls of glass fiber filter material, control box, media feed switch, incline draft gauge, relay and media runout switch and light. The control shall be automatic pressure drop type which senses filter pressure drop and advances the media one complete new section by automatically controlling the drive motor through the timer. The glass fiber blankets shall be sprayed with a fine Underwriter's approved non-inflammable Visco Filter media shall perform satisfactorily down to -20°F. Pressure drop across the clean filter assembly shall not exceed 0.17" W.G. The air filter gauge shall be Dwyer Model No. 250-AF. This Contractor shall provide

filter media for use in each unit during the temporary heating season. This Contractor shall also provide one new roll of filter media for each unit at time of air balance and an extra packaged supply of filtering media equal to one complete refilling shall be given to the Owner. The media shall be 2" thick and have an efficiency of 85% by the NBS dust spot method.

C. Electrostatic Type After-Filter. These shall be AAF Model D, Rollotron, Cambridge or approved equal, consisting of an electrostatic section of the entering side and an automatic disposable media type on the air leaving side. The filters shall be sized for the air volumes indicated for the specific units with an efficiency of not less than 90% as measured by the NBS Dust Spot Test Method using atmospheric air. The collector elements in the agglomerating section shall be of all aluminum construction. Ionizing voltage shall be 12,000 volts and plate voltage shall be 5,800 volts. The storage section shall be heavy gauge zinc coated steel with a 2" thick glass fiber blanket pre-coated with a fine non-inflammable, Underwriter's approved adhesive. The average operating resistance shall be 0.35" of water gauge. The fiberglass media shall be fed across the air stream automatically from a compressed clean roll at a pre-determined rate by an adjustable electric timing device. Used media and accumulated dirt shall be compressed and wound into an enclosed compact roll for easy disposal. The unit shall be furnished complete with:

1. External and internal agglomerator housing, agglomerating cells and storage units for assembly of the filter bank and miscellaneous assembly hardware.
2. Power pack for end mounting.
3. Two unit access door switches, manual reset type.
4. Two unit access door switch warning lights.
5. Two combined switch and signal lights for inside unit housing.
6. Two enameled warning signs for unit access doors.
7. Spare ionizing wires.
8. High voltage cable from power pack to agglomerator.
9. One roll of media for each filter section.
10. Media runout control
11. Control panel, including automatic cascade timer control, warning signal light and a manual switch.
12. Trash screen. (Air distribution baffle screen).
13. 1/6 HP motor and external drive assembly with removable cover.
14. Provide and install at each electrostatic filter bank in each supply fan unit a Dwyer 250AF or equal and approved air filter draft gauge inclined tube type with a range of 0.10 - 1.0 inches of water, furnished complete with static pressure tips, tubing, mounting assembly, extra bottle of red gauge oil, oil dropper and instructions. Accessories shall be mounted in a suitable metal case with hinged door and cam lock and shall be secured to housing adjacent to draft gauge.

15. An extra packaged supply of filtering media equal to one complete refilling shall be given to the Owner by this Contractor when the building is occupied by the Owner.

D. Start-up condition (Electrostatic Filter). In most cases the built-up supply air systems will be set up to operate with less than 50% of their final design air quantity. It shall be this Contractors responsibility to blank off on two sides with sheet metal a certain percentage of the collector cells. (See drawings schedule) to maintain a proper minimum air velocity across the electrostatic filter. If filter manufacturer recommends removal of the blanked off collector cells, these shall be turned over to the Owner for future use.

2.2 ROOM TERMINAL FILTER UNIT

A. Furnish and install high efficiency filter in duct work at terminal location before entering certain rooms.

1. Filters shall be AAF Dri-Pak in line duct unit, Cambridge Hi-Flo or Continental Conosac. Rated 95% efficient on NBS dust spot test using atmospheric dust. Filter assembly shall be complete with bag type cartridges, filter frame, unit housing, gaskets, flanges and access doors. See drawings for schedule.

2. Air filter gauge across the filters shall be Dwyer 209-AF, of approved equal, with a range of 0.20" - 3.0" water.

2.3 EXHAUST HOOD FILTER FOR RADIOACTIVE HOODS

A. Furnish and install high efficiency filter and housing as detailed on Drawing M-105 for the radioactive exhaust hoods. See Drawing Schedule Sheet M-106 fume hood schedule for absolute filter requirements.

1. Filters shall be AAF Astrocel, or Cambridge Absolute on Flanders Series 800, or Farr, rated 99.97% efficient on standard DOP test with 0.3 micron particle. Filter shall have glass asbestos media mounted in a stainless steel frame. Filters shall be fire retardant up to 250°F. and shall be capable of withstanding 100% RH. Provide a 2" throw-away type fiberglass filter to act as prefilter.

2. Absolute filters shall be 11-1/2" deep and prefilters shall be 2" deep. See Drawing Schedules for filter overall dimensions required.

3. Air filter gauge across filters shall be Dwyer 209-AF, or equal with a range of 0.20" - 3.0" water.

4. Before installation the absolute filters shall be tested and approved by the University of Minnesota Department of Environmental Health.

2.4 THROW-AWAY FILTERS

A. Throw-away filters shall be equal to AAF-Amer-Glas replaceable 2" thick filters. Contractor shall install new filter media before building is turned over to University. An additional set of filter media shall be given to the Owner at this time also.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing all equipment, materials and performing all labor necessary for the air conditioning refrigeration systems and other related systems.

C. Related work specified elsewhere:

1. Basic Methods and Materials: Section 15100.
2. Pipe and Pipe Fittings: Section 15110.
3. Valves. Section 15120.
4. Piping Specialties: Section 15130.
5. Mechanical Supporting Devices: Section 15140.
6. Vibration Isolation: Section 15150.
7. Mechanical Systems Insulation: Section 15160.
8. Hot Water Heating System: Section 15650.
9. Ventilation and Air Conditioning: Section 15800.
10. Chemical Treatment: Section 15990.

D. Furnished but not installed under this section:

1. Cooling coils.

E. Installed but not furnished under this section:

1. Chemical treatment equipment.

PART 2: PRODUCTS AND INSTALLATION

2.1 ABSORPTION REFRIGERATION MACHINES

A. This Contractor shall furnish and install, as specified herein, two (2) high pressure absorption refrigeration machines, Trane D10C, or approved equal, to be located in the basement equipment room as shown on plans.

B. Capacity:

1. Refrigeration capacity tons - 976.
2. Chilled water passes - 3.
 - a. GPM - 2500.
 - b. Entering water temperature - 49°F
 - c. Leaving water temperature - 40°F.
 - d. Maximum pressure drop in feet - 50.
3. Condenser Water:
 - a. GPM - 4400
 - b. Condenser water passes - 3 (2 pass absorber +1 pass condenser)
 - c. Entering water temperature - 85°F.
 - d. Leaving water temperature - 96°F.
 - e. Maximum pressure drop in feet - 28.
4. Steam:
 - a. Valve inlet, psig 125.
 - b. Concentrator flange, psig 123.
 - c. Full load maximum steam rate lbs./hr. each 12,298.
5. Capacity based on .0005 fouling factor.

C. Machines:

1. The machines shall be of hermetic design, complete factory assembled and leak tested. Exposed refrigerant circuit piping shall be factory insulated.

2. Absorber and concentrator tubes shall be of seamless cupro-nickel material and shall be individually replaceable from either end of the machine. Headers shall be designed for a working pressure of 250 psig except concentrator header designed for 50 psig working pressure and evaporator header designed for 150 psig working pressure. All headers shall be tested at 1-1/2 times their design pressure. Evaporator, Condenser and Absorber headers shall be removable.

3. The machines shall be equipped with a hermetic pump-motor assembly which is cooled and lubricated without the use of external cooling water during normal operation. A mechanical-magnetic strainer assembly shall be installed in the pump motor circuit. Pump motor to be factory piped and wired. The pump motor shall be removable without removing the solution or allowing air to enter the machine. The pump motor shall be a 30 HP 460/60/3.

4. Non-condensable gases shall be removed from the machine through a purge system consisting of an electric motor driven vacuum pump requiring no external water supply. The machine shall be automatically protected against air re-entry in the event of a power failure. It shall be impossible for the purge unit to eject solution from the machine. The pump motor shall be a 1/2 HP, 460/60/3.

5. The machines shall provide for automatic decrystallization. The machine shall be installed on a level surface. The Contractor shall provide all flanged pipe connections to provide for access to tubes for inspection and cleaning or removal.

D. Accessories:

1. Each unit shall have a complete, factory installed and wired electric control panel. The control shall include the following as minimum:

- a. Terminal block.
- b. Control transformer and separately fused 115-volt, single-phase control circuit.
- c. Motor temperature cutout.
- d. Low temperature cutout.
- e. Time delay relay for dilution cycle.
- f. Pump motor starter.
- g. Purge motor fuse.
- h. External lights to indicate operation of the unit, pumps, and purge system.

2. Each unit shall have a completely factory assembled and mounted pneumatic capacity control panel. The pneumatic control panel shall include the following as minimum:

- a. Chilled water.
- b. Pneumatic-electric pressure switch.
- c. Solenoid air valve.
- d. Pneumatic temperature gauge.
- e. Supply air pressure gauge.
- f. Branch air pressure gauge.

3. The panel shall be supplied with 460 volt, 3 phase, 60 cycle power. The Electrical Contractor shall furnish and install, external to the panel, a separately fused disconnect.

4. The units shall be equipped with a condensate heat exchanger that shall reduce the temperature of condensate leaving the unit, at full load condition, to 230°F. With the condensate heat exchanger, the unit shall be internally trapped so that condensate may be drained to a condensate receiver without the need for field installation of traps.

5. Provide type 'A' isolation for .35" static deflection and plates and setting plan for machine base. Units shall be mounted on concrete pads.

6. All vents and drains on the machine shall be piped to floor drains. Provide a valve on vent and drain piping. Valves shall be located such that they are accessible from equipment room floor.

7. All assembly accessories shall be as specified elsewhere in the specifications and as shown on the drawings.

8. This contractor shall vent absorption unit in each pass of the absorber, condenser and evaporator water boxes. Extend vents above insulation.

9. This contractor shall ensure that piping adjacent to the machine does not restrict removal of headers for inspection, cleaning and removing tubes.

10. This contractor shall provide gauge cocks and thermometer wells for temperature and pressure readings at the inlet and outlet of the evaporator, at the inlet and outlet of the absorber, and at the outlet of the condenser. A pressure gauge shall be installed at the inlet of the concentrator. See Section 15130. Thermometer wells shall be Honeywell 14500430.

11. Insulate the chilled water headers and other portions of the unit, as pointed out in the manufacturer's literature, to prevent condensation on surfaces during operating conditions and to prevent excessive heat loss to the equipment room. External unit pipes with surface temperatures sufficiently hot to constitute a danger to operating personnel shall also be insulated. See Section 15160.

12. This contractor shall field assemble machines (if required) and leak test in accordance with instructions in the manufacturer's installation bulletin.

13. This contractor shall connect the rupture disc located on the first stage concentrator to an appropriate outside vent. The vent piping shall be connected to the concentrator by a flexible coupling.

14. This Contractor shall provide sufficiently sized vacuum pump and personnel to evacuate the unit prior to charging (if required).

15. This contractor shall pipe a 1/2" drain line from a tapping on the unit heat exchanger through an F&T trap to the condensate receiver. Trapped line shall include a solenoid, strainer, and gate valves around the trap. All items should be able to withstand 360°F temperatures. Solenoid shall be field wired through unit control panel to allow drainage when the unit is off. Wiring by Mechanical Contractor as per manufacturer's recommendations.

E. Controls:

1. Each refrigeration unit shall be provided with a pneumatic control system and connection which automatically controls leaving chilled water

temperature at 40°F. Control shall be accomplished by modulating the amount of steam supplied to the machine with a steam valve supplied by the equipment manufacturer. The machines shall be equipped with a part load economizer which operates over full range. The necessary factory installed controls shall be provided to prevent steam inrush on start-up from exceeding 120% of full load steam consumption rate. The location of the chilled water controls shall be on the chilled water main leaving the individual machine. Provide a low leaving water temperature cut out for each machine.

2. The respective primary chilled water pump, condenser water pump and cooling tower shall be electrically interlocked with the refrigeration machine such that the automatic operation of the chillers shall be as follows:

a. First the primary chilled water pump shall be manually started. A motorized butterfly valve on the chilled water line to the absorption machine shall open. When this valve is proven open the chilled water pump will be allowed to run. Interlocked with the chilled water pump starter and chilled water flow switch through a set of auxiliary motor start contacts, are the Heat Source Pneumatic-Electric switch and the condenser water pump starter. A motorized butterfly valve on the condenser water inlet to the absorption machine shall open. When this valve is proven open the condenser pump will be allowed to run.

b. A need for cooling, as indicated by the temperature of the chilled water shall cause the branch line pressure of the pneumatic chilled water temperature control to rise. The rising branch line pressure shall close the contacts of the P-E switch allowing the condenser water pump, to run which in turn shall energize the cooling tower system.

c. Turning the absorption unit system switch to the ON position shall energize the time delay relay. This shall supply control voltage through the contacts of the low temperature control, motor temperature control, and the liquid level switch to the unit pump starter, starting the unit pumps. A solenoid air valve is energized through a set of interlocking contacts on the unit pump starter. The energized air valve shall supply thermostat branch line pressure to the pneumatic steam valve, allowing the valve to function. Variations in branch line pressure shall operate the pneumatic valve, controlling the flow of steam to the concentrator.

d. When lowering chilled water temperature, as sensed by a controller, indicates that cooling is no longer needed, the reduced branch line pressure shall allow the contacts of the P-E switch to open. This stops the chilled water pump, which in turn de-energizes the time delay relay, the solenoid air valve and the cooling tower system. De-energizing the solenoid air valve to close, stopping the flow of steam to the concentrator. The evaporator, concentrator and absorber pumps shall continue to function for approximately seven (7) minutes, under control of the time delay relay bringing about a mixing of the dilute and concentrated solutions, contained in the absorber and concentrator, prior to complete shutdown.

e. Furnish and install time delay relays to provide 10 second minimum time delay between each motor start. Furnish time delay relays for interlocked chilled water pump, condenser water pump and cooling tower system on each group of equipment.

f. This Contractor shall provide and install McDonnell and Miller Model No. FS7 standard construction flow switches with brass wetted parts suitable for 150 psi operating pressure. Paddle shall be of proper size for pipe size being served. Condenser water flow switches and chilled water flow switches shall be wired into the machine control panel circuit. Flow switches shall be installed in the condenser and chilled water piping to allow the refrigeration machine to start only when proper water flow is provided. If machine is in operation and the condenser or chilled water flow is not normal the refrigeration machine shall stop immediately and shall remain out of operation until proper flow is provided. Whenever machine is shutdown the control panel shall provide for seven (7) minutes dilution cycle. This Contractor shall supply, install and wire a pressure electric switch on the condensate line from each absorption machine such that the machine will be rendered inoperative if pressure in the condensate line rises above the set point of the P-E switch.

g. Secondary chilled water pumps (2 plus 1 standby) shall be energized by a water flow switch in the primary loop. Provide flow switch and contacts for each secondary chilled water pump.

h. This contractor shall extend control wiring for cooling tower system operation to a tower sequence control panel as hereinafter specified as part of the interlock wiring described in item (b) above. This sequencer panel to be located in Unit 'A' basement mechanical room where indicated will allow any condenser pump to operate in conjunction with a pre-selected cooling tower cell. The control wiring between sequencer panel and individual cooling tower cells shall be by the Mechanical Contractor.

i. Butterfly valves referred to under Item (l) above, on chilled water and condenser water inlets to the absorption machine shall be centerline Model LT or approved equal with Series 29000 actuators. The valves shall have 304 stainless steel one-piece stamp, taper pin attachment disc to shaft, hard back seats of EPT, bronze disc and bushings. Disc shall be machined for 150 psi close-off, double stem seals, keyed connection to actuator lever and integral flange gaskets. The actuator shall be designed for 80 psi air and be complete with limit switch, solenoid valve, and position indicator. Actuator shall be trunnion mounted.

F. Service and Guarantees. The manufacturer shall provide the following service:

1. Meet with and advise Contractor on rigging and installation problems.
2. Advise on and assist with wiring and control problems.
3. Pressure test, evacuate and charge machines.
4. Start-up machines and supervise start-up of system.
5. Train operators and provide re-training as required during first year.
6. Provide written report to Owner, Architect, Engineer and Contractor upon completion of 1-5 above.
7. Provide periodic operating inspections during first operating season.
8. Handle emergency service calls on machines during first operating season.

9. Supervise start-up of system at beginning of second season.

G. Chiller Sequence Control

1. This Contractor shall supply and install a Power Process Equipment Inc. or approved equal, Model PPEI-CT-3 system prewired and piped for floor mounting.

The existing 3 chillers and the two additional chillers to be added at this time, shall have the primary chilled water pump start function extended to the new chiller sequence panel. This panel shall be incorporated into the cooling tower sequence panel hereinafter described under Item 2.5 Cooling Tower.

2. Chiller sequence will be operated from the primary chilled water temperature. The sequence system will operate a flashing light on the appropriate start pushbutton for the chiller system required to start. When the chiller is manually started, the light will be continuous. On a drop in primary chilled water temperature, each individual chiller will be stopped automatically in the sequence in which they were started. The light will go off when the chiller stops. The differential indicating when a chiller is to start or stop depending on how many degrees the primary loop is above or below the system set point of 40°F shall be manually adjustable at the panel. A 9 point sequence switch shall be provided to determine operating sequence of 5 chillers now and four future chillers.

3. The panel shall also include lapse time meters for each existing chiller, and 2 new chillers and space for 4 future chillers and temperature indication of primary loop chilled water temperature.

4. The primary chilled water temperature control system shall consist of a Hays, or approved equal, electric transmitter using 20 milliamp DC transmission signals. The signal will be received at the panel over two wires and a PPEI Model AG 4000 controller shall be used to sequence the chiller operation. This sequence controller shall have totally adjustable differential and set point. Provide a temperature indicator on the panel which will receive 4-20 milliamp DC signal and read directly in degrees Fahrenheit with a range of 35°-80°. The temperature transmitter shall be mounted in a brass or stainless steel well in the primary chilled water pipe loop.

5. Provide adjustable 20 second time delay relays in conjunction with each temperature controller. Magnetic relays shall protect the sensing element.

6. Provide separable sockets for sensing elements.

7. All wiring associated with the chiller sequence panel shall be by this Contractor.

2.2 CHILLED WATER AND CONDENSER WATER PUMPS

A. Pumps shall be horizontally split casing type with suction and discharge in the lower half to permit inspection access to rotating parts without disconnecting the suction or discharge piping, coupling or motor.

B. Pumps shall have non-overloading characteristics and shall be furnished at the midpoint of the pump curve. Pumps shall have a flat curve characteristic and be capable of operating with a 10% variation on either side of the point of selection to allow for drift in the system curve.

C. Chilled water pumps and condenser water pumps shall operate on a system basis as shown on the drawings. Chilled water pumps shall be equipped with precision John Crane mechanical seals on both sides of the impeller. Condenser water pumps shall be equipped with packed stuffing boxes on both sides of the impeller. Pump casings shall be 250 psi thickness. Flanges for condenser water pumps shall be 250 ASA.

D. Renewable bronze casing wearing rings shall be provided. Stainless steel shaft sleeves shall be provided on pumps with mechanical seals. Condenser water pumps will have hardened steel sleeves.

E. If special tools are required for replacement of the wear rings a set of tools shall be included for each size and style pump furnished on the project. The shaft sleeves and impeller shall be keyed to the shaft by means of a common key. To preclude any leakage along the shaft beneath the shaft sleeve, compression "O" rings shall be furnished between each sleeve and shaft.

F. Each pump shall be mounted on a heavy cast iron sub-base having a drip lip and tap for drain piping. Pipe drains to nearest floor drain. A flexible coupling shall connect the pump with the electric motor. Shaft coupling shall be protected by a metal guard. The pumps shall have the capacity as shown on the drawings.

G. Pumps and motors shall be checked for alignment prior to initial start-up. The alignment shall be accomplished prior to grouting with the coupling checked with a dial indicator. Each base mounted pump shall be furnished with plugged tappings on the suction and discharge of the pump housing for pressure gauge connections.

H. Each pump shall also be furnished with a manual air vent petcock on the pump casing.

I. Provide ARI certified pump curves on all chilled and condenser pumps.

J. Where noted in Pump Schedule on drawings, secondary chilled water pumps shall be variable speed units. Motors shall be 1750 RPM, 480 volt, 3 phase, 60 cycle horizontal variable speed squirrel cage type.

K. Variable speed control center shall be equal to Aurora, Simplex 10 Apco-Matic, and be a floor mounted NEMA 1 enclosure including the following:

1. Circuit breaker.
2. Magnetic starter with three leg overload protection
3. H-O-A switch.
4. Manual speed control.
5. Pilot light.
6. Emergency run provision.
7. Phase and undervoltage protection.

8. Control transformer.
9. Regulated DC power supply.
10. Power bridge with Thyristors and anti-hunt control.
11. Solid state logic and triggering circuits.
12. Transducer.

L. All necessary control wiring between variable speed control center and its associated pump and motor shall be by Mechanical Contractor.

M. All motors shall be 1750 RPM unless otherwise noted in schedule.

N. Variable speed control center and pump shall be a factory pretested package.

O. See drawings for Pump Schedule.

2.3 EXPANSION TANK AND CHILLED WATER SYSTEM ACCESSORIES

A. Refer to Section 15650. Article 2.8 Hydronic System Accessories.

2.4 CHILLED WATER COILS

A. All coil capacities and selection data shall be certified in accordance with ARI Standard 410-64, and each coil shall bear the ARI certification label. Coil shop drawings shall include complete computer selection performance data.

B. The primary surface shall be 5/8" O.D. seamless copper tubes with continuous copper fins extending from tube to tube. The fins shall be mechanically bonded to the tubes to provide a permanent bond. The casing shall be zinc grip galvanized steel, 16 gauge formed end supports and top and bottom channels. The channels shall have 3/8" holes 3" on centers for fastening to coil supports. See detail on drawings for coil installation and support. All coils shall be supplied for same end connections.

C. Tubes shall be without turbulators. Coils shall be drainable, double row water coils, in which each row starts and terminates in a common header with "U" bends joined with silver brazing. Serpentine shall be required to result in specified capacities with maximum pressure drop of 20 feet. All coils shall be suitable for 150 psig working pressure and piped to counterflow of water and air.

D. Coils shall be of sizes and capacities as scheduled below. Inlet water temperature to coils shall be 41°F with 12°F rise.

E. See drawings for Cooling Coil Schedule.

F. Coils in package supply air units shall be of the same manufacturer as the package unit. See Section 15800.

2.5 COOLING TOWER

- A. A three cell cooling tower shall be constructed on the existing 20th level roof of Unit 'A' as indicated on the drawings. As shown, the new tower cells shall be located adjacent to an existing cooling tower and shall be constructed within an existing sump basin. The completed tower shall be similar in dimensions to the existing tower and shall not rise above the existing architectural screen.
- B. The new cooling tower shall be a three (3) cell Marley Company Model #585-48-100-3 induced draft double flow. Equipment manufactured by Pritchard Company and Flour Company will be acceptable providing that they fully comply with the specifications. The cooling tower shall be erected and delivered in the area designated. The cooling tower basin will be fabricated and supplied as noted under the general contract and coordinated with the tower manufacturer to allow for anchor location.
- C. The cooling towers shall have a total capacity to cool 12,600 GPM from 103 degrees - 85 degrees D.B. and 78 degrees design W.B. Each cell shall have the capacity to cool 4,200 GPM from 103 degrees - 85 degrees Dry Bulb - 78 degrees Wet Bulb.
- D. All lumber used in the construction of the cooling tower to be heart redwood or treated fir. Lumber for structural members to be in accordance with "CTI Code Tower Standard Specifications" CTI Bulletin STD-103. Grades for non-structural members to be in accordance with "Standard Specifications for Grades of California Redwood Lumber," California Redwood Association. Standard #15 West Coast Lumber Inspection Bureau, and the Douglas Fir Plywood Association. All lumber shall be pressure treated after fabrication with chromated copper arsenate in strict accordance with standards of American Wood Preservers Association. Retention shall average not less than 0.75 lb./cu.ft.
- E. All bolts, nuts and cut washers shall be hot dip galvanized. Structural connectors shall be of non-corrosive material such as fiberglass or structural ceramic materials. All base plates and castings shall be hot dip galvanized cast iron. Nails and special washers shall be stainless steel. Mechanical equipment hold down bolts shall be stainless steel.
- F. Casing shall be single 3/8" corrugated cement asbestos board construction so as to shed water inward to prevent water leakage and bolted to tower columns with stainless steel lag bolts and machine bolts and neoprene bonded stainless steel washers. Corner roll trim shall be furnished.
- G. Air inlet louvers shall be 3/8" corrugated CAB supported on top of support on not more than 4 feet centers, and so arranged to prevent splashout when fans are not in operation. They shall be wide spaced so as to not restrict air flow.
- H. The structure shall be designed to withstand a minimum live wind load of 30 psf based on conventional stress analysis methods approved by Wood Handbook of the Forest Products Laboratory, CTI Procedures, and all local and National Codes, and so designed to transmit all live loads through diagonals to perimeter anchorage. All structural members shall be through bolted.
- I. The minimum size columns are 4" x 4" and shall extend to bottom of basin. Columns are on 8'-0" centers transversely and 4'-0" centers longitudinally with

an unbraced length of 6'-0". Structural framework shall be designed to support a heavy duty steel distribution piping, fans, valves and all appurtenant equipment.

I. All interior unanchored columns shall be shop fabricated so as to permit extension of 4 feet below curb. Interior unanchored columns are to be field cut and fitted to the basin floor.

J. The tower fan deck shall consist of tongue and groove treated fir exterior grade plywood minimum thickness 1-1/8" and designed to withstand 60 lb./sq.ft. live load. Provide pipe supports for condenser water pipe.

K. The tower fan deck perimeter shall be surrounded by a 3'-6" redwood handrail with intermediate knee boards designed in accordance with recommended standard of the "Accident Prevention Manual for Industrial Operation" by the National Safety Council. Rails shall be of 1-1/2" x 4" clear material with eased edges and through bolted to 4 x 4 posts on not more than 4'-0" centers. The 4 x 4 post shall be double bolted to tower structure. Tower deck and rails shall meet OSHA requirements.

L. The distribution system shall consist of an open, easily cleanable, hot water distribution basin of gravity type. Covered distribution boxes are provided for even water distribution from valve to basin. Splash boxes are located near fan deck to provide access to valves. Flume type distribution is not acceptable.

I. Distribution basin floor is 5/8 plywood pre-cut drilled for nozzles. Inboard basin side and ends are 1-1/2 x 10. Outboard basin sides and ends and partitions are 1-1/2 x 8. Injection molded target type nozzles are sized to operate with a 3-1/2" x 5" water depth in basin. Positioned for easy maintenance and replacement and placed to provide equal water loading over all parts of fill. A 12" cast iron horizontal distribution valve shall be furnished to balance the flow of water to each basin.

M. Fill splash bars shall be polypropylene, ladder type with 8" spacings. Fill shall be of the interlocking type requiring no nails and shall be supported on not more than 2'-0" centers. Support members to be through-bolted to tower structure. Water loading shall not exceed 15 gallons per square foot. Fill shall be U.L. labeled with flame spread not to exceed 15.

N. An effective drift eliminator shall be of a 2 pass design, located in the leaving air stream from each bank of the fill, and shall be designed to limit drift loss to less than 0.2 of 1% of total water circulation. These shall be constructed of fir slats held in spacer separators.

O. Cell partitions shall be asbestos cement board with one hour fire rating, exterior grade face. Cell partition shall be full height and width, watertight transverse partition from fan deck to basin, hinged access door shall be provided in this partition. Partition shall be 1" asbestos cement board on each side of columns.

P. Interior access to the plenum area is provided by a hinged access door through the side of tower.

Q. Walkways are to be 2'-0" wide redwood located the longitudinal dimension of tower in the plenum area at the cold water level extending from cased wall to cased wall.

R. Tower shall be anchored to the existing concrete basin with "Kwik" bolts, or "Wej-It" as detailed on the drawings with the following qualifications.

1. Size shall be 3/4".

2. Installed in 3500 psi concrete, pull out strength shall be minimum of 23,633 lbs.; shear strength shall be 19,000 lbs.

3. Bolt shall be drilled 3-1/4" into concrete.

4. A minimum of 1-1/2" undisturbed concrete shall be maintained under all bolts as shown on drawing detail.

5. The area between the concrete, anchor bolt and tower structural member to be anchored shall be sealed with General Electric silicone sealant as shown on the drawings.

6. Anchors shall be plated with zinc, conforming to Federal Specification QQ-Z325, then chromate plated, or stainless steel.

7. A minimum of 2" of thread shall be available, on all bolts, despite unevenness of existing basin floor.

S. Fan cylinders shall be 192" diameter and constructed of glass reinforced polyester "Aero Dynamic Contour" vertical rib 5'-6" high minimum. Cylinder wall shall have a removable access panel to each fan cylinder.

T. The tower shall be furnished suitable for installation of a sprinkler system conforming to NFPA Bulletin #214.

U. Electric motor drive shall be mounted on fan deck outside of the air stream. Each fan shall be driven by a totally enclosed fan cooled 1800/1200 rpm, 3 phase 60 cycle, 460 volt motor. Motors shall be specifically designed for cooling tower service and outdoor installation and conforming to NEPA standards. Motors shall be not less than 100 HP, two (2) speed 1800/1200 rpm, single winding, variable torque and a service factor of not less than 1.15.

V. Mechanical Equipment:

1. (Fan Drive). Fan wheels shall have a minimum 8 blades for quiet and smooth operation and shall be designed specifically for cooling tower operation. Each blade shall be of adjustable pitch and individually clamped in a common hub. Fan blades shall be solid cast aluminum or solid glass reinforced polyester. Hubs shall be hot dipped galvanized steel or high tensile cast iron. Aluminum blade shanks shall be insulated from galvanized hubs to prevent electrolytic corrosion.

2. (Speed Reducer). Each fan shall be driven through a right angle speed reduction unit especially designed for cooling tower service. The reduction-gear housing shall be of cast iron construction with large oil reservoir and oil

filter and with wide spread mounting base. The fan shaft shall be tapered to allow easy removal of fan. Geareducer shall have a minimum service factor of 2.0 at operating H.P.

3. (Extended Oil Fill Line). Each geareducer shall be provided with an extension pipe with hose connection and external sight glass to permit filling, draining, sampling, and checking oil level from outside fan housing.

4. (Driveshafts). The driveshaft connecting motor and geareducer shall be especially designed for cooling tower service. Shaft ends shall be equipped with keyway and non-lubricated flexible coupling. Each driveshaft unit shall be dynamically balanced. Shaft shall be 300 Series stainless steel. Driveshaft guards shall be supplied.

5. (Vibration Limit Switch). Each fan cell shall be equipped with a manual reset type vibration limit switch.

6. (Unitized Motor and Geareducer Support). Support is a welded HDG torque tube assembly designed to resist misalignment of motor and Geareducer. Support is mounted transversely.

7. The complete fan drive train (including motor, gear reducer, and fan) shall be mounted on Type C isolation mounting with five (5) inch deflection. See Section 15150 for vibration isolation.

W. Test and Guarantees: The cooling tower supplier is to be the "Centralized Responsibility" and shall agree to guarantee and be the source of information on spare parts lists, prices, recommendations for repairs and replacements, lubrication problems, etc. on all equipment offered regardless of the manufacturer's sources of that equipment.

X. Technical Cooling Tower Data: Bidders shall furnish the following data covering the equipment he proposes to furnish.

Name of Manufacturer _____

Number of Cells _____

Dimensions, Overall Feet: Length _____

Width _____

Height _____

Weight, Pounds: Dry _____

Operating _____

Filling: Wetted Surfaces, Area, Sq.Ft. _____

Effective Splash Surface Area, Sq. Ft. _____

Total Filling Volume, Sq. Ft. _____

Filling: (continued)	Water Loading, Gal/Sq. Ft.	_____
	Length of Air Travel Thru Filling, Average ft.	_____
	Water Fall Height, Ft. Total	_____
	Filling Height, Average Ft.	_____
	Number of Filling Decks	_____
	Wetted Surface, including Fillings, Sq.Ft. Total	_____
Fans:	Number of Fans per Cell	_____
	Diameter, feet	_____
	Speed, RPM	_____
	Number of Blades per Fan	_____
	Blade Material & Construction	_____
	Hub Material	_____
	Method of Adjusting Blade Pitch	_____
	Fan Efficiency, each fan 100% of design water flow	_____
	Design Blade Angle:	_____
Power, H.P.	_____	
Air Flow, CFM	_____	
Static Pressure Drop, Inches H ₂ O	_____	
Total Fan Pressure, Inches H ₂ O	_____	
Louvered Area, Sq.Ft. Gross	_____	
Reduction Gears:	Name of Manufacturer	_____
	Type	_____
	Size, H.P.	_____
	Speed, RPM	_____
Fan & Motor Support:	Size, Type and Material	_____
Basin Level Fluctuation, Maximum Allowable, In.		_____

Total Pumping Head, Maximum Ft. (Measured as specified under Design Conditions)

Water Losses, Maximum at Design Conditions, % Evaporation

Drift

Total

Fan Housing: Type and Material

Height above Fan Deck

Water Inlet Connections: Number

Size and Type

Y. Cooling Tower Control

1. This Contractor shall supply and install a Power Process Inc., or approved equal, Model PPEI-CT-3 system for cooling tower sequence control incorporated into the chiller sequence control panel previously specified under Item 2.1.

2. Existing Sequence.

a) The existing Cooling Tower located on the 20th level roof of Unit "A" consists of 3 cells each able to be individually sequenced and controlled.

b) Presently any of the 3 existing chiller-condenser pumps can operate with any cooling tower cell.

c) Existing Tower Cell No. 1 is winterized and has a tower bypass valve and is presently sequenced to always be first cell on the line and last off. Tower cell No. 1 is controlled by a 3 stage temperature controller sequencing, tower bypass valve, fan low speed and fan high speed.

d) Tower Cells No. 2 and 3 are each controlled by a two stage temperature controller sequencing fan low speed and fan high speed.

e) The present cooling tower interlock panel is located in the 19th floor equipment room of Unit 'A'.

f) When a tower cell is called upon to operate, a butterfly valve opens on the inlet water to the tower cell and a solenoid drain valve closes. On tower cell shutdown the reverse sequence occurs.

3. New Sequence.

a) Three additional cooling tower cells will be constructed as part of this project, adjacent to the existing 3 tower cells on Unit 'A' roof. See Drawing M-66.

b) Each new tower cell shall have an automated butterfly valve on the inlet water to the cell and a solenoid valve on the drain line. Butterfly valves shall be Center Line Model LT or approved equal with Series 29000 actuators. The valves shall have 304 stainless steel one-piece stems, taper pin attachment disc to shaft, hard back seats of EPT, bronze disc and bushings. Disc shall be machined for 150 psi close-off, double stem seals, keyed connections to actuator lever and integral flange gaskets. The actuator shall be designed for 80 psi air and be complete with limit switch, solenoid valve, and position indicator. Actuator shall be trunnion mounted.

c) A sequencing panel shall be provided in Unit 'A' basement to sequence new and existing tower cells (6 total). This Contractor shall make the necessary modifications to the existing system reusing equipment and wiring where possible to accomplish the following sequence and control:

1. Supply and install a Power Process Equipment Inc., or approved equal, Model PPE1-CT-3 system with a NEMA 4 panel pre-wired and piped for floor mounting. The panel shall include a Summer-Winter switch which shall operate as follows:

In Summer the system will measure tower leaving temperature from each pair of cells and operate each cell pair in a 5-step sequence of:

Inlet Valves Open (2)
First cell low speed fan
Second cell low speed fan
First cell high speed fan
Second cell high speed fan

The cell pairs will be sequentially started by the first three chiller-condensor pumps operated. The cooling tower sequence shall be selected by a three-position alternator switch. The last three condenser pumps to start will not add any tower cells. High speed to off shall not occur directly. When switching from high speed to off, a built-in time delay acceptable to the cooling tower fan manufacturer shall be provided for low speed to operate before the fan stops. This shall occur in both the Auto and Manual modes of control.

When a condenser pump has been energized through a chiller interlock wiring, a signal shall be sent to the sequencing panel asking for cooling tower operation.

The first step of control on a preselected pair of cooling tower cells shall be to open the butterfly valves on the linets to the 2 cells. These butterfly valves when full open shall operate a limit switch allowing the chiller-condensor pump to run.

In Winter operation, the winterized cooling tower cell only shall operate when any one chiller starts in the same sequence and control as described for the summer operation. The tower leaving temperature shall be used to control the tower in the same manner as in summer operation except that in addition to the summer sequence, a bypass

valve shall be operated to maintain leaving temperature when other operation cannot maintain the desired tower leaving temperature. An existing bypass valve shall be modified so that it can be used in conjunction with the new control equipment.

2. Information displayed on the panel shall include elapsed timers for metering the operation time of each cell, low speed of each fan, and high speed of each fan. It shall include running lights for indicating the same status information of each cell. It shall include selector switches for override of each cell function. The cell selector switches shall have Off, Valve Open, Low Speed, High Speed, Auto positions. In the automatic position, cell operation shall be controlled by tower leaving temperature according to the sequence as described under summer and winter operation. Provide temperature indication of tower leaving temperature (condenser water return). Indicator lamps in the control panel shall be heavy-duty oil-tight control units with lamp operator operating voltage of 24 volts. Provide a common rotate-to-test switch which shall operate all lights on the panel. Space shall be provided in the panel for three (3) future additional cooling tower cells (final total 9). Space in the panel shall also be provided for chiller sequencing as described under Article 42.

3. The tower leaving temperature control system shall consist of a Hays or approved equal electric transmitter using 4-20 milliamp DC transmission signals. The signal will be received at the panel over two wires and a PPEI Model AG4000 controller shall be used to sequence the tower operation. This sequence controller shall have totally adjustable differential and set point. Provide temperature indicators on the panel which will receive 4-20 milliamp DC signal and read directly in degrees Fahrenheit with a range of 30-110°F. The temperature transmitter shall be mounted in a brass or stainless steel well in each of the three tower basin outlets.

4. Provide adjustable 20 second time delay relays in conjunction with each temperature controller. Magnetic relays shall protect the sensing system.

5. Provide separable sockets for sensing elements.

d) All wiring associated with the Cooling Tower sequence panel shall be by this Contractor.

2.6 CONDENSING UNIT COOLING WATER SYSTEM

A. Cooling Tower

1. The tower shall be a Marley Model 4623 induced draft tower to cool 75 gpm from 100°F to 87°F at a 78°F WBT.

2. Tower casing and basin shall be 14 ga. galvanized steel on both interior and exterior and shall be shipped factory assembled.

3. Fill shall be non-combustible, Polyvinyl Chloride (PVC) plate type with a flame spread of 25 which qualifies as non-combustible per standard 220 of NFPA.

4. Air inlet and draft elimination shall be provided by broad, wide spaced steel inlet louvers, and asbestos honeycomb panels at varying angles to remove entrained moisture. Drift loss shall not exceed 0.2%.

5. Distribution basin shall be provided with closed inlet flumes, and spiral target nozzles. Basin shall be equipped with float operated make-up valve (shipped separate), bottom outlet drain plug, suction screen and anti-cavitation plate.

6. There shall be one 30" diameter propeller type fan with 4 steel blades. Fan drive shall be through V-belts with weather protected motor of 3/4 HP, 1740 RPM, 480V, 3 phase, 60 cycle. Fan shaft shall be stainless steel. Bearings shall be bronze sleeve type with extended oil line and fill cup on outside of tower. Provide fan guard.

7. Tower shall be mounted on Type 'c' vibration isolation with 3.5" deflection. See Section 15150 for isolation.

B. Cooling Water Pump

1. Furnish and install cooling water circulating pumps having a leakproof mechanical seal, John Crane specifically for water service from 40°F to 210°F. Pumps shall be Allis-Chalmers, Chicago Pump Company, Peerless, Armstrong, Aurora, Ingersoll-Rand, Bell & Gossett, Taco and Thrush.

2. Pumps shall be flexible coupled (Falk or Lovejoy), single suction, centrifugal pump with cast iron casing, bronze impeller and stainless steel shaft. Provide coupling guard.

3. Base-mounted motor and pumps shall be complete with steel base plate. Certified pump curves shall be furnished with shop drawings. Special emphasis is placed on flat head characteristics of pump operation. Pump impeller diameter shall not be less than 90% of the maximum diameter to promote quiet operation.

4. Pumps shall have grease lubricated ball bearings. Piping to pumps shall be properly installed and aligned to prevent any distortion of the pump casing under all operating conditions. Pump characteristics shall be as scheduled on the drawings.

5. All motors shall be 1750 RPM unless otherwise noted.

6. See drawings for schedule.

C. Remote Dry Basin

1. Basin shall be shop or factory welded constructed of 1/4" hot dip galvanized sheet steel reinforced as required. See drawings for basin size. Provide two 5" x 1-3/4" channels for housing redwood 2x4's for center partition inside of tank.

2. Basin shall be provided with two 2-1/2" connections at each end of tank, located centerline 8" above tank bottom, one 2" overflow connection, centerline 4" to top edge of tank and one 2" drain connection at low point of tank.

3. Shop drawings required.

D. Control

I. Control of the system shall be as follows:

a) System pump shall run continuously. System Pump CP-31 and standby system pump CP-32 shall be supplied with a duplex pre-wired panel complete with two magnetic starters and automatic alternator for sequencing pump operation. Each pump shall be able to be manually switched to lead pump. Automatic operation of the standby pump shall occur if a flow switch in the combined pump discharge line indicates no flow from the lead pump. This flow switch shall also activate an alarm which shall be located in the Basement Equipment Room where directed by Architect/Engineer. Provide a 1030 second adjustable time delay relay wired into this circuit.

b) An adjustable thermostatic control with its sensing element submerged in the discharge portion of the indoor basin shall cycle the Tower Pump on a call for colder water. Set point of controller shall be 83°. Tower Pump CP-33 and standby tower pump CP-4 shall also be supplied with a duplex pre-wired panel complete with two magnetic starters and automatic alternator for sequencing pump operation. Each pump shall be automatically sequenced from lead to lag with the standby pump being available automatically if a flow switch in the combined pump discharge line indicates no flow from the lead pump. This flow switch shall also activate an alarm which shall be located in the Basement Equipment Room where directed by Architect/Engineer. Provide a 10-30 second adjustable time delay relay wired into this circuit.

c) A second adjustable thermostatic control with its sensing element submerged in the discharge portion of the indoor basin shall cycle the cooling tower fan. The set point of this controller shall be 85°F.

d) All controls and alarms and wiring shall be by this Contractor.

e) Water level in the indoor basin shall be controlled by a float valve.

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SECTION 15950 MECHANICAL WORK FOR FIRE MANAGEMENT AND ENVIRONMENTAL CONTROL SYSTEMS

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes furnishing all equipment, materials and performing all labor to accomplish all required mechanical work for fire management and environmental control systems.

C. Related Work Specified elsewhere:

1. Basic methods and materials: Section 15100.
2. Pipe and Fittings: Section 15110.
3. Piping specialties: Section 15130.
4. Ventilation and air conditioning: Section 15800.
5. Air conditioning Refrigeration: Section 15900.
6. Fire management and environmental control systems: Section 16900.

PART 2: PRODUCTS AND INSTALLATION

2.1 FIRE MANAGEMENT AND ENVIRONMENTAL CONTROL SYSTEMS (ECS)

A. The following work is part of this section of the specification and will be performed by the mechanical contractor with supervision by the FM and ECS Electrical Subcontractors under Division 16.

1. Confirm control damper sizes to FM and ECS Subcontractor before fabrication.
2. Installation of automatic control dampers.
3. Furnishing and mounting of damper blank-off plates.
4. Installation of immersion wells and pressure tapping.
5. Installation of water flow switches.
6. Installation of automatic control valves.
7. Installation of liquid level switches.
8. Installation of pressure tapping and associated shut-off cocks.
9. Installation of orifice plates and companion flanges.

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division I General Requirements and Section 15010 General Provisions - Mechanical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the furnishing of all equipment, materials and performing all labor necessary to connect the chemical treatment system and other related equipment.

C. Related work specified elsewhere:

1. Basic Materials and Methods: Section 15100.
2. Hot Water Heating System: Section 15650.
3. Air Conditioning and Refrigeration: Section 15900.

D. Equipment specified is based on Western Company and Mogul Chemical Company water treatment data. Similar equipment as manufactured by Mitco, Walco, Norman and Dearborn Company are approved equal. All equipment provided shall be a single water treatment company for individual responsibility on service and equipment.

E. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of industrial water treatment, whose business is in the field of water treatment, and shall have water analysis laboratories, development facilities and service department.

PART 2: PRODUCTS AND INSTALLATION

2.1 COOLING TOWER BIOCIDES CHEMICAL FEEDER

A. The existing cooling tower chemical treatment system is a Western Company Model 6100 with On-Off PH control, On-Off Inhibitor control and On-Off Conductivity control. This contractor shall supply and install a 5-gallon Biocide Feeder for algae and slime control. Feeder shall be located in the existing Unit 'A', 19th Floor Equipment Room, adjacent to the existing tower treatment Control. A feeder pump shall be piped from the feeder tank to an injector fitting to be installed in the existing 30" condenser water supply line to the cooling towers.

1. Pipe: Schedule 80 black steel, 3/4".
2. Fittings: Screwed.
3. Injector Assembly: 3/4".

4. Pump: High Capacity chemical type, 10 GPH at 50 psi, 1/4 HP, 110 volt, 1 phase, 60 cycle. Mount on floor stand with pump on Type 'B' isolation for 1-1/2" static deflection.

B. System shall be sized to handle an ultimate of 24,000 GPM condensing water (6600 tons).

C. Control of system operation shall be by manual switch. An adjustable timer (0 - 10 minutes) shall be employed in the control circuit such that the feeder pump can be set up to run for a predetermined time and shut down automatically.

D. All piping, valves, strainers, connections, control wiring, etc. to make this system function properly shall be the responsibility of this Contractor.

E. Biocides used shall be Western type 'D' and N-87 (Owens Service). Each to be alternated in feeder on a weekly basis.

2.2 ENVIRONMENTAL ROOM COOLING TOWER SYSTEM CHEMICAL FEEDER

A. Provide a chemical treatment system for the environmental room cooling tower system as specified herein. The treatment equipment shall be located adjacent the remote interior basin in the 15th Floor Mechanical Room. System shall be equal to Mogul water treatment program WC-3.

Furnish and install a Mogul Solutrol Conductivity Controller, complete with bleed-off solenoid valve and sampler, for automatic control of bleed off and inhibitor feed. Unit shall be solid state, with built-in overload protection and disconnect switch. Spare electrodes shall be included. Furnish and install a Mogul Treatment pump package unit, consisting of a positive displacement pump, 1/4 HP, 120/3/60, with manual reset thermal overload, a pressure relief valve, and a 50 gallon polyethelene solution tank, all piped and mounted on a stand. Pump shall have Type 'B' isolation for 1-1/2" static deflection.

1. Pipe: Schedule 80 black steel, 3/4".

2. Fittings: Screwed.

3. Injector Assembly: 3/4".

B. System shall be sized for 75 GPM of condenser water.

C. All piping, valves, strainers, connections, control wiring etc. necessary to make the system function properly shall be the responsibility of This Contractor.

D. Chemicals to be used in this system shall be equal to Mogul Formulas for scale, corrosion and for prevention of algae or slime.

2.3 HYDRONIC SYSTEMS CHEMICAL FEEDERS

A. Feeding Equipment: Furnish and install as shown on the drawing. Continuous by-pass feeders of 2-1/2 gallon capacity for radiation and radiant panel systems and 7 gallon capacity for reheat systems. The feeder shall be supplied with fill and drain valves, filling funnel, gauge glass fittings and gauge glass, gauge glass float, flow regulator valve, flow indicator, and miscellaneous

fittings for connection of fill and drain accessories. Design operating pressure shall be 125 psig maximum.

2.4 SERVICE PROGRAM

A. The contractor shall provide a water management and service program for a period of one year from start-up of the above systems to include the following: Initial water analysis and recommendations, system start-up assistance, training of operating personnel, periodic field service and consultation, all performed by a qualified full-time local representative, plus laboratory and technical assistance from the engineering staff. Provide one year supply of chemicals for the above systems. All chemical furnished shall meet the Minnesota Pollution Control Agency Standards. Furnish test equipment for determination of PH, treatment residual and bleed-off control.

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ELECTRICAL SPECIFICATIONS FOR

UNIT B/C OF THE
UNIVERSITY OF MINNESOTA
HEALTH SCIENCES EXPANSION
PROJECT NO. MINN. 18 (HP)

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Assistant Vice President for Physical Planning University of Minnesota

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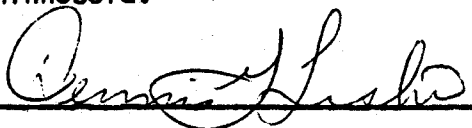
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The Cerny Associates, Inc. Minneapolis, Minnesota
Hammel Green and Abrahamson, Inc. Saint Paul, Minnesota
Setter, Leach and Lindstrom, Inc. Minneapolis, Minnesota

As to Electrical Engineering:
I hereby certify that these plans, specifications or reports were
prepared by me or under my direct supervision, and that I am a duly-
Registered Professional Engineer under the laws of the State of
Minnesota.



Date: September 2, 1975

Reg. No. 9112

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this Division. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Provisions of this section apply to all work of the Electrical Contractor.

1.2 CODES AND STANDARDS

A. The entire installation shall meet all requirements of the 1975 National Electrical Code (NFPA 70) and all State and local regulations as they may apply. Standards of the following associations or organizations shall be followed and applied where applicable as minimum requirements.

(UL)	Underwriters Laboratories
(IEEE)	Institute of Electrical and Electronic Engineers
(NEMA)	National Electrical Manufacturers Association
(NFPA)	National Fire Protection Association
(NBFU)	National Board of Fire Underwriters
(EEI)	Edison Electric Institute
(IPCEA)	Insulated Power Cable Engineers Association
(ASTM)	American Society for Testing and Materials
(OSHA)	Occupational Safety and Health Act of 1970
	National Electric Safety Code (Handbook H30) of the National Bureau of Standards.

B. The rules and regulations of the University of Minnesota Physical Planning and Development Department shall be checked and complied with where applicable.

1.3 PERMITS AND LICENSES

A. All licenses shall be secured and paid for by this Contractor before actual work is started and he shall observe any requirements stipulated thereon. The University will obtain required permits from the State and Municipality.

1.4 INSPECTION

A. The installation shall be made in a neat and workmanlike manner by persons licensed and skilled in the trade and shall be done under the supervision of a master electrician licensed to do work in the State of Minnesota.

1.5 GUARANTEES AND TESTS

A. All wiring shall be tested for opens, shorts and grounds with megger equipment prior to acceptance. Contractor shall be responsible for proper installation of all items in this Contract and shall remedy, free of charge, any defects in materials and workmanship and repair all damage resulting therefrom in accordance with provisions of the General Conditions.

B. Specific equipment warranties different than one year shall take precedence. Specific tests beside those mentioned above shall be performed as required in other sections of these specifications.

C. Incandescent lamps are excluded from the provisions of guarantees, but they shall not be installed until final completion of the project to replace the temporary incandescent lamps used for construction lighting.

1.6 DIMENSIONS AND CORRELATION

A. For the purpose of clearness and legibility the drawings are essentially diagrammatic and are intended to indicate size, capacity and location but not exact details or arrangements of construction. Architectural, mechanical and structural drawings shall be examined so that all details of the project are understood and work procedures known before bid and installation. Exact locations and details shall be obtained from dimensioned drawings but shall not take precedence over field dimensions.

B. Miscellaneous equipment (pull boxes, junction boxes, fittings and expansion joints) necessary to complete the work satisfactorily shall be furnished and installed even though not specifically shown on plans.

C. This Contractor shall cooperate with other contractors for proper anchorage, placement and accomplishing of all work. In general, plumbing and ventilating lines are laid out first. Interference between the work of the various contractors shall be resolved before installation. In the event of conflict of space requirements or location with other trades, he shall refer the matter to the University for decision.

1.7 CUTTING, PATCHING AND DEMOLITION

A. This Contractor shall be responsible for all necessary cutting and patching required in connection with his work and where necessary because of removal or change of existing work. Cutting of structural members and finished surfaces shall not be allowed without permission from the Architect or Structural Engineer. These cutting and patching requirements will be modified only if general construction specifications and drawings specifically and clearly state that certain or all portions of same required for each of the various trades is to be performed by the General Contractor. Refer to Section 01910.

B. This Contractor shall remove existing electrical conduits, wires, fixtures, boxes and wiring devices from the existing Diehl Hall, Unit A and Mayo Hospital Complex to accomplish the work as shown on the plans. Light fixtures and electrical equipment not shown to be reused shall be turned over to the University and all other conduit, wire boxes, etc. shall be removed from the site by the Contractor. Abandoned conduit in ceilings, walls and floor slab shall be cut off below new

finish line to allow new finish surface to be applied. Contractor shall verify that circuits or wiring removed do not interrupt service of any kind beyond remodeled area. If necessary, Contractor shall re-route conduit and wire to maintain services to areas beyond the remodeled spaces.

C. The Electrical Contractor shall repaint all areas where he has performed cutting and patching at rooms, spaces or locations that are not repainted under the General Contract. Generally these will be locations where no demolition, cutting and patching is performed by the General Contractor.

D. Contractor shall carefully review the Contract Documents for all other contractors with respect to coordination of the demolition, removal and remodeling work. Cutting and patching to expose and remodel existing mechanical or electrical systems shall not be construed as the work of another contract unless specifically called for on another contractor's documents.

E. Refer to Sections 01910, 04200, 09100 and 09900 for execution and requirements for patching and painting and comply with applicable provisions as to materials and workmanship.

1.8 EXCAVATING

A. Contractor shall do all trenching, excavating and backfilling required for his work. Any street, sidewalks, curb or paved area repairs necessary because of Electrical Contractor's work shall be his responsibility. Refer to General Conditions, Section 02200 and Section 02400 for requirements of trenching, excavating, backfill and compaction; comply with applicable provisions.

1.9 CLEANING

A. The Contractor shall periodically remove waste and rubbish and maintain order. Premises shall be left clean and free of debris and unused construction materials before acceptance. Refer to Sections 01010 and 01700 and comply with applicable provisions.

B. All electrical materials, equipment and apparatus including light fixtures and lamps shall be thoroughly cleaned, to be free of dust, dirt, rust and foreign materials before acceptance.

1.10 PAINTING AND LABELING

A. All equipment furnished under this Contract shall be factory finished and painted or galvanized. Any marred finishes on this equipment shall be painted to match as a responsibility of this Contractor.

B. Provide typewritten card index with plastic cover describing circuits in each panelboard.

C. For transformer and primary switchroom doors provide permanent standard porcelainized, 9" x 12" "DANGER HIGH VOLTAGE" signs.

D. Provide engraved 1/8" black-white-black laminated bakelite or plastic labels securely fastened with screws or escutcheon pins to identify electrical equipment as follows:

1. Panelboard name, and voltage fastened on inside of hinged door.

2. Distribution switchboard name on the front and individual distribution switches or breakers. Blank plates shall be provided for "spare" switches.

3. All main power and special system junction boxes. Locate these on the inside of flush boxes and in finished areas and outside of the box where they are surface mounted or in equipment spaces.

4. All motor control stations, combination starters in motor control centers, starters and disconnects, except when these items are adjacent to each other, only one label is necessary.

5. Plastic imprinted adhesive labels (Dymo Tape) will not be acceptable except for Item (3).

E. Provide engraved identification for switch and wiring device plates (Section 16310) and flush mounted motor controls where shown on plans. All engraving shall be sized as large as possible and shall be paint filled, black is standard; use red for emergency. For motor controls engrave on 3/8" black-white-black plastic laminate.

F. Exposed conduit with primary cables shall be painted orange continuously and stenciled every ten feet with 1" high black letters, "13,800 VOLTS".

G. Refer to other sections of these specifications for labeling, graphic diagrams and high voltage signs that must be provided with individual equipment.

1.11 QUALITY AND WORKMANSHIP

A. All materials shall be new, free from defects and shall be listed by, or bear the Underwriter's label where subject to such approval. Materials shall be of the same manufacture or brand for each type of material unless designated otherwise.

B. All materials and finishes shall be adequately protected during construction, from moisture, temperature extremes and physical abuse. All materials shall be assembled in a workmanlike manner in accordance with current recommended standard practice. Certain work such as painting, patching, core drilling and welding shall be done at the Electrical Contractor's direction, responsibility and expense but accomplished by workmen skilled in the particular trades.

1.12 SHOP DRAWINGS

A. Refer to Section 01300.

1.13 LIST OF MATERIALS, LIST OF SUBCONTRACTORS AND OTHER SUBMITTALS

A. Refer to Section 01300

1.14 SAMPLES

A. Refer to Section 01300.

B. All requests for substitutions prior to bidding (see Article 12 of the Instructions to Bidders) for certain light fixtures shall be accompanied by a complete production run sample for evaluation by the Engineer. Refer to Section 16400 for lighting fixtures requiring samples.

1.15 OPERATION AND MAINTENANCE INSTRUCTIONS AND AS-BUILT DRAWINGS

A. Refer to Section 01700.

1.16 TEMPORARY ELECTRIC SERVICE AND LIGHTING

A. This Contractor shall install temporary secondary electric services and lighting for new building construction as outlined in Temporary Facilities, Section 01500 and herein.

B. Temporary non-building (construction) service shall be provided. The Electrical Contractor shall arrange for the electric service with the University of Minnesota Electrical Construction Superintendent. The electrical energy costs will be paid by the University directly to the power company. The Electrical Contractor shall furnish all materials and labor for the temporary service.

1. The temporary service connection point shall be the existing spare 1200A-3P bolted pressure contact switch located at the existing Substation #1A in Unit A, Room B-99 as indicated on the plans. Refer to Sheet #E-23.

2. Provide ground fault protection for 1200 amp temporary service feeder located near existing Substation #1A. Ground fault protection shall be zero sequence sensing as specified in Section 16200 and shall be set and connected to coordinate with the existing ground fault protection at Substation #1A main switch. Ground fault protection shall be packaged in a NEMA 1 enclosure as an integral part of a 1200A-3P circuit breaker to provide fault clearing ability. Circuit breaker A.I.C. rating shall be as scheduled in Section 16300, Article 2.8.

3. The service shall be nominal 1200 ampere, 277/480 volt, 3 phase, 4 wire. Feeder to the service location shall be (3) 4"-4 #600MCM conductors in parallel. At the temporary service location provide current transformers, cabinet, metering equipment with demand register and service distribution panel rated at 1200 amperes. The Electrical Contractor shall include in the service distribution panel all disconnect switches required for the services described by paragraphs 3 through 6 of this Article. The temporary service equipment shall be conveniently and centrally located at the construction site at a point approved by University of Minnesota Electrical Construction Superintendent and shall not interfere with construction progress.

4. From the service distribution panel provide subservices as required and as indicated hereinafter. Within the building provide 4-100 ampere panelboards on each floor for floors B, 1, 2 and 3 and 2-100 ampere panelboard on each floor for floor M, 4 through 15. Panelboards shall be 120/208 volt, 3 phase, 4 wire served by 480 volt to 120/208 volt, 3 phase dry type transformers. Multiple 100 ampere panels may be served from one transformer providing the capacity of the transformer and feeders are sized for the load to be served.

a. Each panel shall be 30 circuit with 24-20 amp., 1 pole breakers and 3-20 amp., 2 pole breakers. Provide GFI circuit breakers as required by code for temporary services.

b. For each panel location provide a receptacle panel with 24-20 amp., 120 volt, 3 wire grounded type single receptacles and 3-20 amp., 240 volt, 3 wire grounded type single receptacles. Each receptacle shall be connected to a separate circuit.

4. From the temporary service locations each individual contractor shall provide his own portable cords and outlets for hand tools. Each Contractor shall provide his own shed service from the temporary locations. The Electrical Contractor shall provide the office service for the University's offices when located in Unit B/C.

5. Within the building provide a sufficient number (minimum 2000) rubber covered lamp sockets uniformly spaced so that in general 200 watt lamps (maximum) will provide satisfactory lighting on temporary cable connected to the disconnects and located for all trades. Lighting shall be adequate to provide suitable working conditions for high quality workmanship, as approved by the University, and safe lighting conditions. As work progresses, these sockets shall be re-located by the Electrical Contractor as required. All trades will provide their own portable cords and outlets in the building for portable tools. All light bulbs will be furnished by General Contractor, but shall be installed, removed and reinstalled as burn outs occur by the Electrical Contractor.

6. Within the capacity of the temporary construction service, Electrical service for welders, cranes and temporary elevator shall be provided by each Contractor and may be taken from the Temporary Service. Electrical energy costs will be paid by the University. The energy demand shall not exceed the service and any damage resulting from misuse, overloading or faulty equipment shall be paid for by the responsible persons.

7. The entire installation of construction light and power, including the service, sub-service, wiring devices and equipment shall meet code requirements and shall be safe, substantially supported and adequately connected.

8. The Electrical Contractor shall submit a one line diagram type sketch (3 copies) of the proposed temporary service to the University of Minnesota Electrical Construction Superintendent for approval at least one week in advance of the desired start of the installation of the same. The sketch shall show and describe all cables, raceways, meters, switches, and overcurrent protection (fuses) and any additional information as may be required by the University.

9. After approval by the University Electrical Construction Superintendent, the Contractor may then proceed with installation of the temporary service.

10. Before energizing the temporary service connected to the University of Minnesota electrical system, the Contractor shall submit to the University Electrical Construction Superintendent (3 copies) of "REQUEST FOR TEMPORARY CONSTRUCTION ELECTRIC SERVICE CONNECTION TO UNIVERSITY OF MINNESOTA ELECTRICAL SYSTEM" form. Copies of this form are available from the University Electrical Construction Superintendent.

11. The Electrical Contractor shall meet University requirements for switching and overcurrent protection of the temporary electric service served from the University's distribution system.

C. Temporary service in building shall be provided after satisfactory enclosure and when the permanent electrical secondary system has been energized. The permanent service characteristic is 120/208 volt, 3 phase, 4 wire and 277/480 volt, 3 phase, 4 wire.

1. The Electrical Contractor shall install and connect items (including service transformers, main switches and panelboards) required to provide light and power in the building. The Electrical Contractor shall string temporary wiring for hand tools. The Electrical Contractor shall provide and install metering. Bulbs for temporary lighting shall be provided as specified by paragraph B.5, University will pay for electrical energy used, directly to power company. Permanent convenience outlets shall not be used, and permanent fixtures shall not be installed until finish operations are in process but fixtures shall be installed prior to casework installation. The Electrical Contractor shall install temporary convenience outlets for use of hand tools, consisting of 60-20 amp, 120 volt, 3 wire grounded type duplex receptacles on each floor for floors B, 1, 2 and 3. Provide 30-20 amp 120 volt, 3 wire grounded type duplex receptacles on each floor for floors M, 4 thru 15. Within shelled spaces and shelled floors provide only the permanent receptacle outlets with temporary receptacle devices. Each receptacle shall be connected to a separate circuit. Provide GFI circuit breakers as required by Code for temporary services. Other temporary wiring and devices shall be provided by each contractor as required. All devices shall be safe, substantially supported and adequately connected. Removal of temporary system and devices shall be by the Electrical Contractor. The Electrical Contractor shall install the permanent convenience outlets when approved by the University, just prior to occupancy.

2. After the electrical installations are complete, prior to occupancy and when approved by the University, all temporary electrical services, wire, conduits, devices and equipment shall be removed by the Electrical Contractor.

D. The Electrical Contractor shall supply promptly to the Electrical Construction Superintendent the date of temporary service disconnection and meter reading at that time.

E. Safety Lighting shall be maintained by the General Contractor upon commencement of Unit B/C Project, including lamps. The General Contractor will pay all energy costs directly to the power company.

1. A Safety site lighting system has been installed and is operating under another contract (Early Excavation). This lighting installation will be turned over to the new Unit B/C General Contractor who will then be responsible for maintenance and addition of safety site lighting as required.

2. The Electrical Contractor shall cooperate with the General Contractor in effecting this transfer by reconnecting properly into the new Unit B/C temporary service of Paragraph B above and make such changes without cost to the General Contractor or the University.

F. A prior temporary service rated at 200 amp., 120/240 volt, single phase, 3 wire has been installed under an earlier contract for excavation (Unit B/C ECX) and is connected to the power company's distribution system.

1. This service may continue to be used until the new temporary non-building construction service is installed. At that time the electrical

contractor shall reconnect this service to the new temporary service equipment, record meter reading at that time and remove metering equipment as required.

2. Energy costs will be paid by the General Contractor until the service is reconnected to the new temporary service.

G. The General Contractor will provide and maintain site and safety/security lighting at the storage area at the N.E. corner of Harvard and Delaware, on tracts 2, 3, 4 and 5. The Electrical Contractor shall provide and install electric service to this lighting from the Utility source including metering and service disconnect as required. General Contractor will pay the energy costs directly to the Utility Company.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements of pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the basic construction materials for erection and installation of the building electrical systems.

PART 2: PRODUCTS AND INSTALLATIONS

2.1 RACEWAYS AND FITTINGS

A. All electrical conduit shall be galvanized rigid steel conduit, except that EMT 1-1/4" or smaller may be used in furred ceilings, interior partitions, walls or where exposed and not subject to mechanical injury. No conduit smaller than 3/4" shall be used except on specific instruction from the Engineer or where noted on the plans. EMT shall not be used in poured concrete construction.

B. Flexible conduit, Greenfield, shall be used for motor connections and between recessed fixtures, and their junction boxes. Provide jacketed type Sealtite conduit for connections to exterior or wet location equipment. For motors conduit shall not exceed 18" in length and equipment in grounding conductor shall be provided within the raceway run with the circuit conductors. Greenfield may be used inside of counters and cabinets when approved by the Engineer.

C. Conduit for underground secondary circuits shall be rigid galvanized conduit with 20 MIL bonderized PVC cover, Robroy Industries, Plasti-Bond or equal.

D. P.V.C. conduit shall be used where specified for special installations only, conduit shall be Carlon Type 40 or equal approved for indoor application.

E. All steel conduit and all locknuts, fittings, couplings, nipples and connectors shall be protected from corrosion by hot dip galvanizing or cadmium coating both inside and out, except electrical metallic tubing shall have only enamel or epoxy coating on the interior. All rigid conduit shall have standard pipe threads.

F. In shafts, vertical runs of conduit up to 2" in diameter may be supported at every floor but support intervals shall not exceed 14', 2-1/2" and larger conduit may be supported at every second floor but support intervals shall not exceed 28'. For cable support in all conduit runs in vertical shafts, provide internal cable supports every 20 feet. Cable supports shall be segmented canvas bakelite type, non-ventilated, for either 600 volt or 15 KV insulated cables. Supports shall be O.Z. type DR or approved equal.

G. All conduits crossing building expansion joints shall be provided with O.Z. grounding type expansion fittings, Type EX or AX.

H. Conduits shall be dried, cleaned and de-burred before wire is pulled. Standard locknuts and fittings shall be used with rigid conduits, O.Z. Type A or B insulated steel bushings shall be used on all 1-1/4" or larger conduits. Terminations at cabinets and junction boxes shall be with double locknuts and phenolic bushings (1" and larger). Conduits connecting to dry type transformers shall be O.X. type HRK bushings.

I. All exposed conduit shall be run parallel to wall and floors and shall be supported in a substantial manner with pipe straps expansion bolts, screws, lag screws, clamps, mineralac clamps or Kindorff or Unistrut trapeze hangers.

<u>Conduit Sizes</u>	<u>Maximum Spacing of Supports</u>
3/4" and under	7 feet
1" and over	10 feet

J. Condulets shall not be used for 1-1/2" or larger conduits. EMT conduit fittings shall be raintight gland compression type or equivalent approved by the Engineer. Indenter, set screw or slip-on types are not acceptable. Couplings and connectors shall be malleable iron or steel.

K. Where rigid steel conduit emerges from a floor slab, other than a permanent wall, a coupling fitting shall be set flush with finished floor, so that a pipe plug can be inserted for future connections or if the line is abandoned.

L. All outdoor conduit shall be graded a minimum of 6 inches per 100 feet with no traps. Pitch to drain into manholes, pull boxes or suitably located drain tees. Where cold slabs occur or in cold rooms, conduit shall not be trapped. Where conduits penetrate roofed areas, provide pitch pockets per Section 07510.

M. In areas indicated on the plans, install all wiring and conduit work to meet all requirements for a hazardous location as defined in National Electrical Code, Article 500, for flammable gases, under Class I, Division 1 or Division 2 as indicated. Provide seal off fittings wherever conduits enter or leave the space and within 18" on either side of all wiring devices.

N. All conduit where possible shall be concealed in the ceiling, floor or wall construction unless indicated as exposed on the plans.

O. Conduit shall be Youngstown, Republic or equal.

2.2 WIREWAYS

A. Gutters and wireways shall be constructed of galvanized sheet steel conforming to Code requirements. Covers shall be screw cover type and all elbows and fittings shall be made without sharp edges or projections.

B. Gutters and wireways shall be of sufficient cross section to contain conductors, including all splices.

C. Provide permanent welded ground lug in all gutters or wireways. Cover screw connections or sheet metal screws will not be acceptable.

D. Wireways shall be Square D or equal.

2.3 OUTLET, JUNCTION AND PULL BOXES

A. All outlet boxes shall be galvanized. Standard 4" octagonal boxes shall be used for ceiling outlets except as otherwise specified or required. Ceiling outlet boxes shall be equipped with 3/8" fixture studs where required. Outlet boxes in furred construction shall be supported by bar hangers or lightweight channel iron; exposed ceiling outlet boxes shall be secured by wood screws, machine screws, toggle bolts or lead anchors as applicable. All boxes shall be supported independently of support from connecting conduit.

B. Standard 4" square boxes with proper plaster rings shall be used for device outlets in plastered walls. Gang boxes with plaster rings shall be used where more than two devices occur at one location.

C. Use properly sized tile boxes and covers for device outlets in glazed tile, brick and unfinished concrete block walls. These boxes shall be ganged where two or more devices occur at one location.

D. Standard 4-11/16" square boxes shall be used for ceiling and other outlets as required for additional wire space.

E. Square boxes with industrial covers shall be used for exposed wall outlets.

F. Provide Appleton, Killark, or Crouse Hinds FS and FD condulets for outdoor outlets and ceiling outlets wherever required for vaportight fixtures and wet locations. Provide explosion-proof cast boxes for Class I Division I and Division 2 areas.

G. In light switch boxes provide code gauge steel partitions where voltage between adjacent terminals exceeds 300 volts.

H. Covers shall be provided for all outlet boxes, as required, and shall be of a design to fit the particular box and location, and shall be readily adjustable for alignment with the walls and finishes. Where these covers are to receive a finish coat of paint, Electrical Contractor shall furnish same with one coat of primer. In finished spaces, covers shall be similar to those specified under finishing plates, Section 16310.

I. Light fixtures without integral J-boxes suitable for wiring temperature rating shall have J-boxes installed in an accessible location close to fixture.

J. All pull boxes are not shown on the plans but they shall be provided as required for ease of wire pulling and in long runs (90 feet or more), or when more than four quarter bends shall occur in any conduit run. All pull boxes shall be sized to conform to requirements of the National Electrical Code. Pull boxes shall be recessed in all finished portions of building.

K. All junction and pull boxes shall be accessible and permanently labeled to identify the system and wiring within. Refer to Section 16010.

L. Outlet boxes shall be Appleton, Steel City, Raco, or equal.

2.4 WIRE AND CABLE

A. All wire and cable furnished and installed under this contract shall be new and of the best quality. Wire and cable shall be of size, type and number shown on plans. All conductors shall be of soft annealed copper of not less than 98% conductivity and in all other respects to the requirements of the ASTM specifications, latest edition. Unless otherwise noted, insulation shall be rated at 600 volts.

B. All branch circuit wiring shall be color coded according to Article 210-5 of the National Electrical Code and as follows:

1. 120/208 volt: A - black; B - red; C - blue; Neutral - white;
Ground - green; travellers - yellow;

2. 277/480 volt: A - black/yellow tracer; B - red/yellow tracer;
C - blue/yellow tracer; Neutral - white/yellow tracer;
Ground - green; travellers - yellow/black tracer

3. All feeders if not color coded shall be permanently marked with paint or tape at their terminations for identification.

C. All feeder wire shall be type THW and branch circuit wire shall be type THW or THWN-THHN, unless indicated otherwise, of sizes shown on plans. All wire larger than Number 6 shall be stranded. Unless indicated otherwise, no wire smaller than Number 12 shall be used for branch circuits. Number 14 may be used for relay and motor control.

D. All wire pulled through the wiring channels of continuously mounted fluorescent fixtures shall be type RHH and THWN. Wire connected to recessed type and vaportight fixtures shall be type AF. All underground wires exterior to the building shall be in conduit and shall be type THW or THWN. Branch wire in high ambient areas shall be type THHN.

E. Interior helical spring twist type connectors shall be used on number 8 and smaller wire sizes. These shall be Ideal 70 or 450 Series, Scotchlocks or approved equal.

F. Number 6 and larger wires shall terminate in solderless lugs. All terminations taps and splices shall be compression type Burndy, Hydent or approved equal.

G. No splices shall be made in any conductor except when absolutely necessary and then in approved junction or pull boxes. Secondary service wires and feeders shall be of one continuous run without splices.

H. To relieve strain on the insulation and the conductors when pulling wire, a wire pulling lubricant shall be used, powdered soapstone or approved equal except for isolated power systems shown on the plans and specified under Section 16600 where no lubricant shall be used.

I. Portable cords for receptacles, equipment and ceiling attachments shall be Type SJO. All cords shall have a grounding conductor and cords shall be properly installed with cord grip devices at each end. Conductor size shall be #14 stranded minimum.

J. Refer to Section 16500, 16600 and 16900 for wiring and conductor requirements for specific systems. Refer to Section 16210 for 15KV cables.

K. Wire and cable shall be General Cable, General Electric, Rome, Hatfield, Anaconda or equal.

2.5 SURFACE RACEWAYS

A. In laboratories, and where shown on plans, provide surface metal raceways complete with wiring and receptacles as indicated. Surface raceways shall be Wiremold, or approved equal with special colors to be selected by Architect to coordinate with casework.

B. Provide all hardware elbows, fittings, boxes (if required) and back entry devices as necessary. Standard 10' bases, 5' covers and 5' dividers shall be used. Contractor shall cut raceways as required to fit the spaces allocated and for assembly in continuous odd length rows. Surface raceways shall be back fed from flush in wall horizontal electrical boxes.

C. All surface raceways shall be provided with a green color insulated copper ground conductor. This conductor shall be connected to the supply panelboard ground bus and to each ground screw on each receptacle.

D. Surface raceways shall be provided where shown on the plans as follows:

1. In laboratories and as noted provide Wiremold #G-3000. Install receptacles and stainless steel plates where shown and of type indicated as listed in Section 16310.

2. In projection rooms and as noted provide Wiremold #G-4000 with divider partition for low and high potential services. Provide #G-4046B combination duplex receptacle and telephone outlet covers. Provide completely wired duplex receptacle specified in Section 16310 where shown.

2.6 CABLE TRAYS

A. Provide a complete cable tray system including all necessary hardware, horizontal bend fittings, vertical inside and outside bend fittings, tees, crosses, offsets, splice plates, blind end plates, hanger rods and clamps and support hanger brackets as required, and as shown on plans. Vertical and horizontal offsets shall be provided as necessary to coordinate with the Mechanical and Structural installation.

B. System shall be Chalfant Series 6S, trough type, galvanized 16 gauge steel, in standard 10 lengths. Openings shall be 3-4/16" oval with 1-3/4" rungs between. Trays shall be 9" or 12" wide as indicated on plans.

C. Provide two support rods every 8' or wall bracket support where applicable. At feed points provide #6SCB425 conduit to tray adapter fitting. For vertical runs provide nylon cord lacing every 3' for substantial bracing. Cable tray systems of Binkley, Huskey/Burndy, P&W and Cope shall also be approved.

D. For primary cable support in primary switchgear rooms and vaults provide similar system, except aluminum ladder type, 12" wide by 3" high. Ladder shall be Chalfant "Cablebeam" Class II to match and extend existing system. All rungs shall be 12" apart and welded. All splices shall be bolted.

E. Electrical Contractor shall provide and install an approved fire barrier where cables penetrate a fire rated partition at electrical cores, connection to existing Unit A Building, and where indicated on plans. Barrier shall be Multi-Cable Transit Assembly by Nelson Electric or rigid steel conduit per detail 2/E32.

F. Manufacturer of cable tray shall provide shop drawings complete with plan layout indicating all sizes and components of the system.

2.7 FLOOR BOXES & OUTLETS

A. Provide floor boxes or through floor outlet fittings where shown on the plans completely wired and equipped with receptacle or wiring device. Boxes and fittings shall be installed so that the tops are perfectly flush with the finished floor. All exposed parts shall have satin aluminum finish. Verify floor finish before ordering boxes. Provide carpet flanges where necessary.

B. Floor pedestal outlets for telephone and power shall be through-floor outlet fittings (after set type) Hubbell FA-1366X/FA-1566X box assembly or Hubbell FA-1355/FA-1555 toggle assembly as required. Assemblies shall be suitable for a 6-1/4" thick floor consisting of 3" concrete and 3-1/4" metal deck. Provide a surface floor fitting for each outlet completely wired with pedestals and receptacles as specified below:

1. Office Areas : Pedestals shall be standard type: Hubbell SC-3090-telephone; Hubbell SC-3091-single duplex receptacle; Hubbell SC-3092-double duplex receptacle. Provide 20 amperes duplex receptacles as specified under Section 16310. Finish shall be satin chrome with stainless steel plates.

2. Laboratory Areas: Pedestals for power shall be heavy duty type Hubbell SA 6686 or SA 6688 with receptacles as indicated on the plans and specified in Section 16310. Finish shall be satin aluminum with stainless steel plates as required.

C. Flush floor outlets for power and telephone shall be Steel City Series #662 floor boxes. Box shall be cast iron #662-CI-AL with aluminum edge ring. Provide top assemblies P-60-3B-AL with aluminum floor plate. Provide partition plates #P-60-Q for duplex receptacle specified under Section 16310.

D. Floor boxes in the Auditorium shall be cast iron hinged cover type, 8"x x 12" L.X. 4" deep, Lew #8126-BE. Contractor shall set box flush with concrete floor and provide machined notching in hinged cover to allow for cable exit as directed by the University Electrical Construction Superintendent.

2.8 FLOOR TRENCH AND DUCT RACEWAYS

A. Provide floor trench duct raceway systems as shown on the plans and as herein specified at the following locations.

1. Rooms 12-163 and 12-167

System shall be Conduflor 4900 Series 24" wide with special 12" long cover with 1/4" stop to receive a poured epoxy floor covering. Refer to detail 10/E-58. Where indicated on the floor trench provide a threaded sleeve through the cover to allow for future wiring. Close off sleeves with stainless steel abandoning caps Conduflor #182-2SS. Provide single threaded lift out plug for each cover for removal of covers. Furnish to the Owner 2 cover removal tools.

2. Room 3-75

System shall be Conduflor 4900 Series 12" wide with 24" long cover to receive 1/8" vinyl tile covering. Provide as indicated floor trench to wall duct adapters and wall duct to allow for system wiring. Refer to detail 15/E58.

3. X-ray Rooms

Refer to Sheet E-57 for layout of trench and ducts. System shall be Square D or approved equal. All trench and duct shall be Sized as indicated on the plans complete with removable covers. Floor trench cover shall accommodate 1/8" vinyl tile covering. Duct installed above the ceiling shall be suspended from resilient connectors. Refer to Section 13500 for connectors which are provided for ceiling suspension. Connector shall be Consolidated Kinetic Inc.

B. All floor trench shall be gasketed to provide a water tight seal between trench and cover. Install trench flush with finished floor and provide full length removable covers unless otherwise noted. Provide barrier strips within trench to separate high voltage wiring from low voltage wiring where indicated. Insert crossover tunnels where necessary to maintain this separation.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provision - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the basic installations, assemblies, methods of fabrication and supporting devices for the electrical system.

PART 2: PRODUCTS AND INSTALLATIONS

2.1 GROUNDING CONTINUITY

A. All conduit systems, equipment housings, material housings, junction boxes, cabinets, motors, ducts, wireways, light fixtures, portable equipment and all other conductive surfaces shall be solidly grounded in accordance with the National Electrical Code to form a continuous, permanent and effective grounding system.

B. Patient Care Areas:

1. Grounding continuity shall be provided as specified herein and as indicated on the plans to conform with National Electrical Code, Article 517. In general the clinical areas located on floors 1 through 9 are classified as patient care areas for general patient care except as otherwise noted. All non current carrying conductive surfaces of electrical equipment subject to personal contact shall be grounded by an insulated green jacketed copper conductor sized in accordance with N.E.C. table 250-95 and installed in the conduit system with the circuit conductors. All branch circuit wiring shall include this ground conductor which shall be connected to the panelboard ground bus from the wiring device, equipment or outlet as required.

2. Certain surgical areas located on the first floor and detailed on Sheet E46 are classified as critical patient care areas and will require equipotential grounding systems as specified in Section 16600.

3. X-ray rooms and equipment shall be grounded in accordance with National Electrical Code, Article 660 and as specified, herein for general patient care and as indicated on the plans.

C. Non-Patient Care Areas:

1. Grounding for non-patient care areas shall conform with NEC, Article 250 and as specified herein and as indicated on the plans. In general the basement floor, mezzanine, 10th through 16th floors and areas west of grid EW on floors 1 and 2 are considered as non-patient areas. Grounding continuity for branch

circuits shall be established by an insulated green jacketed copper conductor sized in accordance with N.E.C. table 250-95 and installed in the conduit system with circuit conductors. This ground conductor shall be connected to the panelboard ground bus from the wiring device, equipment or outlet as required.

2. Grounding continuity shall be established by using standard couplings, connectors, fittings and green jacketed copper conductor jumper in conduit with circuit conductors for motors feeding from motor control centers.

D. Refer to Section 16220 for a complete description of the basic grounding system.

2.2 CASEWORK ELECTRICAL UTILITIES

A. The Electrical Contractor shall furnish and install all receptacles, boxes, plates, pedestals and all conduit and wiring required and shown on the plans for all casework electrical requirements. The Casework Contractor will provide all cutouts for the electrical outlet boxes required for the various electrical devices.

B. Electrical Contractor shall coordinate and provide all data to the Casework Contractor for the correct placement of all required outlets. Both the casework schedule, equipment details and the electrical plans shall be studied and referred to before proceeding with the installation. It shall be the Contractor's responsibility to provide a satisfactory and coordinated installation.

C. Fume hoods will be package units and will come complete with their components installed and partially prewired. The Electrical Contractor shall provide all power circuits to these units and make all connections. In addition, provide conduit, wire and connections at each hood for the pilot light and the pressure switch in the duct above the hood. Pilot light and pressure switch will be furnished and installed by the Casework and Electrical Contractors, respectively. Pressure switch is specified under Section 16900.

2.3 MILLWORK ELECTRIC UTILITIES

A. The Electrical Contractor shall furnish and install all receptacles, boxes, plates, pedestals and all conduit and wiring required and shown on the plans for all millwork electrical requirements. The General Contractor will provide all cutouts for the electrical outlet boxes required for the various electrical devices.

B. Electrical Contractor shall coordinate and provide all data to the General Contractor for the correct placement of all required outlets. The millwork details and the electrical plans shall be reviewed before proceeding with the installation to assure a correct and coordinated installation.

2.4 EQUIPMENT CONNECTIONS

A. Completely wired outlets and disconnects shall be installed as required for equipment furnished by others. Verify connection requirements for all equipment, installed or furnished by others, before installation.

B. In general, the service to equipment is laid out for anticipated electrical requirements as listed on Architectural Equipment Schedule. Actual equipment furnished may differ and shall be checked from the shop drawings to assure proper power supply. Report any differences to the University for procedure or adjustment. Equipment will be furnished by General, Mechanical or Electrical (Group I) and the University (Group II).

C. Package environmental rooms will be provided and installed by the University (Group II). The electrical contractor shall provide the 120/208 volt, 3 phase, 4 wire feeder and disconnect sized as shown on the plans. Final location of the disconnect shall be coordinated with the University's equipment. Electrical Contractor shall cooperate fully with the University in the placement and installation of this feeder and disconnect. The University will extend wiring from this disconnect and make all final connections to the equipment and room.

D. X-Ray equipment will be provided and installed by the University (Group II). The Electrical Contractor shall provide the electrical installations shown on the plans for X-ray rooms located on Floor #1 Room #232, 235, 240, 243 and on Floor #3 Room #141. Refer to details on Sheet E-57 for raceway, floor trench, electrical equipment and power connections to be provided by the Electrical Contractor to accommodate the University's X-ray equipment. Final inter-connecting power and control wiring of the University's X-ray equipment will be provided by cash allowance as specified in Section 01800. The Electrical Contractor shall coordinate with the University final locations and sizes of all raceways trench and power connections. The University and Engineer will provide to the Electrical Contractor X-ray equipment installation drawings for all additional electrical installation work to be accomplished under the cash allowance. The Electrical Contractor shall cooperate fully with the University to complete the installation according to the X-ray manufacturers recommendations and installation drawings.

E. Floor 1, X-ray Room #318 electrical installations including lighting, receptacles, raceways, floor trench, power equipment connections and control wiring will be provided by cash allowance specified under Section 01800. The University and Engineer will provide electrical installation drawings to the Electrical Contractor for the required work in this room.

2.5 CONDUIT INSTALLATIONS IN STRUCTURAL MEMBERS

A. Where conduit rough-in requires groups, rows or clusters of conduit at one location, a minimum of 4" shall be maintained between conduits. Where the normal spacing of reinforcing bars cannot be maintained, or the bars are interrupted by conduit groupings, the Electrical Contractor shall provide extra reinforcing bars, around the conduit groupings as approved by the Architect and Structural Engineer. Submit layouts in advance of setting conduit groupings for directions of added bars and approval of layout.

B. Unless otherwise approved by Architect and Structural Engineer, conduit embedded in concrete (other than those merely passing through the concrete) shall not be larger in outside diameter than $1/3$ the thickness of the slab, wall, beam, girder or joist in which they are embedded or spaced closer than 3 diameters. Conduit shall be installed so as not to impair the strength of the concrete. Submit proposed methods to the Structural Engineer, including drawings where required to describe the proposed methods, for review of possible deviation

from these requirements and wherever questionable installations are encountered. Submit prior to installation and to prevent delay of work.

2.6 INSTALLATION IN STEEL STUD PARTITION WALLS

A. As shown on architectural plans most interior walls are steel stud, drywall type. These walls fit to horizontal members at the ceiling and floor consisting of 18 gauge sheet steel or 1/8" aluminum channels. Refer to Architectural Details for method of electrical installations. Refer to Electrical Details 1/E-4 3/E26, 4/E26 for wall access limitations.

B. All low voltage wiring, except telephone cable and all 120 volt and higher circuits shall be installed in conduit. All steel stud openings to permit horizontal conduit runs shall be cut by this Contractor if not furnished as standard by the stud subcontractor.

C. All openings in these walls for all electrical devices will be provided by the wall subcontractor as directed by the Electrical Contractor. Provide box cover rings or other mounting devices where required.

D. All openings in the horizontal wall support members for conduit shall be provided by the Electrical Contractor. These openings shall be neatly drilled to the approximate size of the service entering.

E. The Electrical Contractor at his option may wire duplex receptacles shown in partitions by providing a junction box above the ceiling and dropping a single conduit run to each receptacle in lieu of running continuous conduit from receptacle to receptacle.

2.7 INSTALLATION IN LEAD SHIELDED WALLS

A. Radiation Shielding:

1. Where indicated on the architectural floor plans X-ray rooms will be shrouded with lead sheets installed by the General Contractor for radiation shielding.

2. All electrical installations shall be made inside of the shroud and shall be put in place prior to the lead installation.

3. Conduit entries shall be minimized and entry point shall be coordinated with the General Contractor.

B. Acoustic Shielding:

1. Where indicated on the architectural floor plans certain rooms will be shrouded with lead above the ceiling from the top of the partition to the structure and around the perimeter walls to adjacent rooms. This installation will be provided by the General Contractor for acoustic shielding.

2. All electrical conduit penetrations through the lead shielding shall be minimized and the required seal about the conduit or raceway shall be provided by the General Contractor. Electrical installations made after the lead shielding is installed causing penetrations of the acoustical seal shall be by the Electrical Contractor.

C. The Electrical Contractor shall coordinate and cooperate with the General Contractor to accomplish the installations of electrical systems with the installation of the lead shielding.

2.8 VIBRATION CONTROL

A. Transformers and engine-generators shall be installed in a special manner to minimize transfer of vibration to adjacent structure or equipment.

1. Dry type transformers shall have integral flexible neoprene absorbers. If any exceptions are made to this requirement, other measures shall be taken.

a. If floor mounted, provide 4 compressed glass fiber pads per transformer as approved by the Engineer.

b. If trapeze supported, provide spring and neoprene rod insert absorbers as approved by the Engineer.

2. Floor mounted oil immersed transformers and their associated sub-station components shall be placed on top of pads, two per cubicle.

a. Pads shall be vibration isolation type of compressed glass fiber jacketed in neoprene or of multiple layers of ribbed-neoprene or waffle pattern neoprene of sufficient height and of proper stiffness to support the load without exceeding 1/4" static deflection.

b. The floor shall be grouted or shimmed to assure a level base for alignment. The pads shall be loaded in accordance with the loading rates recommended by the manufacturer.

3. The standby engine-generators shall be factory equipped with heavy steel skid bases on top of which the units are mounted on spring loaded isolators as specified in Section 16210. These isolators shall be selected specifically for the engine (4 isolators) and the generator (2 isolators). In addition the steel skid shall be set upon six fiber glass pads as specified in paragraph (2) (a) (b) above.

2.9 FASTENERS AND SUPPORTS

A. All fastening and supports shall be of an approved type. The use of wire, nails, etc., for fastening exposed conduits is prohibited. Threaded inserts, expansion or toggle bolts shall be used for fastening to masonry walls.

B. Where possible conduits shall be grouped together and rigid racks of angle iron or structural channels shall be provided. Individual conduits shall be clipped to the ceiling or wall with malleable iron pipe straps wherever possible. Where individual conduits must be hung from the ceiling approved conduit supports and rod hangers must be used.

C. Provide rigid rods or bars for the support of lighting outlet boxes and grid boxes. No perforated metal straps may be used.

D. Provide supporting frame racks of angle iron, flat bar, and channel structural members wherever required for the support of wiring troughs, safety switches, motor starters and controls, and associated equipment. Supporting frame racks

shall be rigidly bolted or welded together and adequately braced to provide a substantial structure. The welds and edges of all brackets shall be filed or ground smooth for painting. Racks, supports and frames shall be Kindorff, Steel City, Unistrut or approved equal.

E. Supporting frame racks shall be mounted on permanent walls wherever practicable. Where free standing supporting frame racks are required they shall be located in an area as approved by the Engineer in order to avoid interference with the normal operation and maintenance of building equipment. Supporting frame racks shall be of ample size to provide for a workmanlike arrangement of all equipment mounted thereon. All wood panels shall be 3/4" minimum thickness plywood; all panels shall be provided with two coats of fire-retardant enamel on both sides and edges. Plywood shall be Building Grade with Pine or Fir finish on both sides. Plywood inside of cabinets or panels may be 1/2" thick minimum.

2.10 INSTALLATION IN CABLE TRAYS

A. Low voltage cables including telephone, television, computer, intercom, etc., above ceilings may be installed without conduit but shall be neatly secured and laid into cable trays in an organized manner. Refer to Section 16100, Article 2.6.

B. Inside of cable trays provide nylon ties every 10 feet to bundle small wires. Leave space always on the same side where feasible for telephone cables and space for future cables of other systems.

C. When approaching cable trays from walls, cables shall be run at right angles (not random), shall be neatly bundled and supported every 5 feet with open eye type clips or suitable nylon ties.

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PART I: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes providing a complete electric service system including service, service entrance equipment, substations, substation feeders, grounding, fusing and all connections and terminations as shown on drawings and specified. The service shall be 13.8KV, 3 phase, 4 wire grounded 60HZ and shall be connected to the University of Minnesota electrical distribution system which include existing primary feeders CAM 18X and CAM 19X and a new primary feeder CAM 25X located in the Unit A Building.

C. Provide from the existing primary service entrance equipment located in the Unit A Building two new 13.8KV electrical service feeders to Unit B/C. Provide new feeders, feeder switches, tie switches and modifications to the existing switchgear as shown on the drawings and specified.

D. A new primary underground electrical service entrance feeder (CAM 25X) will be provided to the Unit A Building under another contract. This 13.8KV feeder shall be connected to a new CAM 25X line switch. The electrical contractor shall provide the new line switch and connect the CAM 25X feeder as indicated on the drawings and specified.

1.2 PRIMARY AND SECONDARY VOLTAGE INTERRUPTIONS

A. Electric service interruptions involving University property or required by the contractor to perform his work shall be arranged for and approved by the University before interruption.

B. Requests for primary outages and energizations shall be submitted in writing to the University's Electrical Construction Superintendent for approval at the earliest possible date, and in no case later than two weeks prior to the outage and/or energization. Proposed outage information shall be submitted on a University of Minnesota "Request for Electric Outage" form (3 copies) available from the University's Electrical Construction Superintendent.

1. The Contractor shall verify with the University's Electrical Superintendent that all equipment and installation involved is completed, tested, and ready for service and that all related shop drawings and operational data have been submitted before submitting the outage and/or energization requests.

2. The Contractor shall have all material for each high voltage 15KV splice, termination and shop drawing thereof (1 copy) prepared and available for inspection by the Electrical Superintendent of Construction on the job site at least 72 hours before the splicing and/or terminating is scheduled to begin.

C. Scheduled outages will be scheduled at the convenience of the Owner. The Owner reserves the right to cancel or change the scheduling of any such outage up to 24 hours before its previously approved starting time. There shall be no additional cost to the Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours notice has been given by the Owner to the Contractor.

D. The Contractor shall minimize all outages on the Owner's electrical system and shall employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary to accomplish this. A minimum of twelve (12) weeks before the first outage desired by the Contractor or upon request by the Owner, the Contractor shall submit a reproducible schedule (bar graph form) of his proposed sequence of all the primary electric feeder and substation outages and energizations; and temporary vault use involved in the project. This schedule shall show construction time in calendar days required for and between the various outages and energizations and shall include any weekend work. The schedule shall also list the splices and other work to be completed during and between each outage. After the schedule has been reviewed by the Owner, the Contractor shall submit it to the Engineer (1 copy) and Owner (5 copies) with the dates he proposes to commence and complete the various schedule entries. As work progresses, the Contractor shall revise, update and resubmit the schedule as the Owner shall request.

E. At the time of energizing each 13,800 volt feeder, the Contractor shall be prepared to handle any situation that may arise from a cable or equipment failure or other faults on the system. If a failure or a fault, it is the Contractor's responsibility to check out and place the system in proper operation with the required personnel and equipment, as soon as possible.

F. Primary 13.8 KV electric feeders shall be made available for splicing during normal working hours. Any splicing work done on an overtime basis on these splices shall be at the Contractor's expense.

G. The 13.8 KV feeder shall be connected so that there is parallelability across the 13.8 KV tie switches and between all incoming 13.8 KV feeders so that the building transformers can be transferred between 13.8 KV feeders without having to be shut off.

H. All modifications to Unit A Building primary service entrance switchgear shall be complete before the 13.8 KV feeders to Unit B/C are energized. This restriction shall not apply to the termination and connection of CAM 25X in Switchvault #2.

1.3 PRIMARY SYSTEM ENERGIZATION

A. Upon being installed all primary switches shall be locked open and tagged with hold cards in the name of a person to be designated by the University. Hold cards are available from the University's Electrical Construction Superintendent. In no case shall these cards be removed without that persons approval.

B. This Contractor shall submit to the University for approval the section to be energized along with the date and time this is to take place. This request shall be in writing and the Contractor shall receive written approval

before proceeding to energize that section of the system. The first energized operation of each 13.8 KV switch installed under the contract shall be by the Contractor. All subsequent operations of these switches shall be by the University, except where specifically stated in writing beforehand between the University and the Contractor.

PART II: PRODUCTS AND INSTALLATION

2.1 DANGER SIGNS

A. Provide a "Danger - High Voltage" sign on each primary switchgear and sub-station room door. The sign shall be porcelainized steel and be not less than 9" x 12" in size.

2.2 PHASE IDENTIFICATION

A. Phase Marking signs (A, B, C) shall be attached to the equipment which consists of laminated signs of 1/8" stock plastic with white lettering on black background, the letters shall be 1/2" tall. Inscription shall be symmetrical on the sign. These signs shall be attached to surface with self-tapping screws or an epoxy glue.

B. Phases shall not be marked in pull boxes or splice boxes.

C. Phases shall be established and marked in an approved or specified manner at all transformer, switchgear, switch connections and terminations A, - B, - C, left - to - right, front - to - rear or top - to - bottom, when facing the front of the equipment.

2.3 PRIMARY CABLE AND SPLICING INSTALLATION

A. Primary service cables shall be 3 - 1/C, 250MCM, 15KV, grounded neutral ethylene propylene rubber, 37 strand, compact round, copper cables for each feeder. Provide with each set of feeder cables a 250MCM, THW, 600 volt neutral conductor. The primary cable and installation shall meet all current IPCEA standards. Cable shall be Okonite "Okoguard", or approved equal. All cable shall have continuous surface printed identification showing manufacturer's name, insulation type, size and voltage rating. All cable shall be new and shall be delivered to the job site in coils or on reels; each coil and/or reel shall have a label for proper identification with manufacturer's name, trade name of wire, size and UL labels.

B. Cables shall be installed in 4" rigid steel conduit for each feeder. Provide feeders as indicated on the plans from the primary switchgear in Unit A switch vault to the new Unit B/C Substations and between all substations at the Basement, tenth and fifteenth floors. The primary feeders shall be "rung out" and also shall be plainly identified at all terminals, junction points, vaults and splices by means of stamped brass or lead tags attached by woven glass or nylon cord. The tags shall be approximately 1-1/2" in diameter and shall have 1/4" high lettering. Feeders shall be tagged at least twice in each pull box, splice box and vault. Cable identification shall consist of inscription (typical) as follows: CAM 18X, CAM 19X.

C. Care shall be exercised while installing all cables so as not to injure the cable. The cable shall be handled in accordance with the cable

manufacturer's recommendations and at no time shall be bent in a radius smaller than ten (10) times the overall cable diameter. Pulling lubricant shall be as approved by the cable manufacturer. All conduits shall be clean and free of all foreign objects before pulling in cables. The contractor shall have the cable manufacturer make the following record copy submittals to the University by at least one week before starting cable installation:

1. A data sheet or report (3 copies) stating the maximum A.C. and/or D.C. voltage that can be applied to the 15 kv cables during the Contractor's field installation acceptance and subsequent proof high voltage A.C. and/or D.C. tests.

2. Certified factory cable test reports (3 copies) for each cable production run showing that the cable equals or exceeds the requirements of the governing standard.

D. Splices or caps shall be made only at splice boxes. The cable ends shall be kept moisture sealed at all times except when a splice is in the process of being made and in no case shall work be stopped on an open cable until the splice is completed. All materials required for proper splicing of cables shall be provided by the Contractor in accordance with the cable manufacturer's recommendations.

1. Splice construction drawings and associated material lists shall be submitted per shop drawing submittal requirements of the contract for approval.

2. The Contractor shall have in his employ a person or persons qualified to handle all required cable terminations and splices under this contract. This person or persons shall remain in his employ on the job site from the first time he is needed until the system is energized and in satisfactory operation.

3. The electrician performing the splicing and termination work on the high voltage cable shall have previous knowledge and experience in this type of work. Evidence of this experience in the form of a previous job history shall be made available upon request from the Engineer.

4. Each splice shall be identified with the Contractor's name and the year in which it was made.

E. Splicing of rubber jacketed cable (2-way straight splices, 3 way tee or 3 way wye) shall be made with factory packed splicing kits designed for the specified cables. Splicing kits shall remain in unbroken cartons until actual use. Splicing kits shall be G&W, Type CA2 Series.

F. Cables in cable tray and locations not protected with conduit shall be arc proofed. The arc-proofing shall consist of bundling the conductors of each circuit, including the ground conductor, with "SCOTCH" brand electrical tape #27, applying a wrap of "IRVINGTON" brand arc-proofing tape #7700 after the cable has been installed. The tape shall be wound spirally with half-lap joints over the grouped cables. Finally, random wrap "SCOTCH" brand electrical tape #27 over the arc-proofing tape to prevent unraveling. Feeder identification shall be located over the fireproofing.

G. Each phase conductor shall be given a continuity and a direct-current high potential test after installation and after terminations have been made, but before connections have been made to busses or apparatus. The phase conductor shall be tested to 80% of manufacturer's test voltage. The voltage shall be raised in 4000 volt increments with a 60 second charge time at each increment to reach 80% of cable manufacturer's test voltage or 32,000 volts whichever is less. The last increment of voltage shall be applied to the cable for 15 minutes. Leakage current will be read after each step. Discharge time to 20 KV shall be recorded on each phase and voltage shall be recorded after 1 minute of discharge. Three copies of the test report shall be furnished to the Engineer within 24 hours after completion of the tests.

2.4 PRIMARY SERVICE ENTRANCE EQUIPMENT

A. GENERAL

1. Provide and install dead front type, free standing, metal enclosed, fused, 15 KV load interrupter type switchgear of the number and type shown on the drawings and specified herein. The required number of free standing sections shall be bolted together to form one rigid unit with each section of the unit containing switch and protective devices of the arrangement, number, ratings, and type shown on the drawings and specified. Provide modifications to existing switchgear as shown on the drawings with equipment as specified herein.

B. ENCLOSURE

1. Construction shall be of the compact frame type using die-formed, welded and bolted members. The sides, top and rear shall be bolted on. All enclosing covers shall be fabricated from not less than 11 gauge steel. Ventilation openings shall be provided for each section. All back panels shall be removable.

2. All cubicle assemblies shall be sized to fit into the spaces provided as measured to scale from the drawings and shall be the responsibility of this Contractor. Maximum height of any cubicle shall not exceed 96" (not including top pot heads). Switchgear shall be finished with one coat of metal primer followed by a finish coat of ASA #61 light gray baked enamel or equivalent.

3. Each switch cubicle shall have a single, full length, flanged front door over switch - fuse assembly. The flanged door shall close over a projecting door frame. The door shall be equipped with a rotary latch type handle and securing bolts. Provision shall be made for operating the switch mechanism by a non-removable handle without opening the full length door. When the switch is open, the switch operating handle shall be in a fully down position against the front of the enclosure. A rectangular, high impact type glass observation window shall be provided in the door over the switch so sized and located that the open and closed positions of the switch shall be readily discernible. Operating handles shall have provisions for multiple padlocking in both on and off positions. Complete unit shall comply with the latest applicable standards of ANSI, IEEE and NEMA.

C. INNER CONSTRUCTION AND ELECTRICAL DESIGN

1. All switchgear assemblies comprising several cubicles shall be group mounted with at least 12 gauge steel full length barriers between adjacent

sections. Each assembly shall be so designed that additional switch sections can be added on either end. All cubicles shall be completely front accessible and all interior components shall be front connected and removable from the front.

2. Each section shall be designed, braced, and contain sufficient volume and venting top, bottom, front, and rear, to prevent distortion of the cubicle under normal operating conditions as well as under interruption of rated short circuit currents.

3. Main buses shall be rated 600 ampere at 13.8 KV, 95 KV BIL and a maximum design voltage of 14.5 KV uninsulated tin or silver plated aluminum supported on Nema rated porcelain insulators for voltage class and BIL specified. All contact surfaces of the switchgear phase and ground bus shall be silver plated or equivalent. The primary switchgear shall be connected so that phasing is A-B-C, reading left to right facing the operational side of the equipment.

4. A 600 ampere ground bus shall be furnished firmly secured to each vertical section and shall extend the entire length of the switchgear. Lugs shall be provided for copper ground cable at each end.

5. The integrated primary switchgear lineup and its component parts shall be designed and constructed to withstand and protect against the stresses associated with a fault condition of not less than 250 MVA, 3 phase, symmetrical at a nominal system voltage of 13.8KV. Also the integrated assembly and its component parts shall be designed and constructed for operation at or above the following ratings:

VOLTAGE

Nominal	13.8KV
Maximum Design	14.5KV
Basic Impulse Level	95 KV

CONTINUOUS LOAD CURRENT

Bus (Phase and ground)	600 amp
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AIR LOAD INTERRUPTER SWITCH

Continuous Load Current	600 amp
Load Current Interrupting	600 amp
Momentary (10 cycle, Rms., Asym.)	20,000 amp
Fault Closing (Rms., Asym.)	20,000 amp

FUSE

Interrupting (60 cycle, Rms., Asym.)	20,000 amp
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6. Each cubicle shall have provisions for extending main and ground buses in each direction to adjoining cubicle and for future additions of cubicles.

The main bus shall be extended to the termination space at the top of the cubicle. A minimum space of 25" shall be provided for terminations.

7. All switchgear shall be General Electric, Westinghouse, I.T.E., S & C or approved equal.

D. INTERLOCKS

1. Doors to individual switches shall be Kirk key interlocked with switches to prevent opening of doors under load. Provide a key for each lock that is installed.

2. The "main" switches and the "bus tie" switch shall be Kirk key interlocked so that the bus tie switch cannot be closed unless one of the main incoming "main" switches is open and both incoming "main" switches cannot be closed unless "bus tie" switch is open. Verify exact interlocking requirements described above with the details on the drawings. Refer to Detail 3 and 4/E48.

E. SWITCHES

L. All switches shall be three gang, fused, load interrupting type as shown on plans with front drive handles. They shall be quick make, quick break type with direct acting spring charged mechanism for both close and open operation.

2. Switches shall be rated for 600 amperes, continuous and load interrupting, 13.8 KV nominal, 14.5 KV maximum and 95 BIL. Switches shall be rated for 250 MVA, 3 phase symmetrical and 20,000 asymmetrical amperes, momentary, and fault closing.

3. Tie switches, where indicated, shall be same as above except without fuses.

4. All switches shall have an operations counter visible from front of cubicle without opening of doors. Operations counter shall be set at zero before switch is turned over to the University. Visible air clearance between live parts when switch is open shall be at least 6".

5. Switches shall be I.T.E. Type HPL-C, General Electric, Westinghouse and S & C equivalent or approved equal.

F. FUSES

1. In fusible units, fault current protection shall be provided by the fuse rating and type as shown on the drawings. 15 KV fuse assemblies shall have individual insulating and isolating barriers between each cubicle outside 15 KV fuse assembly and side of the cubicle. Fuses shall allow easy removal or installation from the front. Where fuses are mounted above the switch, a horizontal guard shall be provided to prevent a fuse from falling into the switch. Fuses will operate during the first half cycle on maximum fault conditions with no expulsion of gases or foreign matter from the tube.

2. Fuses shall be sized as shown on the drawings. Fuses shall be S & C or approved equal, disconnecting 45° muffler type holder with SM-5 (slow speed) fuses.

3. The contractor shall provide to the University (4 copies) time-current curves of the primary rated power fuses and the main secondary board fuses. Submit two copies to the University with the respective switchgear/switchboard preliminary shop drawings and the other two copies in the "Maintenance and Operating Instructions" manuals.

4. Provide and install (6) six spare fuse refills for each fusible switch shown on plans and one fuse handling tool mounted on the switchgear room wall.

5. Provide a wall mounted box in each primary switchgear room and substation room to store 6 spare fuse units of each size and equipment maintenance manuals.

G. TERMINATIONS

1. Pot head terminations shall be G & W or approved as equal, 1/C, 15 KV flange mounted capnut type with stuffing box cable entrance. Clamp type terminations shall be used on the capnuts. Each cable shall be stress cone terminated within the pot head with G & W 15 KV GN-UN stress cone kit or approved equal. Pot heads shall be filled with a hard resin-base, oil insoluble compound as recommended by the pot head manufacturer. Pot heads shall be used for termination of the incoming service, CAM 25X.

2. Stress cone terminations shall be provided for all terminal connections of 15 KV cable other than the main service entry pot head terminations. Stress cones shall be built-up type, with all tapes, shields, solder, flux, cement, insulating paint, tinned braid and side formed solder lugs for the particular size cable shown on the plans. Stress cones shall be G & W as approved equal. All shield braided conductors shall be properly extended and grounded as required in other sections of these specifications.

3. Provide sealing bushings, conduit flanges or potheads at each opening where a cable or conduit enters or leaves a switchgear bay.

H. LABELING, TESTS AND SHOP DRAWINGS

1. Provide and install mimic bus on front of primary switchboard consisting of a one line schematic diagram indicating bus, switches and all component parts of switchboard. This diagram shall be permanently painted on the front of each section with 3/4" wide black enamel. Provide modifications to the existing switchgear mimic bus as required to represent modifications to the existing bus and equipment.

2. All doors giving access to high voltage components or buses shall be provided with a "Danger-High Voltage" sign, porcelainized and not less than 9" x 12" in size, installed by the switchgear manufacturer. Provide and install a laminated plastic nameplate with 1-1/2" high white on black lettering provided to identify each bay. These nameplates shall be entitled with the specific campus feeder, building feeder and bus tie as shown on plans. Contractor shall verify with the University the exact inscriptions to be used.

3. It shall be required that the integrated switchgear assembly and shop drawings be provided with an externally mounted nameplate indicating the manufacturer's drawing number and the following ratings: voltage (KV nominal, KV maximum design and BIL), short circuit interrupting (MVA), momentary (amperes), and fault closing (amperes). In addition, each bay shall bear a

nameplate indicating continuous and interrupting ratings of the load interrupter in amperes, the maximum continuous rating of the power fuse holders in amperes and the catalog number and size of the installed fuse or fuse refill units.

4. The primary switchgear manufacturer shall submit (4 copies) the maximum allowable values for high voltage D-C field tests, contact resistance across the load interrupter switch, and contact resistance across the switch and fuse assembly. Submit two (2) copies to University with the switchgear shop drawings and the other two (2) copies in the "Maintenance and Operating Instructions" manual.

5. Shop drawings shall include detailed switchgear front, top, and end views; switchgear dimensions, an isometric or equivalent single line bussing diagram; sizes, material, platings and ratings of phase and ground busses; nameplate entries and schedules; component material lists; key interlocking diagram; mimic diagram; fuse and fuse holder manufacturer, (type, and sizes); installation and mounting details and requirements; notes listing features and accessories as will be furnished to meet specification requirements; termination spaces, pullboxes and hardware; and all other important equipment information.

I. EXISTING PRIMARY SWITCHGEAR MODIFICATIONS

1. As indicated on the drawings the Unit A Building primary Service entrance switchgear is to be modified and extended to serve Unit B/C. Provide all labor, materials equipment as detailed specified and required to accomplish the work and match the existing equipment. Contractor shall field verify exact details of all switchgear buses and equipment before beginning the work. It is the contractor's responsibility to coordinate all work and schedule required outages and energization with the University as specified in Articles 1.2 and 1.3 of this Section. The existing switchgear is General Electric. Refer to Detail 3/E-48.

2. The work shall include but not be limited to the following items:

a) Addition of new primary feeder switches and cubicles designated #1 and #2 in Switchvault #1 and 3 to serve Unit B/C substation.

b) Addition of a new primary tie switch in an existing tie transition section 2B in switchvault #2. Existing bus includes removable bus section to allow for installation of tie switch. Provide new primary tie switch. Disconnect and remove potheads for tie cables between these tie sections in Switchvaults #2 and #3. Provide new pothead terminations and the cables as shown and specified.

c) Replace existing tie transition section with new primary feeder switch cubicle for future use as a feeder cubicle. Disconnect and remove existing potheads for tie cables between this cubicle in Switchvault #1 and existing primary tie switch cubicle #2A. Provide new potheads and tie cables between existing primary tie switch #2A and Switchvault #2 and the new primary tie switch #1 in Switchvault #1 specified below.

d) Addition of a new primary tie switch in a relocated cubicle from paragraph C above, indicated as tie switch #1 in Switchvault #1. Existing

bus includes removable bus section to allow for installation of tie switch. Tie switch shall be connect Switchgear in Switchvaults #1 and #2 as indicated above and specified.

e) Modify existing Kirk key interlocking and provide additional Kirk Key interlocks to accomplish the interlocking as shown on the drawings (detail 4/E48) and as specified.

f) Addition of a new primary line switch (CAM 25X) in Switchvault #2 to connect and terminate a new 13.8 KV feeder cables (CAM 25X). The new feeder will be provided under another contract and will be end capped in Switchvault #2 with sufficient cable length to allow for termination at the new CAM 25X primary line switch. Feeder cables will be 3-1/C, 250MCM 15 KV with a 250 MCM, THW, 600 volt neutral conductor. The Electrical Contractor shall verify exact cable specification with the University and provide pothead terminations and line switch as shown on the drawings and specified.

2.5
2.4 ELECTRICAL SUBSTATIONS

A. GENERAL

1. Provide and install where shown on the drawings at the basement, 10th floor and 15th floor electrical vaults, complete, close-coupled, coordinated, integral, double ended unit substations including the 15KV high voltage incoming sections, transformer sections, 277/480 volt low voltage sections, transition sections, and control wire and metering as shown on the drawings and specified hereinafter. The substations shall be designed for indoor installation and factory assembled and tested in accordance with the latest applicable standards of NEMA, IEE, and ANSI and shall conform to all applicable local codes and requirements of the body having governing authority.

B. CONSTRUCTION

1. Provide and install door, dead front type, completely metal-enclosed, self-supporting double ended unit substation structures of the number and type shown on the drawings or specified herein. The unit shall consist of the required number of vertical sections coordinated to fit together to form one rigid power center incorporating transition sections and switching and protective devices of the number, rating and type noted herein or shown on the drawings complete with the necessary interconnections, instrumentation and control wiring. Substations shall be Westinghouse, Square D, General Electric, Federal Pacific Electric, S & C, I.T.E. or approved equal.

2. Construction shall be of the universal frame type using die-formed, welded and bolted members. The sides, top and rear shall be bolted on, and all enclosing covers shall be fabricated from not less than 11 gauge steel. Ventilation openings shall be provided for each section.

3. All cubicle assemblies shall be sized to fit into the spaces provided as measured to scale from the drawings and shall be the responsibility of this contractor. Maximum height of any section shall not exceed 96". All assemblies shall be finished with one coat of metal primer followed by a finish coat of ASA#61 light gray baked enamel or equivalent.

4. All switchgear shall be labeled and tests provided as indicated herein.

a. Provide and install mimic bus on front of substation consisting of a one line schematic diagram indicating bus, switches, and all component parts of switchboard. This diagram shall be permanent painted on the front of each section with 3/4" wide black enamel.

b. Four laminated plastic nameplates with 1/2" thru 2" high white on black lettering shall be mounted on the front of each substation. The Contractor shall contact the University for the inscriptions to be used.

5. Kirk key interlocks shall be provided so that individual switch doors cannot be opened under load.

6. High voltage switches shall be three gang, fused load interrupting type with front drive handles as shown on plans. Visible air clearance between live parts when switch is open shall be at least 6".

a. Switches shall be of the stored energy, quick make, quick break type utilizing direct acting spring charged mechanism for both closing and opening functions.

b. Switches shall be rated for 600 amperes, continuous and load breaking, 13.8 KV nominal and 14.5 KV maximum and 95 BIL, 250 MVA, 3 phase symmetrical and 20,000 amperes rms asymmetrical, momentary and fault closing.

c. Switches shall be I.T.E. Type HPL-C, General Electric, Westinghouse and S & C equivalent or approved equal.

7. Fault current protection shall be provided by the fuse rating and type as shown on the drawings. 15 KV fuse assemblies shall have individual insulating and isolating barriers. Fuses shall have provision for easy removal or installation from the front. Fuses will operate during the first half cycle on maximum fault conditions with no expulsion of gases or foreign matter from the tubes.

a. Holders shall be S & C or approved equal, disconnecting 45° muffler type with SM-5 (slow speed) fuses as sized on the drawings.

b. Provide and install six spare fuse refills for each fusible switch shown on plans.

c. Provide and install one fuse handling tool mounted on the substation room wall.

8. Stress cone terminations shall be provided for all terminal connections of 15 KV cable as specified.

a. Stress cones shall be built-up type, with all tapes, shields, solder, flux, cement, insulating paint, tinned braid, and side formed solder lugs for the particular size cable shown on the plans. Stress cones shall be G&W or approved equal.

b. All shield braid conductors shall be properly extended and grounded as required in other sections of these specifications.

C. TRANSFORMER SECTION

1. Each transforming section shall be Pyranol, Askarel, or equivalent non-flammable and non-explosive liquid immersed type transformer design for indoor use and shall have the following ratings: Forced air cooled; 95 KV BIL; 65°C. temperature rise; 60 hz; 3 phase; high voltage delta connected for 13,800 volts; low voltage wye connected for 277/480 volts; 5-3/4% impedance at 480 volts with 2-1/2% taps above and 2-1/2% below rated high voltage. Refer to plans for KVA ratings. In addition, the forced-air cooling fans will have automatic temperature control. The transformer shall have winding temperature indication with sequence contacts. T-T connected transformers are not acceptable. The forced air cooling shall increase the rated continuous load carrying ability by 15%.

2. Transformers shall be manufactured in accordance with all applicable ANSI and NEMA Standards, and come complete with the following accessories:

- a. Liquid drain plug.
- b. Liquid-level marking.
- c. Filling plug in cover.
- d. Provisions for rolling.
- e. Tank grounding provisions.
- f. Relief device with diaphragm for venting the tank in event of internal fault of explosive violence.
- g. Lifting lugs.
- h. Handhole in cover (sealed with re-usable Askarel resistant gaskets).
- i. Magnetic liquid-level gauge.
- j. Dial-type thermometer.
- k. Externally mounted diagrammatic nameplate (located below low voltage bushings).
 - l. Pressure-vacuum gauge.
 - m. Tank base shall be undercoated with asphaltum compound for rust protection (or equivalent).
 - n. Complete set of replacement gaskets for handhold cover and gas absorber.
 - o. Gas absorber, with fill.
 - p. Tap changer, externally operated.

3. Basic construction of transformers shall include suitable air chambers for terminations and space for transitions and stress cones. The flanged connections shall be so constructed and sized that the complete transformer assembly can be unbolted and removed from the substation without disturbing the other sections.

4. The transformer manufacturer should be required to supply the following characteristics with his shop drawings:

- a. Efficiency at full load, 3/4 load, 1/2 load and 1/4 load.
- b. No load loss.
- c. Impedance.
- d. Exciting current.
- e. Per cent regulation at 80 percent P.F. and 85°C.
- f. Per cent regulation at 100% P.F. and 85°C.
- g. Full load losses at 85°C.
- h. Dimensions
- i. Weight
- j. Gallons of liquid.
- k. Voltage rating.
- l. Basic impulse level of primary and secondary windings.
- m. Nameplate location, layout and entries including normal impedance.
- n. Gas absorber location and size.
- o. Tap arrangement and percentage of nominal voltages at different tap settings.

5. Transformer shall be General Electric, Westinghouse or Niagara.

D. LOW VOLTAGE SECTIONS

1. Construction of the low voltage distribution section shall be NEMA Class II, having whatever depth is necessary to accommodate the equipment. All vertical sections shall align in front and rear. The distribution branch protective devices shall be group-mounted with necessary bus connection straps and having the device (line and load) connections accessible from the front. All other bus connections shall be accessible from the rear of the switchboard. Where space for a future device is called for, all necessary buses except device connecting straps shall be furnished. Full length vertical buses shall be provided in every section. Provide full height hinged gutter doors for quick access to wiring terminals.

2. Switchboard shall be completely self-supporting structure of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard 96" high, maximum. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. Switchboard shall include all protective devices and equipment as listed on drawings with necessary inter-connections, instrumentation and control wiring. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished when required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

3. Buses shall be tin plated aluminum sized on the basis of not more than 800 ampere per square inch current density. The bus structure shall be arranged to permit future additions. The bus bars shall be mounted on supports of high impact non-tracking insulating material and shall be braced to withstand mechanical forces exerted during short circuit conditions based on NEMA Standards. A-B-C type bus arrangement - left to right, top-to-bottom and front-to-rear shall be used throughout to assure convenient and safe testing and maintenance.

4. Section shall be designed for 277/480 volts, 3 phase, 60 hz with full capacity neutral and 600 ampere ground bus. Main bus ratings shall be as shown on plans.

5. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. The switchboard exterior shall be finished in ASA-#61 light gray. All hardware used on conductors shall have a high tensile strength and have a suitable protective finish.

6. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

7. Shop drawings shall be furnished providing the following information: complete rating, short-circuit withstandability of bus and of lowest rated device, overall outline dimensions including space available for conduits, circuit schedule showing circuit number, device description, device frame ampere rating, trip or fuse clip ampere rating, feeder circuit identification, conductor ratings and one-line diagram with each circuit device numbered.

8. Switchboard shall be as manufactured by General Electric, Westinghouse, Square D, I.T.E. or Federal Pacific.

E. SWITCHES

1. Main switches, tie switches and distribution switches for each distribution section shall be bolted pressure, load break, switch with shunt trip for single phase and ground fault protection.

a. Switches shall be 3 pole, 480 volt with ampere rating as shown on plans.

b. Provide manual switch operator that does not rotate when switch operates magnetically. Fuse cover door shall be mechanically interlocked to prevent opening when switch is in "ON" position.

c. Switch shall have silver tungsten arc tips, insulating arc chutes, ebony asbestos base and non-ferrous and non-magnetic bolting mechanism.

d. Electric operator shall be stored energy shunt trip type.

e. Main switches and bus tie switches shall be Kirk key interlocked so that they cannot be closed unless one of the main feeder switches is open and these main feeder switches cannot be closed unless the tie switch is open. Verify exact interlocking requirements described above with the details on the drawings. Refer to detail 4/E48.

f. The switches shall be equipped with current limiting, high interrupting capacity fuses specified in Section 16300. Provide three extra fuses for each switch mounted in the fuse compartment.

g. Switches shall bolt directly to the switchboard buses and shall be front accessible.

h. Switches shall be individually enclosed in a steel compartment so that no live parts are accessible to the operator whether the door is open or enclosed.

i. Switches shall have solderless lug connectors with line shields. Contacts shall be silver alloy with spring reinforced fuse clips. Provide Class R fuse rejection clips for all current limiting fuses.

j. The door shall be interlocked with the switch mechanism so that with the switch energized the door cannot be opened and vice versa. Door latch shall be equipped with means for double padlocking.

k. Switches shall be rated for a maximum short circuit rating of 200,000 amperes with current limiting fuses and 100,000 amperes rms symmetrical with current limiting time delay fuse.

l. Switches shall be Square D Bolt-Loc, Boltswitch Company, Pringle or approved equal.

F. METERING

1. Current metering shall be provided for each distribution feeder in each distribution section as indicated on plans.

a. Current transformers shall be provided for each phase of each switch rated for 600 volts and current ratio of 5 to the closest rating of the switch. Current transformers shall be window type General Electric, Type JAK-0 or JAH-0 or Westinghouse equivalent. Current transformers shall be readily removable from front without dismantling large portions of the buses.

b. For each switch provide a rotary 4 position selector switch with pistol grip rated 20 amperes and located in metering panel. Positions are phase A, phase B, phase C and off. Selector switch shall be Westinghouse Type W-2, or General Electric equivalent.

c. For each switch provide a pair of test jacks connected through the rotary switch and installed in the metering panel, General Electric Type PK-2 or approved equal.

d. For each of the switches above and mounted in the metering panel provide switchboard mounting shunt type ammeter, rated 0 to switch ampere rating. Meter shall be General Electric, Westinghouse, or approved equal.

e. Provide permanent marking and identification for test jacks and for each rotary selector to identify the particular switch and phase being monitored.

2. Watt hour voltage and current metering shall be provided for each main switch and distribution switch in each distribution section as indicated on the plans.

a. Current transformers shall be provided for three phases of each switch, rated 600 volts and current ratio of 5 to the closest rating of the switch. Current transformers shall be window type, General Electric Type JAH-0 or Westinghouse equivalent.

b. Potential transformers shall be provided for three phases of each switch, rated for 600 volts and a 4:1 ratio, General Electric Type JVA-0 or Westinghouse equivalent.

c. A watt hour meter drawout type shall be provided for each main switch. Meter shall be for use on a 277/480 volt, three phase 60 hz system with grounded neutral circuit. Dial-type maximum demand register resetting type with 15 minute block interval type shall be provided. Multiplier ratios shall be shown on front of each watt hour meter. Meter shall be General Electric Type DSM-65 or Westinghouse equivalent.

d. Ammeter for each main switch shall be switchboard mounting shunt type 0 to switch rating. Volt meter for each main switch shall be switchboard type to match ammeter, with 0 to 600 volt scale and shall monitor one phase only. Meters shall be General Electric or Westinghouse.

e. Provide a 4 position rotary selector switch with pistol grip rated 20 amperes for each main switch. Westinghouse Type W-2 or General Electric equivalent.

f. Provide external test jacks for recording of watt hours, current and voltage, General Electric Type PK-2 or approved equal.

g. Provide permanent marking and identification for each rotary switch and test jacks to indicate which function and phase is being monitored.

3. Kilowatt-hour meter information shall be submitted in writing to the Electric Construction Superintendent for approval at the earliest possible date, and in no case later than two weeks prior to energizing. This information shall be submitted on and as required on a University of Minnesota "Electric Watt-hour Meter Installation or Removal" form (3 copies) available from Electrical Construction Superintendent.

G. GROUND FAULT PROTECTION

1. A ground fault detector shall be provided for each main and distribution low voltage substation bolted pressure contact switch as indicated on the plans. This detector shall operate a relay which shall automatically open the switch upon detection of a ground fault as described herein.

a) The ground fault protection at the main secondary switches shall be for use on a 480 volt, 3 phase, 4 wire, solidly grounded wye, 60 hz, dual service system with normally open bus tie switch operation. Ground fault protection shall consist of a ground sensor encircling the ground to neutral connection and connected to a solid-state ground relay which initiates tripping to main secondary switches.

b) The ground fault protection for the distribution secondary switches shall be for 480 volt, 3 phase, 3 or 4 wire, 60 hz as indicated on the plans. Ground fault protection shall consist of a ground sensor encircling the 3 phase and neutral conductors where applicable and connected to a solid state ground relay which initiates tripping to the distribution switches.

2. The ground protection shall be adjustable from 5 to 60 or 100 to 1200 primary amperes, as indicated on the plans, and time characteristics shall provide adjustable instantaneous (.03) to 1.0 second.

3. Circuit interrupter shunt trip and relay shall operate from 120 volt AC control and all necessary control wiring, terminal blocks, mounting, fuses and accessories shall be provided.

4. Coordination of the selective ground fault relaying system shall be established by zone selective interlocking. Provide restraint wiring between relays per manufacturers recommendations. Time and current settings shall be as directed by the Engineer.

5. Ground detector equipment shall be completely packaged and prewired for installation in the switchboard. Ground detector shall be Pringle, General Electric, Square D, Federal Pacific Electric or Westinghouse.

PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Certain electrical loads determined to be critical and necessary to the operation of the building are connected to separately derived power systems on a standby basis. These loads include stair lighting, egress lighting, exit lighting, health care equipment and lighting, equipment and special room lighting, refrigeration, fire alarm system, fire pump system, certain pumps, fans and other mechanical motors, the elevator system on a priority - selective basis and other selected loads as shown on the plans. System shall conform to the requirements of the National Electrical Code Article 517 and all other applicable Articles.
- C. All wiring for emergency systems shall be installed in separate conduit systems and fed from emergency panelboards and power sources. The systems shall operate from the basic building power system under "normal" conditions and shall operate from standby engine-driven generator sets during "emergency". Transfer from one system to the other shall be automatic as described herein.

PART 2. PRODUCTS AND INSTALLATION

2.1 DIESEL DRIVEN REMOTE RADIATOR COOLED STANDBY UNIT

- A. Provide (1) standby electric plant in the basement, (1) standby electric plant on the 10th Floor, and (1) standby electric plant on the 15th Floor. Provide a complete installation as shown on the plans, for the standby electric systems including engine-generator, engine mounted start-stop control systems, and automatic load transfer switches with control and mounted accessories as specified.
- B. The generator system stems shall be rated for the duration of a utility failure (up to 30 days).
1. The generator in the basement shall be a 750 KW, 940 KVA, at .8 power factor, 277/480 volt three phase, 4 wire 60 hertz. The standby unit shall be Cummins KTA-2300-GS-750, Caterpillar, Onan, Kohler, equivalent or approved equal.
 2. The generators on the 10th and 15th floor shall be 600KW, 750KVA at .8 power factor, 277/480 volt three phase, 4 wire 60 hertz. The stand by units shall be Cummins KT2300G 5-600 Caterpillar, Onan, Kahler equivalent or approved equal.
 3. ENGINE: The engine shall be Diesel, 4 cycle, 6 cylinder, water cooled with remote radiator. It shall have a minimum rating of 1-1/2 HP/KW at its

operating speed of 1800 rpm. It shall have a full pressure lubrication, full flow replaceable element oil filter, oil cooler, adjustable Woodward SG hydraulic governor to maintain alternator frequency within 3 cycle from no load to full-load alternator output, fuel injectors, air cleaner 24 volt solenoid shift starter, and 24 volt charging DC alternator with transistorized voltage regulator. Provide name plate indicating manufacturer, model number, horsepower, rated RPM, and year of manufacture.

4. ENGINE INSTRUMENTS: The engine instrument panel shall contain an oil pressure gauge, water temperature gauge, and battery charge rate ammeter.

5. ENGINE CONTROLS: Complete engine start control which operates on closing contact and stop control which operates on opening contact. A cranking limiter shall be supplied to provide 4 cranking periods 10 seconds each which will open the start circuit if the plant is not started within that time. The electric plant controls shall also include a 3 position selector switch with the following positions: run - stop - remote. High water temperature, low oil pressure, and over speed shut-down with signal lights and alarm terminals for each,

6. ALTERNATOR: The alternator shall be a 4-pole revolving field type with static exciter and magnetic amplifier voltage regulator. No commutator or commutator brushes shall be allowed. The stator shall be directly connected to the engine flywheel housing and the rotor shall be driven through a semi-flexible driving flange to insure permanent alignment. Voltage regulation shall be within plus or minus 3% of rated voltage, from no-load to full-load. The instantaneous voltage dip shall be less than 17% of rated voltage when full-load and rated power factor is applied to the alternator. Recovery to stable operation shall occur within two seconds. Stable or steady-state operation is defined as operation with terminal voltage remaining constant within plus or minus 5% voltage adjustment from rated value. Temperature rise shall be within rating as defined by NEMA MG1-22.40. Generator insulation shall be Type F.

7. ALTERNATOR INSTRUMENT PANEL: The alternator instrument shall be wired, tested, and shock mounted on the electric plant by the manufacturer of the alternator. It shall contain a main line circuit breaker, running time, meter frequency meter, AC voltmeter, voltmeter switch, voltage adjusting rheostat, AC ammeter and phase selector switch. Provide name plate indicating manufacturer, model no., KW/KVA, P.F. amperes, phase wires, voltage, frequency, and year of manufacture.

8. ELECTRIC PLANT MOUNTING: The electric plant shall be mounted on a welded steel base which shall provide suitable mounting to any level surface. Contractor shall provide six anchor bolts to prevent shifting, six spring loaded vibration isolators of the free-standing type which are laterally stable without any housing. Isolators shall be complete with 1/4" neoprene acoustical friction pads between the base plate and support. All mountings shall have level bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than .8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of rated deflection. Mountings shall be Mason Industries Type B (SLF) with 1-1/2" deflection.

9. ACCESSORIES: All accessories needed for the proper operation of the plant shall be furnished. These shall include an exhaust silencer, two

starting 12 volt 225 amp hour batteries, battery cables, battery and charger rack, fuel filter, oil pump, lubricating oil, 3500 watt water heater, a 0-30 min unloaded running time delay relay on shut down. Provide a 24 volt battery charger with a continuously adjustable changing rate from .05 to 2 amperes. The charger shall be protected by a fuse and be complete with ammeter to indicate changing current. Provide charging leads and bolt type clips of the length required to reach batteries. Muffler shall be the critical silencer type as recommended by the manufacturer (include flexible connections).

10. TESTS: This system shall be built, tested, and shipped by the manufacturer of the alternator or the engine so there is one source of supply and responsibility. The performance of the electric plant series shall be certified by an independent testing laboratory as to the plant's full power rating, stability, and voltage and frequency regulation. The system shall be tested with a representative of the manufacturer present at the time of the acceptance test. The plant shall also undergo a load bank test at unity power factor and rated KW for a period of 4 hours after the installation is complete at the job site.

11. [Supplier shall have a full maintenance staff and be able to furnish a maintenance Contract.]

2.2 AUTOMATIC TRANSFER SWITCHES

A. Provide automatic, mechanically held transfer switches with 3 or 4 poles for a normal and emergency source of 277/480 volts, 3 phase, 4 wire, 60 hertz as indicated and sized on the plans and schedule. Transfer switches shall have adequate capacity for a continuous inductive load at the rated amperes. Provide nameplate that indicates: Manufacturer, Model No., Voltage Rating, Ampere Rating, Number of Poles, and KVA Service.

1. Transfer switches shall have the capacity to withstand the thermal and electro-magnetic effects of the available short circuit current as scheduled below. The switch contacts shall remain closed under these conditions.

Fault Withstand Capability

<u>Transfer Switch Rating</u>	<u>Withstand w/ Circuit Breakers</u>	<u>Withstand W/ Current Limiting Fuses</u>
225 AMP	20,000A SYM. RMS	100,000A SYM RMS
400 AMP	31,000A SYM. RMS	100,000A SYM. RMS
800 AMP	42,000A SYM. RMS	100,000A Sym. RMS

2. The transfer switch shall be a double throw mechanically held, positively interlocked mechanically and electrically and shall not be a combination of single throw devices. It shall be arranged so that a neutral position is not possible electrically or mechanically. All contacts, coils and accessories shall be readily accessible from front of panel for inspection of replacement from the front of the panel without major disassembly of related parts.

3. Each transfer switch shall be arranged to automatically start its respective standby generator when any phase of the normal drops below 70% for

more than a nominal 3 seconds through use of an auxiliary engine starting contract. Transfer shall occur when the generator output is measured at 90% voltage and frequency. Following continuous restoration of all phases of the normal source to 95% for an adjustable period of up to 30 minutes the switch shall retransfer the load to the normal source. Following retransfer the standby generator shall run unloaded for an adjustable period of 30 minutes. In event of loss of standby power and restoration of normal power means shall be provided for instantaneous retransfer. All control components shall be industrial type throughout and all relays to be heavy duty with crisp, repeatable and accurate response, positive contact pressure and wiping action.

4. The automatic transfer switch shall be provided with a manual test switch to allow for frequent testing of the transfer operation under full load conditions. A push button shall be provided to allow by-passing the 30 minute delay on retransfer.

5. Auxiliary contacts shall be provided for interlocks and control of the motorized ventilation louvers upon operation of the generator. Also, provide relays and transformers if necessary for control.

6. The transfer switch and all controls shall be provided in a NEMA 1 enclosure suitable for wall mounting. Provide hinged door and lock, keyed as directed by the University.

7. The switch shall be ASCO or Russel Electric or approved equal. ASCO numbers are used to identify quality and function as follows:

a. Switch - ASCO #940 sized as indicated on the plans and Schedule.

b. Accessories: (2C) Time Delay to ignore momentary outages .8-15SEC adjustable, (3A) Time Delay on retransfer to insure stabilization of normal source - 2-30 minutes, (4B) Close Differential Relays for inductive systems 3 phase 85% drop out, 95% pick-up, (5) Test Switch, (6B) push button to bypass retransfer delay, (7) Engine starting contact, (14A) 2 Auxiliary Contacts closed when main contacts in normal position and (14B) Auxiliary Contact closed when main contacts in emergency position, (28) neutral contact.

B. For each elevator switchboard provide an automatic transfer switch similar to the transfer switches of Paragraph A above. These switches shall be identical to those of Paragraph A except as follows:

1. Each switch shall have the following accessory group: Time delay on transfer .8-15 Sec. Time delay on retransfer to insure stabilization of normal source - 0-30 minutes adjustable, (4B) Close differential relay for inductive systems, 3 phase, 70% drop out, 95% pick-up, (5) Test Switch, (14A) Auxiliary contact closed when main contacts are in normal position, (14B) Auxiliary contact closed when main contacts are in emergency position.

2. Switches shall be sized as indicated on the plans and Schedule. Switches shall be ASCO or Russel Electric equivalent or approved equal.

C. Automatic Transfer Switch Schedule:

<u>Switch No.</u>	<u>Amp Rating</u>	<u>Poles</u>	<u>Load Type</u>
ATS #1	225A	3	Critical
ATS #2	400A	4	Life Safety-Equipment
ATS #3	800A	3	Life Safety-Equipment
ATS #4	800A	3	Elevator
ATS #5	800A	3	Life Safety-Equipment
ATS #6	800A	3	Elevator
ATS #7	225A	4	Life Safety-Equipment
ATS #8	800A	3	Life Safety-Equipment

2.3 BATTERY INVERTER POWER SYSTEM

A. Certain lighting loads determined to be critical located in operating and treatment rooms shall be connected to the standby generator and a battery inverter power systems to provide for a continuous illumination upon utility power failure.

B. Battery inverter power unit shall be a self-contained power pack capable of supplying 500 watt rated load emergency power at 60 Hz., 120 volt for a period of 30 minutes. The performance specifications shall be met for input voltage variations of plus or minus 10% from normal.

C. Operations: With normal power applied, the voltage to the power pack shall feed both the output and the battery charger. Upon loss of normal supply voltage, the power pack shall automatically disengage itself from both sides of the AC input line, switching to the self-contained inverter. Unit shall have short circuit protection and contain all the following components: Transfer relay, DPDT, inverter, test switch, indicating pilot lights, automatic battery charger, wet cell batteries, automatic low voltage battery cutout circuit. Unit shall have warranty period of one year from date of installation.

D. Cabinet shall be surface mounted and constructed of 12 gauge steel in baked-on enamel finish.

E. Unit shall be as manufactured by Siltron Illumination Company, EPP-500AC-120.

F. Provide a relay control system to energize the battery inverter system upon loss of power to any isolated power panel. Refer to Detail 2/E46 for wiring diagram. Relays shall be Asco #5410 (1) pole, 1 N/O installed in a common NEMI enclosure.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instruction to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. A complete grounding service system shall be provided as described herein and as shown on the plans. Service grounds are required for each of the substations as well as for each dry Type 480 Delta to 208 wye transformer. All grounding shall conform to the requirements of Article 250 of the NEC.

C. The completed ground systems shall be interconnected with the lightning counterpoise ground grid as shown on the drawings.

PART 2. PRODUCTS AND INSTALLATION

2.1 GROUND BUS

A. A 1/4" x 4" bare copper bar stock ground bus shall be attached to the walls and floors of each switchgear room and substation room with copper fittings and brass screws or bolts. Solderless connectors shall be used for the grounding system.

B. The uninsulated 1/4" x 4" copper ground bus in each substation room shall be bonded to each section of low voltage switchgear, transformer and primary switch housings and shall be suitably interconnected to provide a continuous bus. Ground bus mounting supports shall be provided for a 3" space between wall surface and bus.

2.2 GROUND CONDUCTORS

A. In each electrical shaft 29, 31 and 32 provide a system ground conductor as indicated and sized on the plans. Refer to one line grounding diagrams, detail 2/E55. Ground conductor shall be one continuous bare, stranded copper cable and run exposed in shafts and equipment rooms.

1. Connect each ground bus at 15th, 10th and basement floor substation rooms to the system ground conductor or water service as shown on the plans.

2. Connect each cable to street side of main water service and provide grounding jumper around the water meter.

3. All connections shall be made with O.Z. or Burndy copper fittings and non-ferrous hardware designed specifically for the cable size and type of attachment required. All fittings, clamps, devices, etc., shall be copper or copper alloys to be compatible with the basic copper buses and cable.

4. Vertical runs of cable shall be supported from structure every 6' with strain clamp, Burndy Type DUW or O.Z. equivalent.

5. All secondary neutrals for low voltage 120/208 volt services in electrical shafts shall be connected to this ground conductor.

2.3 DRY TYPE TRANSFORMER GROUNDING

A. All secondary neutrals for low voltage 120/208 volt wye services shall be grounded to the ground conductor in each electrical shaft as shown on plans. Refer to details 1/E55, 2/E55, 3/E50 and Secondary Distribution Riser Diagrams.

1. Connection shall be made with cable sized according to Table 250-94 (a) of the National Electrical Code.

2. All panelboard boxes, transformer housing, conduit nipple and junction boxes shall be bonded together with proper grounding lugs.

3. All connections shall be made with O.Z. or Burndy copper fittings and non-ferrous hardware designed specifically for the cable size and type of attachment required. All fittings, clamp devices, etc., shall be copper or copper alloys to be compatible with the basic copper lugs and cable.

2.4 TESTS

A. Ground resistance tests shall be made with a null voltage tester and three copies of the test report shall be forwarded to the Engineer for approval. Test shall be made as follows:

1. At the main incoming water service before attachment of any ground conductors.

2. At the incoming water service after attachment of the lightning counter-poise grounding system.

B. Ground resistance shall not exceed 25 ohms.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes all secondary electrical distribution equipment and accessories herein specified and shown on plans to provide a complete connected and fully operating system and sub-systems.

C. All equipment and wiring shall be designed and connected for operating on the 277/480 volt, 3 phase, 4 wire secondary system and the 120/208 volt, 3 phase, 4 wire, secondary sub-systems.

PART 2: PRODUCTS AND INSTALLATION

2.1 BUS DUCT

A. Provide bus ducts as sized and as shown on plans. Low voltage busway systems shall consist of totally enclosed lengths and fittings as necessary, using 10' standard lengths wherever possible. All busway shall be listed by Underwriters Laboratories and so labeled. Maximum voltage drop shall be 2.5 volts per 100 feet for the system on a rated load basis.

B. Busway shall be of the plug-in type and the system shall be polarized. Bus shall be completed with all outlets, taps, elbows, hangers and fittings as required. Busways shall be Westinghouse, General Electric, Square D, Federal Pacific or approved equal. All horizontal runs of bus duct may be feeder type. Vertical runs of bus duct shall consist of standard bus lengths with expansion lengths and spring loaded floor supports as required for the specific installations as shown on the plans. The bus duct manufacturer shall be responsible for certifying a proper installation for shop drawing review by the Engineer.

C. The busway shall be of the totally enclosed type consisting of formed sheet steel housing with external mounting flanges. Bus bars shall be tin or silver plated aluminum for the full length.

D. Busway shall be low impedance, 3 phase, 5 wire, 50% neutral and internal 50% ground bus, 480/277 volt rating. Bus shall be built to withstand NEMA Standard RMS symmetrical short circuit currents.

E. Joints shall be of high compression bolt type which clamps all bus bars at one time.

F. Plug outlets shall be of the dead front type with positive catch arranged so that in opening or closing the cover, the installer will not touch live parts. Furnish twelve outlets per 10' length and four per 5' length, half on each side of busway, all usable simultaneously. Outlets shall be polarized and arranged so plugs can be inserted or removed only when plus is in off position.

G. All cable connections to the bus duct shall be with Burndy "Hydent" compression type connections, or approved equal.

H. Bus duct shall be supported at every 5' interval with 1/4" threaded rod hangers in horizontal runs and at each floor with floor flange bolted supports in vertical runs. Provide a fire barrier where bus duct penetrates floor slabs and fire rated walls.

I. Bus duct shall be finished in medium gray enamel over a rust inhibitor and hardware shall be cadmium or zinc plated.

2.2 BUSWAY PLUGS

A. All plugs shall consist of sheet steel housings finished to match bus duct. Provide necessary clamps for quick attachment of the plug to the busway. Provide solderless mechanical terminals for all wire connections and include ground terminal. All current carrying parts shall be silver plated.

B. Plug bases shall have stab shields and positive pressure reinforced stabs and shall be suitable for either copper or aluminum bus bar type busway. Provide padlocking type cover catches and means for padlocking in off position.

C. Plugs shall be 600 volt, 3 pole interrupter switch type, quick-make, quick-break, interlocked cover type with releasable interlock. Switch unit shall be capable of interrupting 12 times its continuous current rating. Fuse clips shall be positive pressure type with rejection-type clips for current limiting fuses. Switch shall have horsepower ratings for standard or time delay fusing in accordance with NEMA Standards.

D. Plugs shall be of the same manufacture as the bus duct and shall be sized as shown on the plans and required by Code.

2.3 PANELBOARDS

A. Panelboards shall be the dead front type with mains arranged as shown on the panelboard schedule for 120/208 volt or 277/480 volt, 3 phase, 4 wire, wye connection. Enclosures shall be code grade steel complete with door-in-door type trim. The inner door shall be the locking type and the outer door shall be secured by trim type screws on the side opposite the hinge. Circuits shall be listed on clear plastic covered, typewritten card indexes attached to the inner side of the inner doors. Each protective device shall be designated by a number at the device. Final room numbers as provided by the Owner shall be used for all circuit indexes.

B. Panel bus bars shall be solid copper and shall be aligned and rigidly supported on back pan by insulators connected to a removable mounting panel. All lugs shall be copper-bronze for bolted lug connection. Each panelboard shall contain individual insulated neutral bus of same ampacity as the main bus.

Where scheduled panelboards shall contain a separate ground bus which shall consist of a minimum of 16 (30 circuit panelboards) and 24 (42 circuit panelboards) solderless connector lugs for #14 thru #4 conductors and a single lug for up to #1/0. All circuit breakers shall be attached to bus by means of machine screw connections, and shall be removable from the front without de-energizing the panel. Rough-in boxes shall have a minimum width of 20 inches and minimum depth of 4-1/2 inches. Full length vertical buses and cross breaker connection including all hardware shall be provided and installed in all future circuit breaker spares and spaces. All panelboards shall be keyed with identical Corbin Lock #157-67, using WEM-1 key.

C. Each panelboard shall be identified with a black-white-black laminated plastic plate attached to the inner trim. Letters and numbers shall be cut through the black and into the white of the plate. Inscription shall be symmetrical about the centerline of the plates, and plates shall be attached with self-tapping screws. Identification shall correspond to designations used in the specifications and on the plans.

D. The lighting and three-phase motor panelboards shall be dead front type with front removable bolt-in circuit breakers with thermal magnetic trips of sizes shown on schedule on plans. Panelboards shall be designed for 277/480 volt, 3 phase, 4 wire, wye connected, solid neutral. Panelboards shall be General Electric NHB or equivalent. The receptacle and small appliance panelboards shall be dead front type with front removable bolt-in circuit breakers with thermal magnetic trips of sizes shown on schedule on plans. Contractor shall provide a suitable circuit breaker sized for the load for each branch circuit shown on the plans if inadvertently not identified or noted in the panelboard schedule. Panelboards shall be designed for 120/208 volt, 3 phase, 4 wire, wye connected, solid neutral. Panelboards shall be General Electric Type NLAB or equivalent.

E. Circuits shall be connected as shown on the plans for a balanced three phase load. Circuit breaker number for all 3 pole and 2 pole breakers shall have numbers sequenced as follows: 3 pole breaker shall be labeled 1, 3, 5. Typewritten index shall have corresponding numbers in sequence to allow index labeling of a 3 pole circuit without spaces between these numbers.

F. Distribution type panelboards in shaft spaces shall be similar to panelboards except larger size, wall or floor mounted and not door-in-door type. Distribution panelboards shall be General Electric Type CCB or NAB or equivalent. Provide hinged vertical wireway covers for each section. Provide ground bus where scheduled and as specified in above.

G. All circuit protective devices shall be molded case circuit breakers with thermal magnetic trips for 120/208 volt 277/480 volt as indicated. All two and three pole circuit breakers shall have common trips.

I. Circuit breakers shall conform to the following minimum characteristics based upon General Electric nomenclature:

a. Branch Circuit Panelboards, 120/208 volt.

<u>Amps.</u>	<u>Volts</u>	<u>Frame</u>	<u>Sym. I.C. - RMS - 240V</u>
15-100	240	THQB	10,000

b. Distribution Panelboards, 120/208 volt.

<u>Amps.</u>	<u>Volts</u>	<u>Frame</u>	<u>Sym. I.C. - RMS - 240V</u>
15-100	480	TEF	18,000
125-225	600	TFJ/TFK	25,000
250-600	600	TJK6	42,000

c. Panelboards, 277/480 volt

<u>Amps.</u>	<u>Volts</u>	<u>Frame</u>	<u>Sym. I.C. - RMS - 277V or 480V</u>
20	277	TEF	14,000 (277V)
15-100	480	TEF/TED	14,000 (480V)

H. Certain panels as scheduled on the plans shall have built-in line side contactors for remote control of the main bus. Contactors shall be Asco #920 or approved equal for 2-wire remote control, mechanically held. Contacts shall be rated for 600 volts and coils shall be for 120 volt as required to match the control circuit voltage. Contactors shall be 3 pole with ampere rating as indicated in the panelboard schedule.

I. Panelboards shall be Square D, Westinghouse, General Electric, I.T.E., Federal Pacific or approved equal. Manufacturer's shop drawings shall include busing details, mounting methods and lug arrangements.

2.4 STEP DOWN TRANSFORMERS

A. Provide dry type transformers where shown and of KVA rating as shown on the plans. Transformers shall be built in accordance with the latest revised standard of AIEE, ANSI and NEMA.

B. Transformers shall be rated 480 volt delta to 120/208 volt wye, 3 phase, 60 hz with four primary taps, for 2-1/2% and 5% below normal and above normal. Transformers shall have Class H insulation for 150°C rise over a 40°C ambient.

C. Transformer housings shall be constructed of heavy gauge steel with ventilation openings and overall gray enamel finish. Transformers shall be suitable for floor or wall mounting.

D. Transformers shall have decibel ratings not to exceed USASI Standards. Transformers shall be equipped with four internal neoprene rubber anti-vibration pads to completely isolate the core and coil assembly from the enclosure. Provide efficiency, impedance and no load loss characteristics.

E. Transformers shall be General Electric, Westinghouse, Sorgel, Niagara or approved equal.

2.5 FUSES

A. Provide and install secondary fuses in all fusible switches, motor control centers, switchboards sized as shown on the plans. Provide spare fuses as specified in other sections for the specific equipment. High voltage fuses are specified in Section 16200.

B. Fuses shall be of the proper voltage rating either 250 volt or 600 volt class as required for the particular equipment. Fuses shall be Bussmann or approved equal. All current limiting fuses shall be Class R rejection type.

1. Fuses in the main substation disconnect switches shall be of the silver sand current limiting type, Buss Hi-Cap, type KRP-C, except as otherwise indicated or shown on the plans.

2. Fuses protecting feeders to 277/480 volt panelboards shall be dual element silver sand type, Buss Fusetron FRS (600V), below 150 amperes and Buss Low Peak LPS (600V) from 150 amperes and above.

3. Fuses protecting feeders to power panels, motor control centers, dry type transformers, bus duct risers and transfer switches shall be of the current limiting, dual-element type, Buss Low-Peak Fuses - LPN (250V); LPS (600V), 600 amperes and below and Buss Hi-Cap KRP-C above 600 amperes.

4. All motors, whether served from individual disconnects or from a motor control center, shall be protected by Buss Dual Element Fusetron Fuses - FRN (250V); FRS (600V) to 150 amperes and Buss Low Peak LPS (600V) from 150 amperes and above based on nameplate amperes and service factor.

5. All requests for substitutions shall be submitted in advance of bid to the engineer in writing and shall include a coordination table showing that the substitution will provide a coordinated system of overcurrent protection and that the short circuit current let-thru shall not exceed the interrupting capability of the equipment or devices being protected.

6. Contractor shall furnish to the University one set of three of each size and type of all fuses installed in the substation for each substation vault. For each main disconnect furnish 3 spare fuses. Furnish one set of three each, of each size and type of fuses used in each motor control center and each power panel. The Contractor shall indicate by letter to the University with copy to Engineer the list and location of all spare fuses.

2.6 SAFETY SWITCHES

A. Provide safety switches where required and as shown, sized according to the load served or the feeder or branch wire capacity, for motors and equipment. Switches shall be fused or unfused as indicated and as required.

B. Safety switches shall be heavy duty type, 250 volt or 600 volt and 2 pole or 3 pole as required. Switches shall be visible blade type with quick-make, quick-break operating mechanism, full cover control circuit interlock and means for padlocking.

C. Safety switches shall be NEMA 1 or NEMA 3R raintight for wet or outdoor locations.

D. Safety switches shall be Westinghouse, General Electric, Allen Bradley, Square D, Federal Pacific or I.T.E.

2.7 SECONDARY SWITCHBOARDS

A. Construction of the low voltage distribution section shall be NEMA Class 1, having whatever depth is necessary to accommodate the equipment. The distribution

branch protective devices shall be group-mounted with necessary bus connection straps and having the device (line and load) connections accessible from the front. Where space for a future device is called for, all necessary buses except device connecting straps shall be furnished. Full length vertical buses shall be provided in every section.

1. Switchboards shall be completely self-supporting structures of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. Switchboards shall include all protective devices and equipment as listed on drawings.

2. Bus terminals shall be tin or silver plated aluminum sized on the basis of not more than 800 ampere per square inch current density. The bus bars shall be mounted on supports of high impact non-tracking insulating material and shall be braced to withstand mechanical forces exerted during short circuit conditions based on NEMA Standards. A-B-C type bus arrangement - left to right - top-to-bottom and front-to-rear shall be used throughout to assure convenient and safe testing and maintenance.

3. Sections shall be designed for 277/480 volts, 3 phase, 60Hz with full capacity neutral unless otherwise indicated on the plans. Main bus ratings shall be as shown on the plans. Provide ground bus where indicated on the switchboard detail.

4. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. The switchboard exterior shall be finished in ASA-#61 light gray. All hardware used on conductors shall have a high tensile strength and have a suitable protective finish.

5. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position.

B. Main and distribution section individual switching devices shall be fusible, 3 pole, quick make, quick break, 600 volt hinged door type sized as shown on plans.

1. Switches shall bolt directly to the buses and shall be front accessible, heavy duty type.

2. Switches shall be individually enclosed in a steel compartment so that no live parts are accessible to the operator whether the door is open or enclosed.

3. Switches shall have solderless lug connectors with line shields. Contacts shall be silver alloy with spring reinforced fuse clips. Provide Class R fuse rejection clips for all current limiting fuses.

4. The door shall be interlocked with the switch mechanism so that with the switch energized the door cannot be opened and vice versa. Door latch shall be equipped with means for double padlocking.

5. Switches shall be rated for a maximum short circuit rating of 200,000 amperes with current limiting fuses and 100,000 amperes RMS symmetrical with current limiting time delay fuse.

6. All switches shall be equipped with fuses as specified in Section 16300.

7. Shop drawings shall be furnished providing the following information: complete rating, short-circuit withstandability of bus and of lowest rated device, overall outline dimensions including space available for conduits, circuit schedule showing circuit number, device description, device frame ampere rating, trip or fuse clip ampere rating, feeder circuit identification, conductor ratings and one-line diagram with each circuit device numbered.

8. Switchboard shall be as manufactured by General Electric, Westinghouse, Square D, I.T.E. or Federal Pacific.

2.8 CIRCUIT BREAKERS

A. Provide circuit breakers where shown on the plans, sized according to the load served or the feeder or branch wire capacity for motors and equipment. Circuit breakers shall be surface or flush mounted in NEMA 1 enclosures as indicated. Flush mounted circuit breakers shall be installed as detailed on 5/E26 with stainless steel cover engraved with the equipment name.

B. Circuit breakers shall be molded case with thermal magnetic trips for 120/208 volt or 277/480 volt as indicated or required.

C. Circuit breakers shall conform to the following minimum characteristics based upon General Electric nomenclature unless otherwise noted:

a) 120/208 volt application:

<u>Amps.</u>	<u>Volts</u>	<u>Frame</u>	<u>Sym. I.C. - RMS - 240V</u>
15-100	240	THQB	10,000
125-225	600	TFJ/TFK	25,000

b) 480 volt application:

<u>Amps.</u>	<u>Volts</u>	<u>Frame</u>	<u>Sym. I.C. - RMS - 480V</u>
15-100	480	TEF	14,000
125-400	600	TJK4	30,000
600-1200	600	THKM12	35,000

D. Circuit breakers shall be General Electric, Square D, Westinghouse, I.T.E., Federal Pacific or approved equal.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes the wiring devices, relays, and miscellaneous electrical equipment permanently installed to operate and control with 120/208 volt and 277/480 volt electrical system loads.

PART 2: PRODUCTS AND INSTALLATION

2.1 WIRING DEVICES AND PLATES

A. Provide wiring devices as shown on the plans and identified by the appropriate symbols. Hubbell numbers are used to identify the particular type of devices required except where otherwise noted. Pass & Seymour, Leviton, Sierra, General Electric or approved equal switches and receptacles shall be provided. All switches and receptacles shall be U.L. listed and meet NEMA WD-1-1971 performance tests for specification grade devices.

B. All receptacles shall be grounding type. Connect green covered ground conductor to ground terminal at each receptacle.

C. Switch, receptacle and all other plates (including telephone, television, etc., and for all empty outlet boxes) shall be satin stainless steel, Sierra 302 or approved equal with Type 302, stainless steel screws. In dark rooms plates shall be Sierra #400 flat black. Weatherproof plates for outdoor and wet locations shall be duplex Sierra #WPD-8.

D. All receptacle bodies and switch toggles shall be brown.

E. All receptacle plates other than the standard duplex 125 volt 20 ampere type shall be engraved with black filled letters indicating volts, amperes, and phase; for example, "208V-20A-1PH".

F. All receptacle and switch plates for the emergency electrical system shall be engraved "EMERGENCY" with red filled letters.

G. Receptacles:

Poles/ Wires	Volts	Amps	NEMA Configuration	Hubbell Cat. No.	Use	Remarks
2P-3W	250	20A	6-20R	5461	Equipment	Single
2P-3W	125	20A	5-20R	5362	General & Surface Raceway	Duplex-

Poles/ Wires	Volts	Amps	NEMA Configuration	Hubbell Cat. No.	Use	Remarks
2P-3W	125	30A	5-30R	9308	Equipment	Single
2P-3W	250	30A	6-30R	9330	Equipment	Single
• 3P-4W	125/250	20A	14-20R	8410	Equipment	Single
3P-4W	250-3PH	20A	15-20R	8420	Equipment	Single
• 3P-4W	125/250	30A	14-30R	9430	Equipment	Single
3P-4W	250-3PH	60A	15-60R	8460	Welder &	Single
						Equipment
3P-4W	125/250	30A	L14-30R	3430	Equipment	Single Twist
4P-54	120/208	30A	L21-30R	45105	Equipment	Single
4P-4W	120/208	60A	18-60R	7301	Equipment	Single

H. Special Receptacles:

1. Ground fault interrupter (GFI) receptacles shall be 15 ampere duplex, 120 volt, Pass & Seymour #1591 or 1591-F feed through receptacle as required. Install receptacle complete with Sierra #WP-8 stainless steel plates with weatherproof covers where indicated. Plates shall match specified device plates for general use.

2. Ceiling mounted receptacles in dark rooms, etc., shall be 2P-3W, 120 volt, 15 ampere, Appleton #11450G with outlet box hanger eyelets for light fixture support.

3. Refer to Section 16600 Article 2.2 Insolated Power Systems for 120 volt hospital grounding receptacles and special X-ray receptacles.

I. Ceiling Service Reel Receptacles:

1. Ceiling service reel receptacles indicated on the equipment schedule and plans as M471, M471A and M471B shall be provided by the electrical contractor. Contractor shall provide all necessary mounting hardware, bracket etc to the building structure for a secure installation. Units shall be as follows:

a. M471 - Recessed, 2 reel service, with 2-120 volt, 1 phase Hubbell #2300ZG twist lock receptacle and 20'-3 #16 cable per reel. Unit shall be Chemetron Medical Products #669202-64.

b. M471A - Same as M471 except single reel service. Chemetron #669201-64.

c. M471B - Recessed 2 reel service with 1-120 volt, 1 phase, Hubbell #23002G twist lock receptacle and 20'-3 #16 cable on one reel. Second reel with 1-208 volt, 1 phase, Hubbell #22432G twist lock receptacle and 20'-3 #16 cable. Unit shall be Chemetron #669202-120/208-64.

J. Pedestal Receptacles:

1. Pedestal type receptacles indicated on the equipment schedule and plans as C503 and C503A an located on casework countertops, laboratory tables, etc. shall be Lew or approved equal with nickel silver finish as follows:

- a. Single Face - #CB-704NP (3/4") with 1-#803 and 1-#804 cover plate.
- b. Double Face - #CB-704-NP (3/4") with 2-#804
- c. Telephone - #CB-704-NP (3/4") with 1-#805 and 1-#803 cover plate.

2. Install complete and wired with 125 volt grounded receptacles, 20 ampere duplex NEMA 5-20R as specified in this section where indicated on the plans.

K. Switches:

Poles	Amps.	Volts.	Cat. No.	Remarks
Single	20 amp.	277 - A.C.	1221	Toggle - Quiet
Double	20 amp.	277 - A.C.	1222	Toggle - Quiet
Three Way	20 amp.	277 - A.C.	1223	Toggle - Quiet
Four Way	20 amp.	277 - A.C.	1224	Toggle - Quiet
SPDT	20 amp.	277 - A.C.	1557	Momentary Contact
Single	20 amp.	277 - A.C.	1750/1781	Weatherproof
SPDT	20 amp.	277 - A.C.	1385	Maintained Contact

L. Pilot Lights:

1. Pilot lights for single pole switches shall be lighted switch handle type, 125 volt, 20 ampere with red light Sierra #5027R. Pilot lights for 277 volt shall be the same lighted switch handle type, except with #601 adapter.

2. Pilot lights for 3 way switches shall be combination toggle switch with lamp holder and red jewel. Lampholder shall be extra long life Sierra #2156 (120 volt) or 2157 (277 volt) and jewel shall be rectangular acrylic red plastic Sierra #406R.

3. Individual remote or signal pilots shall be Sierra #2156 (120 volt) or #2157 (277 volt) extra long life lampholder and lamp with round red acrylic plastic jewel Sierra #405R.

2.2 LOW VOLTAGE SWITCHING SYSTEM

A. Furnish and install complete remote control wiring system for control of lighting for corridors, stairs, lobbies, etc., as indicated on drawings, diagrams and schedules. System shall be complete with transformers, relays, switches, master-selector switches, pilot lights, wall plates and wiring. All remote-control wiring components shall be of same manufacturer and installed in accordance with the recommendation of the manufacturer. Remote-control equipment shall be as manufactured by General Electric Company or approved equal.

B. All remote-control wiring shall be in accordance with Article 725, Class 2, of the National Electrical Code.

C. Wiring shall be #14 gauge THWN-THHN stranded copper conductors as required. All wiring shall be run in conduit in ceiling spaces and partitions. Complete wiring systems shall be color-coded according to General Electric recommendations and conductors must be tagged or identified at terminals.

D. The following equipment shall be provided to erect a complete system:

1. Remote-control relays shall be heavy-duty, specification grade with clamp type screw terminals on high voltage side, rated 125V and 277V AC, 20 ampere tungsten and ballast solenoid type with one coil for closing and the other for opening, designed for three-wire momentary contact control. Relays shall be No. RR7. Relays for pilot switches shall be the same except with 4 wires control circuits, No. RR8. Provide silicon rectified #RA16 for relay control circuits.

2. Remote-control switches shall be heavy-duty, specification grade. They shall be single pole, double throw, momentary contact type. Switches shall be A.C. quiet type, 15 amp with brown toggles, No. G. E. 5935-1. Where switches are shown with pilots provide separate gang box and plate. Pilots shall be RA18 with red jewel, and G. E. No. S-6, 30 volt lamp.

3. All plates shall be identical to those specified in 2.1 above and shall be engraved with the switch function designation.

4. Master-selector switches shall be eight-position type with individual ON-OFF switches, built-in master locking switch, engraved directory holder and pilot lights. Provide as many of these 8-switch type units together in the 3rd Floor control center Room 75 as detailed on 2/E47. Arrange neatly as indicated on plans for a flush installation. Contractor may provide a special back box for each unit in lieu of the four inch boxes suggested by manufacturer. Master switch units shall be No. RMC9PL, gray finish with pilots. Provide engraved identification for each switch as indicated on the detail.

5. Transformers shall be energy-limiting type approved for Class 2 system, rated 115/24V or 277/24V as required. Transformers shall be 75VA.

6. Provide surface mounted steel cabinets with full access piano hinged door with latch. Door shall have baked enamel finish to match panelboard doors. Component cabinets shall have a partition for mounting the specified and required RR7 and RR8 relays, transformers, and rectifier assembly. Cabinets shall be equipped with buses and suitable neutral high voltage terminal strips and low voltage terminal strips for all relays, and low voltage switch leads. Cabinets shall be U.L. listed for remote-control wiring. In addition to relays required for installation, provide space for 50% additional relays for future use. Provide 2 spare relays per cabinet for future use. Cabinets shall be similar to No. RBS3 or approved equal with relays, transformers, and circuits as shown in the relay schedules on the plans. Provide permanent panel identification label and typewritten directory under a plastic cover mounted inside of the hinged door cover.

2.3 TIME SWITCHES

A. For animal lighting and other loads as shown provide automatic Time Switch with 24 hour dial powered by a self-starting synchronous motor.

B. Time Switch contacts shall be capable of switching 40 amperes per pole continuously at 277 volts and shall be DPST as required. Provide clock motor voltage ratings as required.

C. Enclosure shall be NEMA flush type. Enclosure shall be finished in baked gray epoxy enamel, with combination 1/2", 3/4" knockouts on bottom, both sides, top and back. Provide with lock and key.

D. Time Switches shall be Tork Model 277-1962-FLI or Paragon or approved equal.

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes furnishing and installation of all fixtures complete with lamps and ballasts where required as shown on the plans and on the fixture schedule. Capital letters adjacent to outlets indicate the fixture type and small letters indicate the manner of switching. Where continuous row fixtures are specified it shall be understood that the capital letter next to the outlet identifies all fixtures in the row and all rows are made up of either four or eight foot long fixtures in combination to complete the row. Catalog numbers listed below are for basic four foot long fixtures. Contractor shall be responsible for exact quantities of fixtures required in any row. The channels may be eight feet long, but all plastics, hinged doors and louver sections shall not exceed four feet long. Unless otherwise noted a suitable and typical fixture shall be furnished and installed at each fixture outlet (or as otherwise indicated on the drawings) though inadvertently not identified on the plans or not listed on the fixture schedule.

PART 2: PRODUCTS AND INSTALLATION

2.1 INSTALLATION

A. Fixtures shall be hung from the suspended ceiling grid, tees, etc., except industrial and strip fluorescent fixtures shall be mounted from structure. Provide all clips, sheet metal screws, anchors, etc. for a secure installation.

B. Electrical Contractor shall coordinate the fixture installation for all ceiling types and shall check ceiling finishes, clearances, structure suspension system etc., before placing fixture orders to insure correct application. Refer to architectural reflected ceiling plans and details for ~~details~~ of ceiling systems and exact locations of fixtures.

1. Coordinate the installation, placement and cutting of suspended ceiling components with the ceiling system manufacturer and/or installer.
2. Provide plaster frames for recessed fixtures where applicable.
3. Provide all additional structural members where required for fixture support when not furnished with the ceiling system or by the ceiling installer.
4. Surface mounted fluorescent fixtures shall be mounted from Steel City #6029 or edgewise 1-1/2" Lather's channels provided by the Electrical Contractor.

Provide 3/16" studs and locknuts for every four feet and at the ends of all fixture rows. Channels shall rest on the ceiling support system and shall be securely fastened into place.

C. All fixtures shall be hung straight and true and as design of fixture and accepted practice dictate. All fixtures shall be cleaned immediately before the final inspection. All fixtures shall be newly lamped and in perfect operating condition at the completion of the job. All necessary devices and auxiliary fittings required for a complete and workmanlike installation shall be furnished and installed by this Contractor.

D. Concrete bases and housings for outdoor post and bollard lights will be provided by the General Contractor. Refer to the Architectural Details.

2.2 LAMPS

A. All incandescent lamps shall be inside frosted, rated at 125 volts unless otherwise noted in the fixture listing. Lamps shall be standard 1000 hour life type except R and PAR Type 2000 hours.

B. Mercury vapor lamps shall be deluxe white or beauty lite inside frosted rated for 24,000 hours life except 100 watt lamps shall be 16,000 hours rated.

C. Tungsten halogen lamps shall be rated for 2000 hours and 120 volts.

D. Rapid start fluorescent lamps shall be T-12 white, 3200 (min.) initial lumens and 18,000 hours lamp life.

E. For aisle lights in seating units, furnish and install 120 volt incandescent candelabra base lamp as required.

F. Lamps shall be Sylvania, Westinghouse, General Electric or approved equal.

2.3 BALLASTS

A. Fluorescent ballasts shall be for 277 volts (except where noted otherwise), premium high power factor and CBM-ETL approved. Provide multiple lamp ballasts wherever possible. Ballasts shall have internal thermal automatic resetting protection and inert solid fill and capacitor protection to meet Class "P" U.L. rating. Sound ratings shall be "A" for rapid start. Fluorescent ballasts shall be "Premium" Jefferson, General Electric, Westinghouse or Universal equivalent to Advance Mark II Kool Koil.

B. Mercury vapor ballasts shall be 277 volt constant wattage high power factor type Jefferson, Sola, General Electric or approved equal. Mercury vapor ballasts and light fixtures for interior use shall be designed suitable for application with room ambient noise level of 30NC without additive noise contribution to exceed the noise curve criteria. Fixture manufacturer shall be responsible for the proper ballast application and mounting to insure acceptable operation for the application defined.

C. The fluorescent ballast manufacturer shall provide a two-year guarantee against defects in workmanship or material which includes an in-warranty service program providing for the payment of authorized labor charges incurred in the replacement of defective in-warranty ballasts.

2.4 LIGHT FIXTURES

A. All fixtures shall be U.L. approved and manufactured, installed and wired in accordance with the latest rulings of the National Board of Fire Underwriters and national, state and local codes and ordinances.

B. Incandescent fixtures shall be wired with asbestos-covered, heat resistant wire as required. Fluorescent fixtures shall be internally wired and with not less than No. 16 stranded wire with thermoplastic, asbestos or silicone insulation as listed in Table 402-3 of the National Electrical Code.

C. All fluorescent fixtures shall be designed, tested and guaranteed by the manufacturer for ballast coil temperature not to exceed the U. L. limit of 105°C and ballast case temperature not to exceed 90°C for the particular application.

D. The major suspended ceiling is a custom lay-in modular system. All light fixture details and mounting methods shall be designed to accommodate the ceiling system where fixtures are installed within the ceiling system.

E. Submittal of fixture samples to the Engineer for evaluation shall be required 14 days prior to bid date for approval where indicated in the fixture schedule.

2.5 FIXTURE SCHEDULE

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
A	A two lamp lay-in recessed 1' x 4' fluorescent fixture with frameless lens construction. Chassis, wiring channel, reflectors, cover and end plates shall be constructed of not less than 20 gauge steel, chemically treated, then finished in high temperature white baked enamel to obtain at least an 85% reflectance factor. Lamp socket supports shall be 18 gauge minimum. Lens shall be Holophane No. 7160 or approved equal, injection molded of clear virgin acrylic plastic to ASTM Standard #D-788-69. Fixture shall be designed specifically for this lens with hinged end frames to preclude light leaks and with inside end aligners to prevent drop out. Fixture shall be 5-1/4" deep maximum and shall be designed to accommodate a 47" x 11" finished opening. See Architectural details for reference to the details of the custom modular lay-in ceiling. Refer to Details 5/E4 and 6/E4 for light fixture requirements. Fixture shall be Westinghouse FL2H-SG2414 or approved equal. Submit fixture sample for approval.	2-F40W
A-1	Same as "A" except 3 lamp with 2 ballasts. Westinghouse FL2H-SG3414.	3-F40W

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
A-2	Same as "A" except 2' (nominal) long with single "U" lamp. Fixture shall be designed to accomodate a 24" x 11" finished opening. Westinghouse FL2H-SF-1U12.	1-F40W/U
A-3	Same as "A" except fixture shall have provisions for chain suspending. Fixture shall be supplied without lens. Westinghouse FL2-SG2414CS.	2-F40W
B	A wall mount fluorescent fixture with wrap around white translucent plastic acrylic diffuser. Peerless #GP-1753-240RS or approved equal. Submit fixture for approval.	2-F40W
C	A round recessed horizontal lamp mercury vapor fixture with 6-1/2' light bronze aluminum groove baffle, pre-wired, matte white finish trim and 8" maximum depth. Ballast and capacitor shall be auto-stabilized core and coil type, high power factor, epoxy encapsulated. Marco #X-4119C-XQ-100W or approved equal. Submit fixture sample for approval.	1-100W A-23MV
C-1	Same as "C" except 120 volt incandescent. Marco #X-4119-CI-100W.	1-100/A-19
C-2	Same as "C-1" except larger lamp. Marco #X-4119-CI-150W or approved equal.	1-150/A-21
C-3	Same as "C" except mounted in plaster ceiling. Marco X-4119-C-XQ-100W or approved equal.	1-100W A-23MV
C-4	Same as "C-1" except mounted in plaster ceiling. Marco X-4119-CI-100W or approved equal.	1-100/A-21
C-5	Same as "C-1" except mounted in plaster and larger lamp. Marco X-4119-CI-150W or approved equal.	1-150/A-21
D	A 4' long recessed mounted two circuit light track with 4 quartz adjustable floodlights with matte white finish. Provide complete hardware as required. Lightolier #7601/7512/7514/7546.	4-Q250W PAR-38
E	A ceiling mount exit light with single metal stencil face, matte white finish, 6" red letters and downlight. Moldcast #421-WR-120V or approved equal.	2-T6-1/2/IF
E-1	Same as "E" except double face. Moldcast #422-WR-120 volt.	2-T6-1/2/IF
E-2	Same as "E" except back wall mount. Moldcast #401-WR-120V or approved equal.	2-T6-1/2/IF

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
E-3	A custom ceiling mounted exit light mounting cube frame provided by the General Contractor and installed by the Electrical Contractor. Provide 3 type E-2 exit light fixtures to be field installed by the Electrical Contractor on the mounting frame. Provide wiring from exit lights to outlet box. Refer to Details 35, 36 and 37 on Sheet A4-17. Provide 3 Moldcast #401-WR-120V for each type E-3.	6-T6-1/2/IF
E-4	Same as "E-3" except provide 2 type E-2 exit light fixtures installed at 90° to each other on the cube frame as indicated on the plans. Provide 2 Moldcast #401-WR-120V for each type E-4.	4-T6-1/2/IF
E-5	Same as "E" except with transformer for 277 volt operation. Moldcast #421-WR-277V.	2-T6-1/2/IF
E-6	Same as "E-1" except with transformer for 277 volt operation. Moldcast #422-WR-277V.	2-T6-1/2/IF
E-7	Same as "E-2" except with transformer for 277 volt operation. Moldcast #401-WR-277V.	2-T6-1/2/IF
E-8	Same as "E-3" except the 3 exit light fixtures shall be same as type E-7 with transformer for 277 volt operation. Provide 3 Moldcast #401-WR-277V for each type E-8.	6-T6-1/2/IF
E-9	Same as "E-4" except the 2 exit light fixture shall be same as type E-7 with transformer for 277 volt operation. Provide 2 Moldcast #401-WR-277V for each type E-9.	4-T6-1/2/IF
E-10	Same as "E-7" except with matte black finish. Modicast #401-BR-277V.	2-T6-1/2/IF
*NOTE:	All exit light canopy details and fixture depths shall be identical for 120 volt and 277 volt fixtures.	
F	A round recessed incandescent fixture with fresnel lens, white trim, prewired and maximum 8" depth. Lightolier #1101/1126 or approved equal.	1-150W A-21
G	A 1' x 4' recessed 2 lamp fluorescent fixture with regressed translucent acrylic lens and extruded aluminum frame and trim with baked white enamel finish. Fixture shall be suitable for mounting in plaster ceiling. Lens shall be KSH-19A. Fixture shall be Sechrist #DIGK-240-BWA, Columbia #SL12-240-G or approved equal.	2-F40W
G-1	Omitted.	

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
G-2	Same as "G" except 6" wide and 1 lamp. Sechrist #D6GK-40-BWA, Columbia #SL6-140-G or approved equal.	1-F40W
G-3	Same as "G" except 6" wide. Sechrist #D6GK-240-BWA, Columbia #SL6-240-G or approved equal.	2-F40W
H	A porcelain keyless socket, P&S #44 or equal.	1-100/A-19
I	Void	
J	A pendant mounted 1' x 4' industrial fluorescent fixture with baked enamel finish, 10% upright and turret type sockets. Provide chain suspension as required to suspend fixture at 9' above floor or at height indicated on plans. Miller ID-2101-04, Sylvania #QY10-2404 or approved equal.	2-F40W
J-1	Same as type "J" except surface mounted and no upright. Miller ID-2100-04, Sylvania QY10-2404NA or approved equal.	2-F40W
J-2	Same as "J-1" except chain suspended at height indicated on the plans. Sylvania QY10-2404NA, Miller ID-2100-04 or approved equal.	2-F40W
K	A recessed 2' x 4' 4 lamp vaporproof fluorescent fixture with Corning 70 tempered lens. Fixture body shall be constructed of 20 gauge steel with baked white enamel finish and stainless steel flange trim and door frame with continuous piano hinge and complete neoprene gasketing. Provide plaster frame for mounting in plaster ceiling. Morris Kurtzon #V-2440SS-277V or approved equal. Submit fixture samples of type K-2 for approval of K series fixtures.	4-F40W
K-1	Same as "K" except 1' wide with 3 lamps and plaster frame Morris Kurtzon #V-7873-40SS-277V or approved equal.	3-F40W
K-2	Same as type K-1 except - 2 lamp. Morris Kurtzon #V-7872-40SS-277V or approved equal.	2-F40W
K-3	Same as K-2 except fixtures shall be recessed mounted inside stainless steel exhaust hood Morris Kurtzon #V-7872-40SS-277V or approved equal.	2-F40W
K-4	Same as type K except surface mounted and with complete stainless steel body. Morris Kurtzon SUV-2440SS-277V.	4-F40W
K-5	Same as "K-1" except for lay-in inverted T-bar ceiling. Morris Kurtzon VEC-7873-40SS-277V or approved equal.	3-F40W

Type	Description	Lamp
K-6	Same as K except for lay-in inverted T-bar ceiling. Morris Kurtzon VEC-2440-40SS-277V or approved equal.	4-F40W
L	A vaportight wall bracket fixture with guard, Miller #AC-2092, Stonco equivalent or approved equal.	1-150/A-21
L-1	Same as "L" except ceiling mounted with junction box. Miller #AC2012 with properly sized conduit hubs, Stonco equivalent or approved equal.	1-150W A-21
M	A 55" one lamp fluorescent undercabinet light fixture with in-line 120 volt ballast. Lightolier #10247 or approved equal.	1-F40W
M-1	Same as "M" except 43" long and smaller lamp Lightolier #10245 or approved equal.	1-F30W
M-2	Same as "M" except 31" long and smaller lamp Lightolier #10243 or approved equal.	1-F20T12 TS
N	A 1' x 4' recessed 2 lamp fluorescent fixture with positive latch, translucent acrylic lens and extruded aluminum door frame and trim. Fixture shall be suitable for mounting in plaster ceiling. Lens shall be KSH-19A. Columbia 5114-FK19A-142 or approved equal.	2-F40W
N-1	Same as "N" except 3 lamp. Columbia 5114-FK19A-143 or approved equal.	3-F40W
N-2	Same as "N" except provide 120 volt ballast Columbia 5114-F-K19A-142 or approved equal.	2-F40W
O	Void	
P	A one lamp 4' long strip fluorescent fixture with overall baked enamel finish. Garcy #RN-8000-48H, Lightron #124-140RS-ETL or approved equal. Fixture channel shall not exceed 2" x 2-3/4".	1-F40W
P-1	Same as "P" except 3' long. Garcy #RN-8000-36H, Lightron 124-130RS-HPF or approved equal.	
P-2	Same as "P" except 2' long. Garcy #RN-8000-24H, Lightron 124-120TS-HPF.	1-F30W T12 RS
Q	A recessed incandescent gasketed shower light with flat fresnel lens for installation in plaster ceiling with prewired outlet box. Marco #E515-W35, McPhillip #43-13 PFJB or approved equal.	1-F20W T12 RS 1-150W

Type	Description	Lamp
R	A two lamp 48" strip fixture with overall baked enamel finish and two single lamp ballasts. Fixture channel shall not exceed 2" x 3-1/2", Garcy #RN942-48H-2B, Lightron 125X-240RS-ETL or approved equal.	1-F40BL 1-F40W
S	A surface mounted incandescent fixture with opal glass drum diffuser. Provide fixture with surface conduit collar adapter. Marco #A138-C53 or approved equal.	2-100W A-21
T	A recessed incandescent fixture with hinged fresnel lens and 2 lamp sockets. One socket for general lighting and one socket wired for separate switching of a 15 watt red light. Kirlin #1208-NL, Morris Kurtzon 78G-10-NL or approved equal.	1-150W/AZ1 1-15W/R A-15
U	A sign light for back wall mounting with white letters on black background, reading "DARKROOM IN USE". Housing shall be white finish. Fixture shall be for 120 volt operation. McPhilben #30LW-2C2C or approved equal.	2-T 6-1/2/1F
U-1	Same as "U" except reads "STUDIO IN USE" McPhilben #30LW-C2C or approved equal.	2-T6-1/2/1F
U-2	Same as "U" except reads "MIC ON" McPhilben #30LW-2C or approved equal.	2-T6-1/2/1F
V	A wall mounted cylindrical incandescent fixture with light bronze multi groove baffle and seamless aluminum housing finished matte white. Lightolier #6606SP, Kurt Versen #M706RB, or approved equal.	1-150W PAR-38FL
V-1	Same as "v" except with smaller lamp. Lightolier #6606SP, Kurt with Versen #M706RB or approved equal.	1-75W R-30 2-75W/A19
W	A wall mounted incandescent over-mirror fixture with white opal glass diffuser Lightolier #4731 or approved equal.	2-F40W
X	A surface mounted 1' x 4' shallow fluorescent fixture with aluminum framed regressed translucent acrylic KSH-19A lens. Fixture shall have a maximum depth of 3-1/2". Columbia 6113-K19A-142 or approved equal.	25W-A19
	and recessed incandescent with matte black step white trim. Lightolier #1001/1005. installed in plaster ceiling. Lightolier #1001/1005	1-25W(Red) A-19

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
Z	A shallow round recessed fixture with glass fresnel lens, pre-wired, matte white trim and light bronze ridged baffle and maximum depth of 5-1/4". Kurt Versen #F5616 or approved equal.	1-150/A21
AA	A recessed tungsten-halogen exam light with vented cast aluminum heat sink, aluminum reflector and extruded aluminum matte white trim frame. Kurt Versen #N580-250 or approved equal.	1-Q250-T4 Mini-Can
BB	Existing relocated 3 lamp recessed fixture. Clean fixture and provide new lamps for new installation.	3-F40W
CC	A ceiling recessed luminaire with vertical angle adjustment from 30° to 70", 360" rotation, adjustable focus, tungsten halogen lamp and 6" lens. Century-Strand #2321/1461 or approved equal.	Q500T-12-EGE
DD	A round recessed tungsten halogen fixture with Alzak reflector, black milli-groove baffle and white trim. Kurt Versen #A7177 or approved equal.	1-Q500-T4 Mini-Can.
DD-1	Same as "DD" except for wide distribution. Kurt Versen #A7179 or approved equal.	1-Q500-T4 Mini-Can
DD-2	Same as "DD-1" except smaller. Kurt Versen #A7178 or approved equal.	1-Q250-T4 Mini-Can.
DD-3	Same as "DD" except with slope ceiling adapter. Kurt Versen #A7177-T4 or approved equal.	1-Q500-T4 Mini-Can.
EE	A one lamp surface fluorescent fixture with white enamel steel chassis and white translucent acrylic diffuser. Lightolier #10163 or approved equal.	1-F40W
FF	Existing relocated recessed fluorescent fixture. Clean fixture and provide new plaster frame and lamps for new installation.	2-F40W
GG	A 2 lamp wall mount fluorescent fixture with curved aluminum baffle finished with eggshell white enamel. Provide channel lengths in single or multiple lamps as shown on plans made up of 4' rapid start lamps with fascia 2" longer than the lamp channel assembly. Continuous row fixtures shall be provided with seamless fascia. Provide end caps for fixtures where fixtures do not butt to wall. Trim fascia in field as required. Provide shop drawing layout of all continuous row fixtures for approval. Forum #BAG-2020-WH with lengths as shown on plans or approved equal.	2-F40W

<u>Type</u>	<u>Description</u>	<u>Lamp</u>
HH	A surface wall mounted mercury vapor exterior step light with cast aluminum housing, tempered glass diffusing lens and cast aluminum louver. Contractor shall provide necessary clip angles to support fixtures from precast concrete. Refer to Details 5 and 6 Sheet A9-3. Marco #F632-100MV-277V or approved equal.	1-100W A-23MV
II	Same as HH except fixture shall not exceed 4-1/2" deep. Contractor shall provide necessary clip angles to support fixtures from precast concrete. Refer to Detail 21/A9-3. Marco #F632-100MV-277V or approved equal.	1-100W A-23MV
JJ	A recessed adjustable incandescent fixture with matte black aluminum step baffle, lamp adjustment 30° from vertical and 358° rotation horizontally and white trim. Lightolier #1101/1127.	1-75W R-30FL
KK	A special recessed 2' x 5'-2" fluorescent fixture with 4 lamps staggered alternately over the length of the 5'-2" dimension. Fixture shall be designed for special lay-in inverted T ceiling system. Lens shall be KSH-19A acrylic regressed in aluminum framed hinged and latched door. Refer to Architectural reflected ceiling plans for ceiling suspension system and dimensional data. #LPI-JV-2462G-19R-440-SP or approved equal.	4-F40W

2.6 EXAM AND SURGICAL LIGHTS

A. Equipment Item M-483 - Examination Light

1. Equipment Item M-483 shall be double head ceiling mount examination light.
2. Examination light shall be model U-215, by Burton Lamps (House of Vision, Inc.). No Substitutions.
3. Fixture must comply with applicable requirements of NFPA's National Electrical Code and Flammable Anesthetics Code and must be listed by Underwriter's Laboratories, Inc.
4. Double lighthoods, each with 12" diameter Alzak processed reflector, and color-correcting and heat absorbing glass cylinder housing 150 watt spot-light bulb. Wrap around handles to permit positioning of light with either hand from either side. Simple, push-pull adjustment for focusing brightness and size of light beam without moving position of lighthood. Each lamp capable of being adjusted, independent of the other, up or down and 180° around ceiling rod. Finish to be Silver Metallic. Furnish and install lamps for fixture. Fixture shall be 120 volt, 60 Hz, single phase.

B. Equipment Item M-488 - Surgical Light, Double Head Ceiling Mounted

1. Equipment Item M-488 shall be a surgical light fixture for central hub mounting with double 22" diameter lighthouse/crossarm arrangement, each supported by a centrally mounted horizontal arm - one 24" long support arm and one 36" long support arm.

2. Surgical light shall be Centra 360 by Amsco, Castle 195, or approved equal.

3. Fixture must comply with applicable requirements of NFPA's National Electric Code and Flammable Anesthetics Code and must be listed by Underwriter's Laboratories, Inc.

4. Movable Yoke lighthouse with sterilizable handles (3 per lighthouse), suspended by crosspiece within the yoke and balanced by a tube enclosed spring mechanism. Lighthouse shall have small, medium and large lightbeam patterns, changeable without interrupting the light beam - to give a cool, shadow reduced, color-corrected light at the operative site. Furnish and install lamps for fixture. Fixture shall be 120 volt, 60 Hz, single phase.

C. Equipment Item M-490 - Minor Operating Light

1. Equipment Item M-490 shall be a minor operating light fixture for central hub mounting with single lighthouse/crossarm arrangement.

2. Minor operating room lights shall be Amsco Model C-22-OR with a 22" diameter reflector and lighthouse suspended from a 12" offset rotary tube or Castle Model L-245 with a 23" diameter reflector and lighthouse suspended from a rotating suspension tube with horizontal crossarm and photograph. Lights to be ceiling mounted. Fixture shall be 120 volt, 60 Hz, single phase. Furnish and install lamps for fixture.

3. Fixture must comply with applicable requirements of NFPA's National Electric Code and Flammable Anesthetics Code and must be listed by Underwriter's Laboratories, Inc.

D. Equipment Item M-498 - Surgical Light, Ceiling Mounted

1. Equipment Item M-498 shall be ceiling mounted light for minor surgical and examining work, with single 12" diameter lighthouse.

2. Surgical light shall be Castle No. 80, or approved equal.

3. Lighthouse is suspended from a spring counter-balanced offset arm and yoke assembly which are attached to an extension arm which is mounted from the end of a suspension tube positioned at the ceiling from a tripod assembly. The extension arm is rotatable through 360° around the end of the suspension tube.

4. Lighthouse has a 12" diameter Alzak reflector with step down design to provide Universal focus within a range of 20" to 42" from the lamphead. Unit shall include a cylindrical filter surrounding the lamp which color corrects

light from the lamp and filters out heat. Fixture shall be 120 volt, 60 Hz, single phase. Provide and install 150 watt P25/8 spotlight lamp.

E. Equipment Item M-498A - Surgical Light, Wall Mounted

1. Equipment Item M-498A shall be identical to M-498 except shall be provided with bracket, cord and plug for wall mounting.

2. Surgical light shall be Castle No. 8, or approved equal.

3. Offset arm and yoke assembly are attached to an extension arm which is pivot mounted from a wall bracket.

4. Provide and install a 150 watt P25/8 spotlight lamp. Fixture shall be 120 volt, 60 Hz, single phase.

PART 1: GENERAL

1.1 SCOPE

- A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.
- B. Work under this section includes providing and installing dimming systems for auditorium, seminar rooms, and in special use rooms as shown on plans. Provide all equipment for fully operable systems including dimmer controls, remote controls, relays, pilot lights, conduit and wiring as shown and as described herein.
- C. Systems shall be designed to operate on 120/208 volt, 3 phase, 4 wire, 60 HZ electrical supply and shall be connected for best possible phase balance when more than one dimmer is used in a "package".
- D. Shop drawings shall be provided for all components of the dimming system complete with control wiring diagrams for approval.
- E. The manufacturer shall guarantee his equipment to be free from defects in material and workmanship for a period of one calendar year from date of acceptance by the University.

PART 2: PRODUCT AND INSTALLATION

2.1 AUDITORIUM HOUSELIGHT DIMMING SYSTEM

- A. For the auditorium (Room 2-104) provide a package dimmer and control system as described herein and shown on the plans. Dimmer package shall be Electro Controls Series 8MB, Century-Strand or approved equal. The system shall be completely factory assembled and wired to meet the requirements of the plans and specifications and shall not require field assembly or wiring except for connection of feeders, blank circuits and control circuits.
- B. All equipment necessary for the operation of the board under the intent of these specifications, shall be furnished and provided with overload and short circuit protection. All circuit breakers used throughout the systems shall be magnetic, single pole. All equipment, control and protection devices shall be properly identified with permanent labels.
- C. The dimmer package shall be designed to U. L. Standards and shall be U. L. listed as an enclosed type dimmer and shall include:
1. Ventilated enclosures suitable for surface wall mounting.
 2. 3-60A-IP Primary and 15-20A-IP load circuit breakers, connected 5 circuit breakers per phase.

3. Busing for 120/208 volt, 3 phase, 4 wire service.

4. Control power supply.

5. By-pass circuit for "panic" condition to be controlled by remote momentary contact switches as shown on the plans.

6. 3 - 7.2 KW dimmers connected one dimmer per phase.

D. Dimmers and enclosure shall conform to the following design, performance and requirements.

1. Dimmers shall utilize two silicon controlled rectifiers in a back to back electrical configuration providing a symmetrical alternating current output to the lamp load that it controls. The full load of the circuit is to be carried and controlled solely by the silicon controlled rectifiers. Dimmers shall be listed and approved by Underwriters' Laboratories for controlling incandescent filament lamps.

2. Dimmers shall be the bolt-in type designed for rack mounting. Electrical power and load connections between the dimmer module and the mounting rack shall be through bolt type terminals mounted on the front of each dimmer. Terminals shall be keyed so that line and load will not be interchangeable. All low level signals shall be connected by means of screw type terminals. It shall be possible to install dimmers from the front of the enclosure. All wiring and connections shall be accessible from the front.

3. The following equipment shall be accessible from the front of the module, without removing the dimmer from the rack: control terminals, power and load terminals and two curve adjustment controls. With the exception of the adjustment controls, the dimmer shall not contain any moving parts.

4. Dimmers shall each be identified as follows: manufacturer's name and address, rating of dimmer in volts and amperes, control circuit requirements, catalog number and type listing, and serial number. Identification must meet UL and code requirements.

5. Each dimmer shall be designed for continuous full load operation. An ambient temperature of 0 degrees to 50 degrees C (120°F) shall not diminish performance of the dimmer. The above performance shall be accomplished without the use of a blower or fan for each dimmer. A blower or fan mounted in each dimmer module is not acceptable. A temperature sensing device shall be incorporated to interrupt dimmer operation in the event safe operating temperatures are exceeded. This device shall automatically reset upon return to normal operating temperatures.

6. It shall be possible, from the front of the dimmer module, to operate and adjust the dimmers independently of the control without removing the dimmer from the enclosure.

7. Electrical characteristics shall be: 120 volts - 50/60 Hertz input. The dimmer shall be designed to operate over an input range from 100 volts to 140 volts and to obtain square law curve performance with incandescent filament lamps over this input range. The efficiency of the dimmer at any voltage and any load shall exceed 97%. With control voltage set anywhere between 0 and full on,

the no load losses shall not exceed 8 watts. Maximum full load losses shall not exceed (7.2KW Dimmer) - 120 watts at maximum - 8 watts when turned off. Full load voltage of a fully loaded dimmer shall be within 3 volts RMS of the incoming line voltage when the controller is set at "full bright". Each dimming unit shall carry its full rated load indefinitely. The kilowatt dimmer rating shall refer to tungsten filament lamp loads.

8. The standard dimming curve shall be square law so that a change of specified magnitude on the controller shall produce an apparent corresponding change in light output. Manufacturer shall supply plotted data supporting ability to provide such dimming curves. The dimmer shall always shut off the "off" position of the potentiometer regardless of the "zero" setting so that when control voltage is off, the output voltage shall be zero. The zero setting for dimmers supplied with standard square law curve shall be 5 volts.

9. Control voltage shall not exceed 16 volts and the control current 0.4 milliamperes. Control overvoltage increases of up to 30 percent shall not disrupt dimmer operation. Control current shall not be affected by dimmer loading. The inrush from an "off" to "on" position shall not exceed the rating of the silicon controlled rectifiers as published by the rectifier manufacturer.

10. Regardless of load, the load current voltage from a dimmer unit shall be an alternating output completely symmetrical with respect to the zero voltage and current axis. No direct current shall be introduced in the line. Dimmer shall be so designed as to prevent false triggering of the rectifiers and/or any interaction with other dimmers during any operation of the system.

11. A filtering choke shall be provided to eliminate high frequency components from the entire wave form. The instantaneous rate of current rise shall not exceed 250 Ma. per microsecond over any portion of the entire current wave form. An oscillographic photograph shall be provided by the manufacturer for verification. Overall current rise time shall exceed 500 microseconds for each half cycle of operation. Measurements shall be taken at 50% voltage output with 50% connected load.

12. Electrical isolation between the control and power circuits shall be complete. No phase relationship between line and control nor any common reference voltage is required. Control negative and dimmer neutral shall be independent.

13. The output of the dimmer shall repeat regardless of the direction of movement of the controller. With a regulated line the output voltage of the dimmer shall not change during operation from the value initially established by the controller unless the controller itself is changed. Output voltage curve shall not deviate from a straight line during a fade from one controller to another.

14. Dimmer output shall effectively reach steady state values within a period essentially determined by the lamp filament under any rated load condition when the controller is switched from "off" to "full bright" and for all apparent purposes be essentially instantaneous. Tracking time between controller movement and dimmer response shall not exceed 4 Hertz. Switching oscillations must damp within 15 Hertz.

E. The dimming system shall be controlled by remote control stations located as shown on the plans. Control stations shall be installed in a special

stainless steel control panel per detail 3/E56. Provide the complete control panel under this specification complete with back box, engraved stainless steel cover and controls for houselight dimmer. Switches for control of other lights shall be furnished by the electrical contractor. Houselight dimmer controls shall be Electro Controls #8MD1B or Century-Strand equal linear motion potentiometer, one push button switch for dimmer control and 2 push button switches for panic by-pass on-off control.

2.2 INDIVIDUAL ROOM DIMMING SYSTEMS

A. At each room as shown on the plans and scheduled provide a solid state dimming and control system. Dimmers shall be factory wired complete to load breakers and shall be arranged for connection to a 120/208 volt, 3 phase, 4 wire supply system. Dimmer package shall be Electro Controls Series 8MA, Century-Strand or approved equal. Refer to Sheet E18 for dimmer and Control Schedule.

B. The system shall be enclosed in a ventilated code gauge steel cabinet with baked enamel finish. Enclosure shall house the quantity of electronic dimmers as scheduled herein and shall contain all required control terminals labeled for wiring to control stations. Unit shall also contain the control power supply and required 20A-IP magnetic circuit breakers. All wiring power terminals, etc. shall be accessible by removal of the front panel. The system shall be completely factory assembled and wired to meet the requirements of the plans and specifications and shall not require any field assembly or wiring except for connection of main feeders, branch circuits and control circuits.

C. The dimmer package shall be designed to U.L. Standards and shall be U.L. listed as an enclosed type dimmer.

D. Dimmers and enclosure shall conform to the following, design, performance and requirements.

1. Dimmers shall utilize one triac type silicon controlled rectifier providing a symmetrical alternating current output to the lamp load that it controls. The full load of the circuit is to be carried and controlled solely by the silicon controlled rectifier.

2. Dimmers shall be the bolt-in type. Electrical power and load connections between the dimmer module and the mounting rack shall be through screw type terminals mounted on the front of each dimmer. All low level signals shall also be connected by means of screw type terminals. It shall be possible to install dimmers from the front of the enclosure.

3. Dimmers shall each be indentified as follows: manufacture's name and address, rating of dimmer in volts and amperes, control circuit requirements, catalog number and type listing, and serial number. Identification must meet UL and code requirements.

4. Each dimmer shall be designated for continuous full load operation. An ambient temperature of 0 degrees to 50 degrees C (120°F) shall not diminish performance of the dimmer. The above performance shall be accomplished without the use of a blower or fan for each dimmer.

5. It shall be possible, from the front of the dimmer module, to operate and adjust the dimmers independently of the control without removing the dimmer from the rack.

6. Electrical characteristics shall be 120 volts - 50/60 Hertz input. The dimmer shall be designed to operate over an input range from 100 volts to 140 volts and to obtain square law curve performance with incandescent filament lamps over this input range. The efficiency of the dimmer at any voltage and any load shall exceed 97%. With control voltage set anywhere between 0 and full on, the no load losses shall not exceed 8 watts. The full load losses shall not exceed 40 watts. Full load voltage of a fully loaded dimmer shall be within 3 volts RMS of the incoming line voltage when the controller is set at "full bright". Each dimming unit shall carry its full rated load indefinitely. The kilowatt dimmer rating shall refer to tungsten filament lamp loads.

7. The standard dimming curve shall be square law so that a change of specified magnitude on the controller shall produce an apparent corresponding change in light output. Manufacturer shall supply plotted data supporting ability to provide such dimming curves. The dimmer shall always shut off at the "off" position of the potentiometer regardless of the "zero" setting so that when control voltage is off, the output voltage shall be zero. The zero setting for dimmers supplied with standard square law curve shall be 5 volts.

8. Control voltage shall not exceed 16 volts and the control current 0.4 milliamperes. Control overvoltage increases of up to 30 percent shall not disrupt operation. Control current shall not be affected by dimmer loading. The inrush current from an "off to "on" position shall not exceed the rating of the silicon controlled rectifier as published by the rectifier manufacturer.

9. Regardless of load, the load current voltage from a dimmer unit shall be an alternating output completely symmetrical with respect to the zero voltage and current axis. No direct current shall be introduced in the line. Dimmer shall be so designed as to prevent false triggering of the rectifiers and/or any interaction with other dimmers during any operation of the system.

10. A filtering choke shall be provided to eliminate high frequency components from the entire wave form. The instantaneous rate of current rise shall not exceed 250 MA. per micro-second over any portion of the entire current wave form. An oscillographic photograph shall be provided by the manufacturer for verification. Overall current rise time shall exceed 300 microseconds for each half cycle of operation. Measurements shall be taken at 50% voltage output with 50% connected load.

11. Electrical isolation between the control and power circuits shall be complete. No phase relationship between line and control nor any common reference voltage is required. Control negative and dimmer neutral shall be independent.

12. The output of the dimmer shall repeat regardless of the direction of movement of the controller. With a regulated line the output voltage of the dimmer shall not change during operation from the value initially established by the controller unless the controller itself is changed. Output voltage curve shall not deviate from a straight line during a fade from one controller to another.

13. Dimmer output shall effectively reach steady state values within a period essentially determined by the lamp filament under any rated load condition when the controller is switched from "off" to "full bright" and for all apparent purposes be essentially instantaneous. Tracking time between controller movement and dimmer response shall not exceed 4 Hertz. Switching oscillations must damp within 15 Hertz.

E. The dimming systems shall be controlled by remote control stations located as shown on the plans with controllers and master controllers as scheduled. Controllers shall be linear motion potentiometers with pushbutton control switch. Master controllers shall incorporate pushbutton control switch for each linear motion potentiometer. Provide engraved identification to clearly identify load being controlled. Dimmer controls shall be Electro Controls 8MD Series, Century-Strand equivalent or approved equal. Refer to schedule for control function and controller for each dimmer.

2.3 TELEVISION STUDIO LIGHTING AND DIMMING SYSTEM

A. General

1. The Electrical Contractor shall provide at the television studio Room B-114 and B-116 a complete light control and dimming system including dimmers, control console, patch panel, plug-strip and outlets as shown on the plans and herein specified. Refer to Detail 1/E25 for layout and requirements.

2. The pipe grid system for support of lighting fixture will be provided by the General Contractor.

3. Portable lighting fixtures for the T.V. dimming system will be provided by the University.

4. All equipment necessary for the operation of the system under the intent of these specifications shall be furnished and installed by the Electrical Contractor. System shall incorporate overload and short circuit protection. All circuit breakers shall be magnetic. All equipment control and protection devices shall be properly identified with permanent labels.

5. The system components shall be designed to meet UL Standards and shall be U.L. listed. System equipment shall be Kliegl, Colortran, Electro-Controls or approved equal. Kliegl numbers are used to establish quality and function.

B. Dimmers and Rack:

1. Dimmer Rack shall include 6-6 KW SCR bolt on dimmers conforming to the specification for dimmers and enclosure in Section 16410 Article 2.1. Rack shall be a free standing enclosure, front accessible and ventilated. Dimmer rack shall be dead front design complete with incoming line lugs, 200A-3P main circuit breaker distribution bus, output and control terminal strips. Dimmer rack shall be designed for 120/208 volt; 3 phase, 4 wire distribution system.

2. Dimmer and rack shall be Kliegl #2905-TV.

C. Dimmer Control Console:

1. The dimmer control console shall be two scene preset with master. The control console shall be portable desk top for use in the T.V. studio and T.V. control room. The control console shall have a 10' control cable with multi pin connector. The manufacturer shall provide two matching multi pin receptacles to receive connector receptacles shall be mounted in surface box with baked enamel finish. Console shall include 6 control potentiometers per scene, scene submaster potentiometers, system main key switch, 3 non dim switches, power "on" pilot light, independent master, and scene potentiometer control switches, 2P, 3 position switches "ind-off-preset."

2. Control Console shall be Kliegl #2906-TV.

D. Patch Panel:

1. The patch panel shall be surface wall mounted, cord and plug safe patch type. Panel shall contain five 20 amp circuit breaker/receptacle units and one 50 amp circuit breaker/receptacle per each dimmer (6) and non-dim (3) circuit, for a total of 45, 20 amp and 9, 50 amp. The panel shall also contain 43-20 amp and 2-50 amp safepatch nonretracable plugs with extra flexible cables, maximum cable length 44".

2. Patch Panel shall be Kliegl #2904-TV.

E. Plugging Strip:

1. Plugging strip shall be surface mounted metal raceway with 18" cord and 3 pin grounded connector. Raceway length and quantity as shown on drawing. Each plugging strip shall be provided with terminal box complete with number terminal strip. Raceway shall have baked enamel finish. Each receptacle shall be on individual circuit. The raceway shall be labeled at each cord and receptacle to indicate respective receptacle number to correspond with cord number in patch panel. Labeling shall be 3/4" high painted numerals.

2. Plugging strip shall be Kliegl #5369C with 12" 3# 112 conductor type S0 cable.

3. Provide (10) adaptor cord sets with 3 pin grounded male receptacle on one end and 3 wire standard connector body on other end. Hubbell #5369C, 12" 3# 12 conductor type S0 cable.

2.4 PHOTO STUDIO LIGHTING AND DIMMING SYSTEM

A. General

1. The Electrical Contractor shall provide at the photo studio Room B-113 a complete light control and dimming system including dimmers, control console and special circuit breaker panel.

2. The rolling grid system shall be provided under Section 16410 Article 2.5.

3. Portable lighting fixtures for the photo dimming system will be provided by the University.

4. All equipment necessary for the operation of the system under the intent of these specifications shall be furnished and installed by the Electrical Contractor. System shall incorporate overload and short circuit, protection. All circuit breakers shall be magnetic. All equipment shall be properly identified with permanent labels.

5. The system components shall be designed to U.L. Standards and shall be U.L. listed. System and equipment shall be Kliegl, Colortron, Electro-Controls or approved equal. Colortran numbers are used to establish quality and function.

B. Dimmers and Enclosure:

1. Dimmer package shall include 6-2.4KW SCR dimmers conforming to the specification for dimmers and enclosure in Section 16410, Article 2.1. Dimmer package shall be designed for 120/208 volt 3 phase, 4 wire distribution system. Enclosure shall be ventilated with required terminal blocks for load and control wiring. Unit shall be designed for wall mounting.

2. Dimmer package shall be Colortran #200-024.

C. Control Console:

1. The Control console shall be portable desk top type, two scene preset, independent scene masters for control of six dimmers. The control console shall have a 10' control cable with multi-pin connector. The manufacturer shall provide matching multi-pin receptacle to receive connector receptacle shall be mounted in surface box with baked enamel finish.

2. Control console shall be Colortran #200-101.

D. Dimmer Output Panel:

1. The dimmer output panel shall be surface mounted, door in door construction. Panelboard and circuit breakers shall conform to specification Section 16300 for 120/208 volt, panels. The panel shall be designed with seven individual 60 Amp bus sections with circuit breakers as follows:

<u>Bus Description</u>	<u>Circuit Breaker</u>	<u>Circuit Numbers</u>
Dimmer 1	3 - 20 Amp 1 Pole	1,3,5
Dimmer 2	3 - 20 Amp 1 Pole	2,4,6
Dimmer 3	3 - 20 Amp 1 Pole	7,9,11
Dimmer 4	3 - 20 Amp 1 Pole	8,10,12
Dimmer 5	3 - 20 Amp 1 pole	13,15,17
Dimmer 6	3 - 20 Amp 1 Pole	14,16,18
Constant 7	4 - 20 Amp 1 Pole	19,20,21,22.

2. Branch circuit conductors in panelboard shall have sufficient length to allow reconnection to any circuit breaker in panel. Leave space between each bus group of circuit breakers. Label each group with engraved plate to indicate "constant circuits" or respective dimmer number. Refer to one Line drawing on Sheet E-25.

3. Panelboard shall be as furnished by Colortran #200-999-4 Constant.

2.5 PHOTO STUDIO ROLLING GRID SYSTEM

A. General

1. The Electrical Contractor shall provide a complete photo studio rolling grid system for support of lighting fixtures and power distribution. The University shall provide system light fixtures, and fixtures carriers.

2. The rolling grid system shall be "Roll-O-Rail" as manufactured by Automatic Devices Company or equal "Grid-King" by Berkey Colortran. Automatic Devices Co. numbers are used.

3. The system consist of two main components. The cable rail for support of power distribution cable carrier system and lighting fixture rails fixed and secondary movable for support of lighting fixture carriers. Refer to Detail I/E25 for layout and requirements.

4. All equipment necessary for the operation of the system under the intent of these specifications shall be furnished and installed by the Electrical Contractor.

B. Rolling Grid System Equipment:

1. Rails: All rails shall be 11 gauge extruded aluminum, mill-finish, one piece-unspliced, designed to support 600 lbs on recommended 6' support. #1400-A Channel.

2. Cable Carrier: Cable carriers shall be steel with 4 ball-bearing flanged wheels complete with cable clamp. #1473.

3. Double Carrier for carrying movable rail between main fixed rail, with spring-loaded brake. #1472.

4. Miscellaneous Hardware: The system shall be furnished complete with all necessary hardware, which shall include #1480 end stops at end on all channels. #4208 Hanging clamp with #1477 - 3/8" rod adapter. Support rods shall be 3/8" diameter steel with galvanized finish.

5. Pigtail outlet boxes: The pigtail outlet boxes shall be three and four circuit with 18" 20 Amp cord and 3 Pin grounded theatrical female receptacle. Pigtail outlet boxes shall be labeled at pigtail locations to indicate receptive circuit breaker numbers in panelboard. Labeling shall be 3/4" high painted numerals.

6. Cable: Cable shall be multiconductor, #12 AWG high temperature cable. See drawing for number of conductors required in each cable. Cables

shall be of sufficient length to allow pigtail outlet boxes to reach extreme corner of grid system.

C. Installation:

The cable rail shall be surface mounted on the ceiling (13'-0"). The fixed/movable rail system shall be pendant mounted on 3/8" steel rods with bottom on lower movable rail 11'-0" above floor. The system shall be supported from the ceiling support system. Provide additional channels between main ceiling channels as required.

2.6 OPHTHALMOLOGY CLINIC LIGHT CONTROL SYSTEM

A. General

1. The Ophthalmology clinic located on the 9th floor consists of exam room with control consoles to control lighting and equipment outlets. The control console and optical equipment will be furnished and installed by the University. The Electrical Contractor shall furnish and install the lighting fixtures, wiring devices and junction boxes as shown on the plans and herein specified. Refer to details shown on Sheets E36, 37 and 38 for layout and requirements.

B. Equipment and Installation

1. Power and Lighting control switches shall be as follows:

a. DPDT - Double Pole Double Throw, 2 position "no center off" maintained contact both directions, 20 Amp. 120-277 Volt. P & S #1276.

b. SPDT - Single Pole Double Throw, 2 position maintained contact. 20 Amp, 120/277 Volt. P & S #522-1.

2. Junction Boxes and empty conduit are for future projector control cable. Junction boxes shall be single gang with split telephone type stainless steel plate.

3. The control console will be provided with two multi-pin Cinch-Jones plugs one 6 pin for lighting and one 12 pin for power. The Electrical Contractor shall furnish and install matching Cinch-Jones receptacles 6 pin Type S-406-SB and 12 pin Type S-412-SB. Verify exact matching receptacle with supplier of control console.

4. The Electrical Contractor shall provide matching plug for lighting control receptacles. Complete lighting circuits by jumpering receptive pins of the plug. Provide one per room so that lights can be operated without Owner Console.

5. The control console will have the control switches identified by a number to correspond with pin number in connector. The Electrical Contractor shall engrave the plate adjacent to the respective receptacle with the corresponding number. The engraved number shall be 1/4" high, minimum. The controlled receptacles have their respective number noted on the drawings.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes completely installed, connected, operating and tested systems as herein specified and as shown on the plans and riser diagram details. Equipment shall consist of factory assembled components with warranties and guarantees as herein specified.

PART 2: PRODUCTS AND INSTALLATION

2.1 PUBLIC TELEPHONE CONDUIT SYSTEM

A. Telephone outlets shall be installed as indicated on the plans and accordance with the following:

1. Telephone outlets in steel stud hollow partitions are indicated on the plans but shall not be installed until final locations are designated by University Telephone Services within six months prior to occupancy. Outlets shall be installed in conformance with Detail 2/E-10b.

a. Electrical Contractor shall furnish a total of 500 telephone outlets of the type shown in Detail 2/E-10b. This total includes those indicated on the plans and additional outlets to be designated by University Telephone Services. All such outlets shall be provided with a heavy gauge stranded nylon pull cord.

b. Electrical Contractor shall provide blank stainless steel plates for 100 single gang outlets to match those specified under "Wiring Devices", Section 16300. These plates shall be installed by the Electrical Contractor on the telephone outlets not used at the completion of the project.

2. Electrical Contractor shall install conduit and outlet boxes for those telephone outlets indicated on the plans with conduit run or conduit stubs to ceiling spaces. Outlet boxes shall be double gang with single gang mud ring. In all conduit runs, provide a heavy gauge stranded nylon pull cord. Provide blank stainless steel single-gang plates to match those specified under "Wiring Devices", Section 16300, for all such outlets.

B. All telephone conduit shall be 3/4 inch, unless otherwise shown. Pull-boxes are not shown on the plans, but shall be provided, as required for ease of wire and cable pulling; and in conduit runs that would otherwise be more than 90 feet in length; and in runs that would otherwise contain more than two 90-degree bends. Double offsets will not be allowed in any telephone conduit run. Radius of all conduit bends shall conform to the following schedule.

<u>Size of Conduit in Inches</u>	<u>Inside Diameter of Conduit in Inches</u>	<u>Minimum Radius of Bends in Inches</u>
3/4	0.82	8.2
1	1.05	10.5
1-1/4	1.38	13.8
1-1/2	1.61	16.1
2	2.07	20.7
2-1/2	2.47	24.7
3	3.07	30.7
3-1/2	3.55	35.5
4	4.07	40.7

C. All pullboxes in telephone conduit runs shall be sized according to schedule shown in Detail 3/E10b. Pullboxes shall be recessed in all finished portions of the building.

D. Telephone Cabinets shall be furnished by the General Contractor unless otherwise indicated consisting of 36" x 36" painted plywood inside of the wall cavity with a steel frame and door. See Detail 41/11-4 for construction of cabinet. The Electrical Contractor shall provide a 3" x 6" wireway from the cable tray to the telephone cabinet as indicated on the plans.

E. Telephone cabinets where indicated on the plans to be provided by the Electrical Contractor shall be similar in appearance to electric panelboards doors shall provide full access to panel and be hinged on the left vertical edge and shall be equipped with locking hinged doors and 1/2" plywood backing for mounting terminal strips. Lock shall be Best Cabinet lock set #5L6RL4 which is a 6 pin tumbler, left handed self latching lock which allows key to be withdrawn in locked position only. This lock set provides keying to match Universities X-3 key for telephone facilities. Cabinets shall be 24" x 36" x 4" deep and shall be General Electric, Westinghouse, Square D, Federal Pacific or I.T.E.

F. All telephone equipment, services and cables will be installed by Northwestern Bell Telephone Company. This contractor shall cooperate as necessary to aid in location, provide prints and/or identify conduit and cable tray locations.

G. In Electrical Cores #29, #31 and #32, provide conduit floor sleeves as indicated on the plans for vertical distribution of telephone and communications cables. Floor sleeves to be 4-inch diameter and to extend a maximum of 2-inches above and below the floor slab. All sleeves in the electrical Cores shall be located in line and as close together and as close to the face of the plywood terminal board on the outside wall of the core as is practical. The first sleeve in the line shall be located at the left-most edge of the terminal board. University Telephone Services shall designate which sleeves are to be in use at occupancy. Sleeves not in use at occupancy shall be sealed with an approved 2-Hour-Rated, non-hardening duct seal compound and shall be capped. Sleeves that will be in use at occupancy will be sealed by the Telephone Company after their cable is installed. Electrical contractor shall provide a sufficient amount of the approved duct seal material for this purpose to the Telephone Company.

H. In Electrical Cores reserved and shown for telephone terminal boards, provide 3/4 inch thick plywood primed and finished with two (2) coats of fire-retardant

gray enamel. Plywood pieces shall be 7 feet high unless otherwise shown. Width of plywood terminal board shall equal that of the wall upon which it is mounted, or as shown on plans. Bottom edge of plywood shall be mounted 12" above floor line. Mount plywood on vertical floor-to-ceiling supports of 1-1/2 inch by 1-1/2 inch by 16 gauge Kindorff or Unistrut channels, provide horizontal support as required. Countersink all fasteners used to mount plywood.

I. A 20 ampere, 120 volt dedicated circuit terminated in a double duplex outlet shall be provided on each telephone terminal board located in a vertical shaft space as shown on the plans. The bottom of the outlet box shall be installed on the center-line of the terminal board at a height of 7 feet, 6 inches. Conduit serving outlet box must approach from top so that terminal board is clear below. All telephone terminal board electrical circuits shall be connected to the Emergency Power system as shown on the plans.

J. Where in-wall flush type pay phones are indicated on drawings, the Electrical Contractor shall obtain the special back boxes from the Telephone Company, set them in place and connect empty conduit.

K. Where flush-in wall emergency telephones are shown in the stairways on the plans, provide a recessed telephone enclosure Soundolier #TRE-1 without lock but with latched door. Enclosure shall have baked enamel finish, color to be selected by the Architect. Provide continuous metal raceway top to bottom on left side of box for feed through wiring.

2.2 CLOCKS

A. Provide a wired electric clock on dock outlet as indicated on the plans. All clocks shall operate from 120 volt A.C. with the power source connected to the building wiring system as shown.

B. Clock Outlets shall be a clock hanger outlet Sierra #2123 with NEMA #5-15R receptacle and stainless steel plate.

C. Clocks designated as Equipment #M322 on the plans shall be Simplex Time Recorder Company semi-flush #78-35 with 9" dial and 120 volt movement. Clocks shall have steel case with satin white enamel finish, white dial and flexible 3-wire cord and plug for connecting to receptacle in clock outlet box. Clocks shall have convex glass, black modern Arabic numerals, hour hands and minute hands, and red sweep second hands.

D. Clock designated as Equipment #M323 and located by the Auditorium Room 104 at the Second floor shall be Simplex ICON Type 31-16535 impulse control. Unit shall be flush mounted per detail #20/A10-1. Provide flush mounted remote controller and reset Simplex #629-R without armature and non self regulating. Provide minute impulse button and cut off switch.

E. Elapse time clocks and control designated as Equipment #321 on the plans shall be as follows:

I. ELAPSED TIMER/CLOCK

a. Sorgel ECT 120-2 digital, dual face elapsed time indicator and clock. The light display shall be neon gas with one inch characters which are

plainly visible at 30 feet away. The 60 minute elapsed timer shall incorporate circuitry allowing a count to be held and then resumed when actuated from the control panel. The solid state design allows the elapsed timer to instantly reset. The timer/clock shall have an extra set of contacts, that when closed will actuate the timer. This circuitry allows interfacing with either the Code 4 Alarm or monitor output.

b. The clock shall be capable of either displaying 12 hour or 24 hour time. In the 12 hour mode, the lighted display shall either indicate AM or PM time. Three integral buttons shall set the hour, minute, and second display. Clock shall be set to indicate 24 hour time.

c. The elapsed time/clock shall have front accessible fuses and be mounted in a durable, phenolic case.

2. ELAPSED TIMER/CLOCK CONTROL

a. Shall be a Sorgel ECT 120-12A control panel for use with the ECT 120-2. The control panel shall consist of red lighted "count/reset" and "hold" button mounted on a stainless steel faceplate. A pre-installed wiring harness shall connect the control panel to the elapsed timer/clock.

2.3 COMMUNICATIONS CONDUIT SYSTEMS

A. General

1. Furnish and install empty conduit and boxes as shown on plans and specified hereinafter for intercom, television, audio visual, student response, projector, sound systems, computer terminals, etc. Wiring and equipment will be provided and installed by the University.

2. All conduit shall be 3/4" or larger where indicated. All boxes shall be double gang or larger where indicated. All conduit stubs shall have bushed ends.

3. All outlet boxes shall be provided with plates or covers unless otherwise noted. Plates for standard size wiring boxes shall be blank stainless steel to match device plates specified in Section 16310. Provide engraving where indicated for device plates. Plates for larger boxes shall be flat 14 gauge galvanized steel. These plates shall be provided with properly applied zinc chromate flat prime coat. Final paint coats will be by the General Contractor.

4. Certain communication systems wiring cabinets as noted on plans shall have hinged doors and wood backing. These cabinets shall be identical to the telephone cabinets described in paragraph 2.1 above and as sized on the plans. Covers for these cabinets shall have the standard ASA No. 61 gray enamel finish.

5. Electrical Contractor shall coordinate and verify specified device plate engraving with the University. Plates shall be punched by the Electrical Contractor to receive the University's wiring device. Verify with the University wiring device opening required before plate is punched.

B. Clinical Nurse's Call System

1. Nurse Call Switch outlets shall be double gang outlet box with single gang device ring where individually mounted. Provide engraved stainless steel plate as indicated on the plan and specified. Refer to Detail 1/E32.

2. Nurse Call Switch outlets where gang mounted with other devices shall be barriered from line voltage outlets. Nurse Call shall occupy 2 gangs. Stainless steel plate shall be engraved as indicated on the plans and specified. Refer to detail 1/E32.

3. Nurse Call Dome Light Outlet and buzzer outlet shall be double gang box with single gang device ring. Cover or plate shall not be provided by the Electrical Contractor.

4. Provide 3/4" conduit stubs or conduit system as indicated on the plans. System wiring to be provided by the University will utilize the empty conduit stubs, system and cable tray provided by the Electrical Contractor.

C. Clinical Intercom and Paging System

1. Intercom Call Origination Switch outlet shall be 2 gang box with single gang device ring where individually mounted. Provide engraved stainless steel plate as indicated on the plans and specified.

2. Intercom Call Origination Switch outlet where gang mounted with other devices shall be barriered from line voltage outlets. Call switch shall occupy one gang. Stainless steel plate shall be engraved as indicated on the plans and specified. Refer to detail 1/E32.

3. Intercom Speaker Outlets where indicated as wall mounted shall consist of a back box to be furnished by the University but installed by the Electrical Contractor. Provide all necessary mounting hardware to install box.

4. Paging Speakers will be provided installed by the University above the suspended ceiling at perforated ceiling pans provided by the General Contractor. No work will be required by the Electrical Contractor for these ceiling speakers.

5. Microphone outlets shall be 2 gang box with single gang device ring. Provide stainless steel plate engraved "MIC" and punched to receive microphone jack.

6. Provide 3/4" conduit stubs or conduit system as indicated on the plans. System wiring to be provided by the University will utilize the empty conduit stubs, system and cable tray provided by the Electrical Contractor.

D. Auditorium Sound Systems

1. Provide empty conduit system complete with outlet boxes, terminal cabinets, etc. as shown on Sheet E56 for public address system, intercom system and hearing aid systems. Systems equipment and wiring will be provided and installed by the University.

2. Microphone outlets shall be 2 gang box with single gang device ring. Provide stainless steel plate engraved "Microphone" and punched to received microphone jack.
3. Speaker outlets shall be double gang with single gang device ring unless otherwise noted on the plans.
4. Provide terminal cabinets floor boxes and equipment rack as specified below:
 - a. Audio-Visual Equipment rack shall be Soundolier #W100-36. Provide plugmold strip with 15A 120 volt grounded receptacles mounted inside for rack equipment.
 - b. Audio Visual terminal cabinets shall be as specified in paragraph A4 of this article. Provide for surface or flush mounting as indicated on the plans.
 - c. Floor boxes shall be as specified in Section 16100. Provide duplex outlets within box as indicated on detail 5/E56.
5. Intercom outlets shall be double gang boxes with double gang device ring. Plate or cover is not required by the Electrical Contractor.
6. Hearing Aid outlet shall be double gang box with single gang device ring. Provide blank stainless steel cover.
7. Provide surface metal raceway in control and projection room for power and/signal as specified in Section 16100, Article 2.5 Surface Raceways.

E. Auditorium T.V. System

1. TV camera outlets shall be 6" x 6" x 4" deep boxes with stainless steel covers.
2. TV system terminal cabinet shall be as specified in paragraph A.4. of this article for surface mounting.
3. TV equipment and wiring will be provided and installed by the University in the empty conduit system. System will connect to the TV Studio located on the basement floor with 1-1/2" conduit as shown on the plans provided by the Electrical Contractor.

F. Auditorium Student Response System

1. Student outlet shall be double gang with double gang device ring and blank stainless steel plate.
2. System terminal cabinet shall be as specified in paragraph A.4. of this article for surface mounting.
3. Future installation of equipment and wiring for the system will be by the University.

F. Auditorium Front and Rear Screen Projection

1. Provide power outlets for rear screen projection equipment as indicated on the plans. Outlets for sound, TV and control in conjunction with this system are specified as a part of the previously specified systems.

2. The equipment and control wiring for this system shall be provided and installed by the University.

H. Computer Terminal System

1. CRT outlets shall be double gang outlets with double gang device ring. Provide stainless steel covers with 3/4" bushed opening.

2. Where CRT outlets occur on counter tops, etc. provide outlet in pedestal as specified under Section 16310 Article 2.1 Wiring Devices and Plates. Provide 3/4" bushed opening in plate.

3. Provide 1" conduit stubs or conduit system as indicated on the plans.

4. Wiring and equipment will be provided and installed by the University utilizing the conduit stubs, system and cable tray system shown on the plans and provided by the Electrical Contractor.

2.4 MISCELLANEOUS DOOR CONTROL AND SIGNAL SYSTEMS

A. Door control and signal systems are shown on the plans. Where these systems are indicated provide all conduit, wiring, connections and equipment as shown and specified. All wiring shall be #14TW or THWN installed in concealed conduit whether live or low voltage. Control function and operation of each system shall be as described on the plans.

B. Provide the following specified equipment as required for operation of the systems.

1. Transformers:

a. Edward's #991 for flush j-box installation with buzzer, 120 volt/10 volt, 10 watt.

b. Edwards #88-50 surface mounted rated 50 watts, 120 volt/24 volt.

2. Buzzer: Edward #661 self-contained, 10 volt, 6 V.A. 50 db for flush installation. Provide stainless steel louvered plate.

3. Push Button Switches:

a. Outdoor - Edwards #852, 10 amp, 24 volt, weather proof flush push button complete with plate and gasket.

b. Indoor - Edward #694-12 snap fit, 5/8" diameter for mounting in stainless steel plate on j-box. Push button rated 10 amps at 24 volts.

4. Electric Door Strikes:

Door hardware and strikes shall be provided by the General Contractor rated for 24 volts and wired by the Electrical Contractor.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Work under this section includes completely installed connected, operating, and tested systems as herein specified and as shown on the plans. Equipment shall consist of factory assembled components as specified.

PART 2: PRODUCTS AND INSTALLATION

2.1 EQUIPOTENTIAL GROUNDING SYSTEMA. General

1. Electrical Contractor shall provide all equipment material and wiring necessary for complete installation of equipotential grounding system herein specified and as shown on the plans. System shall conform with the Article 517 of the National Electrical Code, NFPA 56A and 76A as applicable.

2. The equipotential grounding system shall be capable of grounding locally in a patient area with the specified maximum resistance values, the metal objects which a patient can touch or person can touch who also can touch the patient. It shall also provide a localized low resistance ground for grounding connections of all electrical equipment which may be connected to the patient. The objective is to minimize voltage differences between supposed grounds to minimize currents which can flow through patients because of fault or leakage currents in electrical equipment. Bonding together water piping, gas piping, building structure, etc. provides the patient protection against voltage differences between supposed grounds caused by heavy short circuit currents in piping, building structure, etc, which can occur remotely from the patient area. This local grounding is intended to form the electrical environment of the patient.

3. Refer to Sheet E46 for layout and details of the specified system.

B. Installation and Materials

Included in this low-impedance network are the following which shall be grounded by the Electrical Contractor as specified herein and indicated on the plans:

- a. Plumbing gas, vacuum, water and waste.
- b. All exposed conducting surfaces.
- c. All portable equipment (via power cords, plugs, and receptacles plus redundant grounding jacks, cords and permanent connections to equipment).

2. These items shall be grounded to the Patient Grounding Point (P.G.P.) for each patient.

3. Grounding of all exposed conducting surfaces within 10 feet of a patient shall be accomplished by individual insulated wires from the conductive surface to the insulated terminal bus device designated the Patient Grounding Point ("P.G.P.") for each patient. Grounding loops shall be avoided.

4. Grounding, per NFPA #70, NEC 1975, Article 250, from panelboards, etc. shall be as indicated on the drawings and specified. Metal covers or enclosures of equipment with electrical connections shall be grounded to the P.G.P.

5. Grounding wires shall be Type TW stranded copper conductor, insulated, sized as indicated on the drawings and shall in no case be less than #10. Termination of grounding wires will be of the compression type or crimped lugs with one crimp to lock insulation and at least one crimp to lock wire. All terminations shall be copper to copper.

6. The Patient Grounding Point shall be a compression lug, copper-terminal bus insulated from the back box and capable of terminating wire sizes from #10 to #4 A.W.G. Bus shall have sufficient quantity of lugs to terminate all required ground wires plus 20% spare. Bus shall be enclosed within the isolated power panel with access for measurements and maintenance or shall be a separate module as detailed on the plans.

C. Performance

1. Any two conductive surfaces in the patient vicinity shall not exceed the following potential differences at frequencies of 1000 Hz or less measured across a 1000 ohm resistance.

a. General Care Areas - 500 mv under normal operation.

b. Critical Care Areas - 100 mv under normal operation.

D. Inspection and Testing

1. The Contractor shall include the cost of, and make all arrangements for the testing of all equipotential grounding systems. In addition, the Owner will provide testing of the system by an engineer appointed by him. All testing shall be accomplished with Contractor and the Owners testing engineer present. The Contractor shall cooperate fully with the Owner's testing engineer and shall make all adjustments and modifications prior to and subsequent to the required tests.

2. Final acceptance by the Owner and engineer will be given after final testing, if the installation is found to comply in all respects with the specifications and plans. In the event of conflict in measurements, particularly with regard to measurements related to special requirements designed to protect the patient, the acceptance testing will be based on measurements made with instrumentation provided by the Owner's testing engineer.

3. Equipotential Grounding System will be examined by mechanical inspection and measurement of grounding impedances. Terminations requiring tightening

will be indicated. An inspection is necessary to determine the grounding paths as installed and the quality of components and workmanship.

4. Measurements of impedances between each Patient Grounding Point and all exposed conducting surfaces, all grounding contacts of power and signal receptacles, and all grounded objects within ten feet of any part of the patient's location shall be performed by the current-injection method and the measurement current will be large enough to detect, by heating, broken strands in stranded number 10 wire. A current of 20 amperes shall be used as the measurement current.

5. After all tests have been made, Contractor shall give written certification to the Owner and the Owner's testing engineer that the system is in accordance with all codes and all good installation practices in accordance with the specifications.

2.2 ISOLATED POWER SYSTEMS

A. General

1. Electrical contractor shall provide all equipment material and wiring necessary for complete installation of isolated power system herein specified and as shown on the plans. System shall conform with Article 517 of the National Electrical Code, NFPA 56A and 76A as applicable.

2. An isolated power system is a localized, ungrounded electrical system limiting the fault current to ground during the first probable fault. The purpose is to reduce the hazards of spark ignition and macroshock and, in combination with a suitable local grounding system, to reduce the hazard of microshock.

3. Refer to Sheet E46 for layout and details of the specified systems.

B. Equipment and materials

1. The contractor shall furnish and install an isolated power panels as wired and tested and include a low leakage isolating transformer, primary and secondary circuit breakers, line isolation monitor, patient ground bus, 3-wire grounding power receptacles, grounding jacks, and transfer switches for surgical light fixtures. These components shall be assembled and wired within an enclosure suitable for flush mounting as detailed on the plans.

2. The isolated power system shall include grounding busses, specified 3-wire grounding power receptacles and grounding jacks necessary to make the system part of an equipotential grounding system as indicated on the drawings.

3. Isolated Power Panel

a. Isolating Transformers:

1) The transformers shall be constructed with a grounded copper electro-static shield, at least 0.005 inches thick, or equivalent, which completely isolates the primary and secondary windings and/or splices and cross-over leads if present. Toroidal construction will not be acceptable.

2) The transformer shall be an approved substantial design. The core shall be stacked and securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration absorbing method. The coils shall be wound in an acceptable manner and impregnated or otherwise protected from moisture in a manner that will preclude change of characteristics with high humidity. Class H rated insulation shall be used and must have a 220 degree Centigrade UL recognized insulation system.

3) Identification of secondary (isolated) conductors shall be:

- a) Conductor No. 1 -- orange
- b) Conductor No. 2 -- brown
- c) Grounding conductor -- green (electrostatic shield)

4) The transformer shall have the following characteristics at 60 Hz:

a) Primary and Secondary Voltages shall be 208 to 120 volts plus or minus 2 volts respectively for the 5 KVA transformer.

b) Excitation Current shall be less than 20% of rated current.

c) Leakage current from secondary to grounded frame and shield shall not exceed ten micro amperes at 5 KVA.

d) Regulation shall be such that with the primary voltage fixed, the difference between the secondary voltage for no load and for rated load will not exceed 3%.

e) Thermal protection shall be as required for U.L. listing. Temperature rise will be limited to 55 degrees centigrade above ambient temperature under rated load conditions. Measurements will be made in conformance with ANSI Standards.

f) The sound level in the room adjacent to the enclosure shall not exceed 35 decibels for all loadings up to and including the rated power. Measurement data shall be made available upon request to the Engineer for each individual unit.

g) Design RF attenuation of the electrostatic shield, at 2 MHz, shall be 40 decibels. Measurement data shall be available to the engineer for representative units.

h) The secondary winding insulation shall be capable of withstanding without breakdown for a period of one minute, the application of alternating potential with respect to the shield/frame/primary winding of 1,480 volts RMS. This nondestructive "hi-pot" will be performed on each transformer before shipping and the data will be available upon request, to the Engineer.

4. Line Isolation Monitor ("LIM"): The isolated power system shall be provided with an integral line isolation monitor. Monitor shall be capable of detecting all combinations of capacitive and resistive faults, including balanced, unbalanced and hybrid faults. The LIM shall incorporate two channel circuitry designed to continually monitor the impedance from both lines to ground. LIMs which internally switch between either line to ground will not be accepted as equal.

a) A meter will provide continuous visual indication of the total hazard current in the monitored system. The LIM shall incorporate a momentary test switch to insure operational integrity. The LIM shall display a green safe light and red hazard light on the front panel. The unit shall be fused and the fuses will be accessible from the front panel.

b) An external set of normally open and normally closed dry contacts shall be provided on the LIM. The unit shall provide a means for audible and visual alarm when the ground connection to the unit is broken. Under any fault or system condition, the current contribution to the system by the LIM shall not exceed 25 microamperes.

c) The alarm point shall be set for a threshold value of 2 milli-amperes total hazard current under nominal line voltage conditions. The alarm band differential shall not exceed 100 microamperes at nominal line voltage.

d) The LIM shall be UL recognized under UL Subject 1022.

5. Circuit Breakers and Enclosure:

a) The isolated power panel shall include a 2-pole primary circuit breaker and 2-pole secondary circuit breakers with common trip as scheduled. Circuit breakers shall be front removable bolt-in molded case with thermal magnetic trips for 120/208 volt as indicated. Circuit breakers shall be Square D or equivalent with Sym. I.C. 10,000 amperes at 240 volt RMS. Provide full length solid copper bus with cross breaker connection and hardware for specified circuit breakers and spaces.

b) The enclosure shall be constructed of 12 gauge protected steel. The secondary compartment shall be dead front construction with barrier provided between the primary and secondary compartments.

c) The panel trim and cover shall be constructed of #304 stainless steel with matte or brushed finish. Trim shall be a hinged cover design. Access to circuit breakers shall be provided by a matching hinged door with lockable latch and clear plastic covered circuit index inside the door. Locks shall be keyed with Corbin, Yale or National lock according to Owner's specifications.

6. The isolated power panel shall be provided with an integral receptacle and ground module as detailed on the plans and with components as specified.

7. The isolated power panel shall include transfer switches to transfer the O.R. lights to the battery inversion system specified in Section 16210. Transfer switches shall be Asco #5422, 4 pole, 2 N/O, 2N/C contacts.

8. Power Receptacle and Ground Module:

a) Provide remote receptacle and ground modules as herein specified and detailed on the plans. These modules shall contain an equalizing ground bus, ground jacks and 3-wire grounding receptacles and #304 stainless steel cover and shall be suitable for flush mounting. Back box shall be protected 16 gauge steel.

1) 120 volt receptacles shall be 20 ampere, 2 pole, 3 wire, 125 volt hospital grounding type per NFPA 56A, Figure 1, Hubbell #2300HG or approved equal.

2) Grounding jacks shall be Hampden Engineering #SLR-3S. Provide for each jack a 10' - #10 stranded green grounding cord with brass terminal lug on one end and a grounding plug on the other end to match the #SLR-3S ground jack.

3) Equalizer ground bus shall interconnect the ground jacks and the power receptacle ground within the module. Provide sufficient lugs for connection of ground conductors from each device and main lug for connecting to Patient Grounding Point.

9. All isolation power panels, receptacle-ground modules, line isolation monitors shall be as manufactured by Sorgel, or approved equal and shall have U.L. label. All equipment shall be the responsibility of one manufacturer.

C. Wiring and Installation

1. All isolated power wiring to remote receptacles and permanently installed equipment shall be with low-leakage insulated wire. Wire shall be stranded copper conductor cross-link synthetic polymer with maximum dielectric constant 3.5 with 600v insulation. Cable shall be specially compounded by Okonite or General Electric. Contractor shall order cable to allow sufficient lead time for manufacturer of cable.

2. All conduit on load side or secondary side of isolation panels including grounding shall be galvanized metal conduit as specified in Article 16100-2.1. Conduit shall be sized based on maximum allowable fill capacity of 25%. In no case shall conduit be less than 3/4". All conduit bends shall be base on N.E.C. table 346-10 for conductors with lead sheath.

3. Wire pulling compounds or lubricants of all kinds for isolated circuit wiring shall be prohibited. Color coding shall be:

- a) Conductor No. 1 -- orange.
- b) Conductor No. 2 -- brown
- c) Grounding Conductor -- green

D. Performance

1. System Hazard Current: System hazard current is that current that can flow through a low impedance connected between either isolated conductor or line and ground. For the purpose of this specification the contributions of

all wiring, the "LIM" and all devices connected to the completed isolated power system are included. (Portable equipment is not included.) This measured current shall not exceed 400 microamperes.

E. Inspection and Testing:

1. The Contractor shall include the cost of, and make all arrangements for the testing of all ungrounded isolated systems by a qualified factory engineer provided by the manufacturer of the isolation systems. In addition to factory testing, the Owner will provide testing of the system by an engineer appointed by him. All testing shall be accomplished with Contractor and both testing engineers present. The Contractor and Factory Engineer shall cooperate fully with the Owner's testing engineer and shall make all adjustments and modifications prior to and subsequent to the required tests.

2. Final acceptance by the Owner and Engineer will be given after final testing, if the installation is found to comply in all respects with the specifications and plans. In the event of conflict in measurements, particularly with regard to measurements related to special requirements designed to protect the patient, the acceptance testing will be based on measurements made with instrumentation provided by the Owner's testing engineer.

3. Equipotential Grounding System will be examined by mechanical inspection and measurement of grounding impedances. Terminations requiring tightening will be indicated. An inspection is necessary to determine the grounding paths as installed and the quality of components and workmanship.

4. Measurements of impedances between each Patient Grounding Point and all exposed conducting surfaces, all grounding contacts of power and signal receptacles, and all grounded objects within ten feet of any part of the patient's location shall be performed by the current-injection method and the measurement current will be large enough to detect, by heating, broken strands in stranded number 10 wire. A current of 20 amperes shall be used as the measurement current.

5. Isolated Power System will be examined by measurement of Line Isolation Monitor alarm thresholds with both balanced and un-balanced micro and macro-faults. All alarm functions (audio and visual), local and remote will be checked. The System Hazard Current will be measured with a resistive fault, equivalent to 120mA, introduced from each side of the line to ground. Testing of grounding within the Isolated Power Center is included in Article 2.1. In addition to the resistive fault measurements, performance of the "LIM" will also be checked for 2.2 milliampere equivalent faults of the following types:

- a. Balanced resistive faults.
- b. Balanced reactive faults.
- c. Hybrid faults
- d. Balanced minus 45 degree faults
- e. Single resistive, reactive, and minus 45 degree faults.

The "LIM" must alarm reliably under all fault conditions with nominal line voltage.

6. The factory engineer shall instruct the Owner's maintenance staff in the use of the panels and ground detector as a leakage measuring device, and instruct them as to how all of their instrumentation used in electrically sensitive areas can be measured and labeled as to leakage and a periodic test made to ascertain good equipment performance.

7. After all tests have been made, Contractor shall give written certification to the Owner and the Owner's testing engineer that the system is in accordance with all codes and all good installation practices in accordance with the specifications.

8. Upon completion of all tests the factory engineer shall hold a meeting with Owner's medical and maintenance staff and thoroughly explain the operation of the equipment installed, and the need and procedure of periodically testing and logging test results. He shall furnish log books to the maintenance department, and enter the first readings of all panels in these log books and clearly instruct the hospital maintenance staff as to how future entries should be made. All questions that the hospital staff might have shall be answered completely and thoroughly at this time. Proper notification to the Owner's Engineer shall be made so that he may witness any of the tests or meetings conducted by the factory engineer.

F. Portable Ground Integrity Tester

1. Provide one portable ground integrity tester as herein specified. The ground integrity tester shall be as manufactured by Sorgel Electric Corporation, Catalog Number GIT-IIP.

2. Unit shall be capable of accurately measuring voltage potential between any two conductive surfaces, or any single conductive surface and the equalizer ground bus, in the range of 0-8 millivolts. The instrument shall be self powered and not require connection to any outside voltage source. The meter scale shall be easily read, the 0-5 millivolt range shall be color coded green, the 5-8 millivolt range shall be color coded red. The unit shall be designed to withstand accidental exposure of up to 300 V. across the probes without damage to the unit when operating in this mode.

3. Instrument shall incorporate a second testing mode for checking resistance of ground circuits. The scale for this mode shall be calibrated in ohms, the 0-0.1 ohm portion of the scale shall be colored green and that portion above 0.1 ohms shall be red.

4. Furnish minimum 10 foot calibrated test leads for resistance measurements and shielded 15 foot leads for the voltage potential difference tests.

5. The unit shall contain provisions for battery testing and pre-calibrated 3 MV and 0.1 ohms test points.

6. The enclosure containing all the electrical components shall be insulated to prevent accidental exposure of test circuit to outside voltage sources. The case is to be constructed of molded polyester material.

G. Samples: The Contractor shall submit for the approval of the Engineer, one sample of each type special assembly and two samples of the receptacles to the Engineer. Any samples required by the Engineer, if approved, may be used on the project after serving their purpose as samples.

2.3 X-RAY ISOLATED POWER SYSTEM

A. Provide an isolated power panel for portable x-ray outlet power as indicate on the plans and herein specified. Refer to Sheet E46 for layout and details of specified system.

B. The X-ray isolated power panel shall be the same as specified in Section 16600 Article 2.2 with the following exceptions.

1. Transformer shall be 15KVA with 208 volt primary and secondary windings.
2. Unit shall be provided with 90 ampere primary circuit breaker.
3. Secondary circuit breaker shall be 1-60A-2P.
4. Unit shall not include power receptacle and ground module. Refer to detail 1/E46.
5. Unit shall not include transfer switch.
6. Unit shall include "LIM" and equalizer ground bus.

C. Interlocking switching shall be incorporated in the panel to prevent more than one X-ray outlet from being energized at the same time. The ground detector shall monitor only the energized circuit. Circuit switching shall be accomplished from a remote selector push button station with pilot lights to indicate the circuit energized.

1. Provide an indicator alarm unit at each outlet location integral with the X-ray outlet. In the event of a hazardous condition, only the remote indicator alarm on the circuit being monitored shall sound the alarm. Provide the required interconnecting alarm and control wiring as required by the manufacturer.

2. Remote Selector Station shall be Sorgel #8CI-1A for control of 4 X-ray outlets complete with indicator alarm. Front cover shall be 12 ga. stainless steel.

3. X-ray receptacle and indicator modules shall be Sorgel #XR-1A with 60 ampere 240 volt X-ray receptacle and remote indicator alarm. Front trim and hinged door shall be 12 ga. stainless steel.

D. All wiring, installation, performance, inspection and testing shall be as specified in Section 16600 Article 2.2.

E. All isolation power panels, line isolation monitors, remote selector stations and X-ray receptacle modules shall be as manufactured by Sorgel or approved equal and shall have U.L. Label. All the equipment shall be the responsibility of one manufacturer.

2.4 R.F. SHIELDED ROOMS

A. General

1. Provide the materials and installation to complete the R. F. shielded room electrical work for rooms #1-214, #1-215 and #9-135 as detailed on the plans and herein specified. Refer to details 6/E58 7/E58, 8/E58 and 9/E58.
2. These rooms will be field constructed by the General Contractor with a copper screen shield covered on both sides with insulating building materials.
3. It is the intent of these specifications in conjunction with the General Contractors installations to provide an interference-free environment by reducing substantially interference levels of radio frequency with copper shielding grounded at a single point and to isolate and filter the electrical distribution service to these rooms.

B. Installation

1. The Electrical Contractor shall provide power, lighting and grounding to the shielded rooms as shown on the plans. All incoming electrical power lines shall be provided with radio frequency filters. A filter shall be provided for each electrical conductor including grounds and neutrals. The filtered conductors shall penetrate the enclosure through waveguide penetrations which are an integral part of the filter. Filters shall be designed to attenuate R.F. energy on the incoming power feeders a minimum of 100 db of insertion loss from 14 KHz to 10,000 MHz.
2. All conduit feeding the filters shall have ground insulating bushings except where conduit is P.V.C. (Filter enclosure shall be bonded to copper shield with soldered connection.)
3. In rooms 1-214 and 1-215 receptacles, lights and conduit shall be surface mounted inside the room shield supported from the insulating wall and ceiling finish with suitable hardware. In room 9-135 the electrical installations shall be outside the room shield. Lights shall be outside shield and provide light through glass and copper screen shield. Outlets and conduit shall be outside shield with copper screen access door over outlet. Access doors and light fixture shielded glass lense by General Contractor.
4. Provide a grounding conductor bonded to the copper shield at a single point as indicated on the details. Conductor shall be sized as indicated on the details and shall be connected to the instrument ground conductor in the electrical core. Conductor shall be provided with a disconnect switch located above the ceiling of the room where indicated and labeled "R.F. Room - Ground Shield" and "On-Off".
5. The Electrical Contractor shall coordinate his installation with the General Contractor. Refer to the specification Section 06100 for performance, installation and testing procedures to be accomplished under the contract. The complete electrical installation shall be isolated from the shielding except where noted otherwise.

C. Materials and Equipment

1. R.F. Filters shall be Ray Proof Class 93 or equal as scheduled. Filters shall be designed for a minimum attenuation of 100 db of insertion loss at 14KHz to 10,000 MHz.

2. Filter Schedule:

<u>Ampere Rating</u>	<u>Volts to Ground</u>	<u>Phase</u>	<u>Power Freq</u>	<u>Use</u>
40A	120V	Single	60HZ	Rooms 9-135 and 1-215 for line, neutral and ground conductors
60A	120/208V	Three	60HZ	Room 1-214 for line, neutral and ground conductors.

3. Provide panelboards as shown on Details 8/E58 and 9/E58 and constructed as specified in Section 16300 Article 2.3 panelboards.

4. Conduit, and outlet boxes shall be PVC approved for indoor surface installation with approved fittings. A ground wire shall be provided with each branch circuit installed in P.V.C. from the panelboard. Branch circuit wire shall be TW or THWN-THHN.

2.5 ELECTRONIC EQUIPMENT GROUND SYSTEM

A. General

1. Where indicated on the plans certain grounding for R.F. shielded rooms and electron microscopes, etc is established by connecting an equipment ground conductor to an electronic ground system specified herein. The electronic ground system is separate from the power distribution ground system. A ground system connection point is provided at each floor level at electrical shaft #29.

2. Refer to plans and Sheets E25, E49 and #50 for layout and components of the system.

3. The Electrical Contractor shall provide all necessary materials installation and testing of system as shown, specified and required.

B. Materials

1. Grounding cable shall be copper 28/14, 1/2" diameter rope lay 115,000 cm. Refer to Section 16610 for additional specification of cable.

2. Grounding plate buried below grade shall be copper 18" x 18" x 20 gauge with two cable clamps. Refer to Section 16610 for specification of plate.

3. Conduit shall be P.V.C. approved for indoor and underground application Carlon type 40 or equal. P.V.C. molded junction boxes shall be used for installation of ground bar and clamp at each floor level as indicated on the plans. Each junction box shall be provided with two spare 1" conduit hubs for future use.

4. Ground bar within junction box shall be copper 4" x 4" x 1/4" clamped to the copper ground conductor with 0.Z type KG, 2 piece cable to flat bar grounding connector. Drill and tap copper bar and provide standard ground lug for connection of electronic equipment grounds.

5. Provide a cable support wedge at each floor level for support of ground conductor.

C. Performance and Testing

1. Install grounding plates as indicated on the plans to obtain a ground resistance of grounding grid not to exceed 25 ohms. Electrical Contractor shall provide testing of ground grid to obtain ground resistance reading. If resistance exceeds 25 ohms provide additional grounding plates and cable paralleled with previously installed grid to obtain the specified resistance. Test shall be accomplished with normal soil moisture content to be experienced following construction and enclosure of building. University of Minnesota Electrical Construction Superintendent shall witness testing.

2. Submit 3 copies of the test report to the Engineer for approval and record.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. The Electrical Contractor shall provide and install a complete lightning protection system as shown on the drawings or specified hereinafter. The Contractor shall provide and install all air terminals, roof conductors, grounds, connectors, fasteners and any miscellaneous items required but not shown on plans or specified hereinafter.

PART 2: PRODUCTS AND INSTALLATION

2.1 INSTALLATION AND STANDARDS

A. The system shall be installed by a Lightning Protection Contractor actively engaged in the installation of Underwriter's Master Labeled Lightning Protection Systems and shall be so listed by the laboratories. He shall have a minimum of 2 years in this field. The system shall comply with all applicable requirements of the latest "Requirements for Master Labeled Lightning Protection Systems, UL96A" and the Lightning Protection Institute. Upon completion of this work the lightning protection contractor shall deliver to the Owner, for attachment to the building, a Certificate of Compliance with the Lightning Protection Institute standard. A final inspection of the system shall be made by Underwriter's Laboratories fieldmen.

B. Horizontal conductors shall be coursed in a neat and workmanlike manner around ventilators and similar obstructions in a horizontal plane and without abrupt turns. No bend in a conductor which embraces a portion of a building such as an eave, shall have a radius of less than 8 inches. The angle of any turn shall not exceed 90 degrees and conductors shall everywhere preserve a downward or horizontal course.

2.2 MATERIALS

A. Fittings and attachments shall be of bronze bolted pressure type construction. Thermoweld welding processes are not approved. All material shall be as manufactured by Thompson Lightning Protection, Inc., St. Paul, Minnesota or approved equal.

B. The steel building columns shall be used as down conductors unless shown differently on the drawings.

C. All air terminals shall be copper of a height and style shown on the drawings.

D. Conductors shall be 98% conductivity (annealed) stranded copper of at least 115,000 cir mils. The conductor used for secondary bonding and interconnecting of metallic masses (roof drains, plumbing vents, etc) shall be at least the equivalent in strength and conducting cross-sectional area of a No. 6 AWG copper wire (26,000 cir. mils), except where full-size lightning conductor is required or otherwise noted on the drawings.

E. Details of connections, methods and descriptions of materials, appear on Drawings E-24 and E44. Specific product numbers are identified below to establish sizes and quality.

1. Ground Plate - Cat. No. 233 - Pure copper, 18" x 18" x 20 gauge.
2. Cable - Cat. No. 28R - 28 strands of 14 gauge copper, 1/2" diameter, rope lay 115,000 cm.
3. Secondary cable - Cat. No. 14 - 14 strands, of 17 gauge copper, rope lay 26,000 cm.
4. Air Terminal - Cat. No. 55 - 1/2" x 12" solid copper with base adapter and nickel-plated tip.
5. Tee Splicer - Cat. No. 706 - Pressure type, bronze with brass bolts.
6. Parallel Clamp - Cat. No. 423B - adjustable bronze with brass bolts.
7. Hinged Base - No. 30 - Bronze with hinged base for perpendicular point mounting from a sloped roof.
8. Pipe Railing Point Base - No. 681 X - Heavy duty bronze with brass bolts with cable attachment.
9. Primary steel Bonding Plate - No. 586 - Bronze 4" x 4" with pressure type connector.
10. Secondary Bonding - Flat items; #702 Plate, Pipes; Pipe Clamp, U-bolt type up to 3"; strap type for larger than 3".
11. Masonry Clip - No. 174 - Copper clip with 1/4" x 1" brass screw and masonry anchor.
12. Thru roof connector, #709, 1/2" x 12" solid copper, right angle with 746M roof flashing.
13. Miscellaneous Hardware - Provide all copper or bronze hardware, washers, screws, etc. for a complete connected system as shown on plans.

2.3 GROUND CONNECTIONS

A. Provide and install the counterpoise grounding system specified hereinafter or as shown on the drawings Sheet E-24. Ground connections shall be provided at

all steel columns as shown on the drawings. Prior to connecting the ground plate at each steel column, a continuity test of the column shall be made by a comparison of ohms resistance to ground at the basement level and at the top of the structure.

B. The incoming water piping shall be connected to the counterpoise system as shown on the drawings.

C. The ground conductor (not to be confused with distribution grounding) and lightning conductor shall be bonded to the steel columns by use of steel bonding plates of at least 16 square inches, welded (continuous 1/4" round) to clean steel.

D. A continuous counterpoise conductor as shown on the drawings shall connect all ground plates or column grounding plates, (counterpoise conductor shall be installed in bottom of drain tile trench.

E. All grounding mediums shall be bonded together. This shall include electric and telephone service grounds and other metallic piping systems such as gas piping, etc.

F. Bond all roof drains, pipe vents, metal louvers and grills, etc. to the primary building steel columns or related lightning cable. Connections to roof drains shall be made below roof.

PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Contractor shall provide all equipment, materials and wiring necessary for complete installations of the systems herein specified and as shown on the plans, and in the motor schedules. Refer to Section 16900 for work not included in this section of the specifications.

PART 2: PRODUCTS AND INSTALLATION

2.1 MOTOR WIRING

A. The Contractor shall provide and install all disconnect switches, motor starters, push buttons or special starting controls unless indicated by others on the motor schedule. He shall provide and install all conduit boxes, fittings and wiring for all motors and controls (except as noted below) as shown on the plans or as required. He shall oil all motors if required before starting and verify the mechanical or equipment supplier to see that any motor he connects is running in the proper direction. Check all overloads and fuses under operating conditions to assure that they are sized for proper motor protection without nuisance tripping and replace those found inadequate or improper. All overloads shall be sized for maximum rating allowed by Code. Overloads are not required on single phase motors equipped with internal thermal protectors. The motor schedule on the plans is included for the Contractor's convenience; any motor inadvertently omitted from this list but shown on the plans shall be connected.

B. In general, equipment and control wiring shall be provided as follows.

1. All PE and EP switches, control solenoids, relays, motorized dampers, low voltage transformers for air handling equipment shall be provided and wired under Section 16900 of this specification.

2. Control wiring and electrical interlock wiring for air conditioning refrigeration equipment shall be provided by the Mechanical Contractor under Section 15900 including conduit and wire.

3. All other wiring, unless otherwise indicated, shall be provided by the Electrical Contractor. Provide wiring and connections for pressure switches, float switches, etc., as noted in the Motor schedule and required, unless otherwise indicated.

4. Electrical Contractor shall provide all power interlock wiring of controllers for Mechanical and Equipment Contractors as scheduled or required unless otherwise indicated.

5. Electrical Contractor shall provide line voltage wiring and fractional horsepower starter for cabinet horizontal unit heaters. Thermostat shall be provided under Section 16900 of the specification.

6. Electrical Contractor shall provide completely wired power outlets and disconnect switches for elevators as shown on plans. Controls and wiring will be by others. Provide conduit and wire as shown from the distribution panel or safety switch to individual motor-generator controllers.

7. Electrical Contractor shall provide power outlets, disconnects and power wiring for package units. Controllers and control wiring will be provided by the Mechanical Contractor.

C. The Mechanical and Equipment Contractors will furnish schematic wiring diagrams to the Electrical Contractor for all of their equipment that must be wired by the Electrical Contractor. Where manual-off-automatic switches are specified make connections so pneumatic switch or controlling device is in the automatic circuit only.

D. Electrical Contractor shall furnish and install fused disconnect switch sized and fused if necessary, where required by Code for each motor.

E. All fractional HP manual starters, push buttons, controllers, disconnects, and selector switches shall be labeled by Electrical Contractor with "Equipment" as shown on motor schedule with an engraved black bakelite plate fastened with Minnesota Mining permanent adhesive. Where no push button is required, furnish and install same type on label on disconnect switch or starter. All flush switches which are in public access areas (not closets or equipment rooms), shall have labels engraved directly onto the plate. Wherever the controller and disconnect are together, only one label is required.

F. Provide fuses for all disconnect switches and combination as specified in Section 16300. Provide electrical interlock disconnect devices for all switches with interlock circuits.

2.2 MOTOR CONTROLS

A. Provide magnetic starters with three overload elements, push button or selector switch and reset button as required on housing, or remote push button or selector switch and pilot light if shown for all motor controllers shown on plans and designated in the motor schedule.

1. Coil voltages shall be 120 volts as required. For 480 volt motor starters provide transformers sized for required pilot and control load. Transformer shall be sized for sufficient capacity of 5 EP switches minimum.

2. Starters for outdoor and wet locations shall be NEMA 3, raintight.

3. Provide auxiliary contacts for each starter as indicated in the motor schedule in addition to the holding contact where required. In cases where more

than 4 contacts are required, provide separate multi-pole relay in the starter or adjacent to it in a separate NEMA 1 box.

B. Provide where shown on plans fractional HP manual starting switch units complete with overload elements, neon type pilot light and number of poles as required. Equip these starters with Satin Stainless Steel plates in finished areas to match wiring device plates specified under "Wiring Devices" with engraved designations.

C. Provide all miscellaneous relays required for interlocking single phase motors and for control of such equipment as filter drive motors and electronic precipitator power. Relays shall be one, two or three pole as required rated 10 amp (15 amp for precipitators), 60 hz and in NEMA 1 enclosures.

D. All relays and pilot or control transformers shall be separately fuse protected.

E. All motor controls shall be Square D, General Electric, Westinghouse, Allen Bradley, Federal Pacific, or approved equal. Controls shall be of the same manufacturer.

2.3 MOTOR CONTROL CENTERS

A. Motor Control Centers required for control of 480 volt, 3 phase motors shall be provided under Section 16900 of this specification except as indicated in paragraph B below.

B. Existing motor control centers located in the Unit A Building that require the addition of magnetic starters and disconnect switches within existing cubicles or addition of new cubicles with new starters and disconnect extending from an existing motor control center shall be provided under this Section of the specification by the Electrical Contractor.

1. The existing motor control centers are of General Electric manufacture. All new starters, disconnects, cubicles, busing and equipment required to expand these motor control centers shall be General Electric.

2. Motor control centers shall be designed for 480 volt, 3 phase, 3 wire combination motor starters detailed and scheduled on the plans. The control centers shall be totally enclosed, dead front, free standing, 90" high constructed of code gauge steel with structures bolted together to form one assembly. Units shall be finished with baked gray enamel. Buses may be copper or tin plated aluminum.

a. The combination fused switch and magnetic starter units shall be hinged door type.

b. The fused switches shall be quick-make, quick-break, handle operated. Switches for all starters with interlock control circuits shall be provided with integral electrical disconnect.

c. Magnetic starters shall be across-the-line, full voltage type with controls as indicated on the schedule.

d. Horizontal and vertical bus shall be of copper or aluminum construction with horizontal bus rating as shown on plans.

e. Motor control centers shall be front mounted only, NEMA Class I, Type B.

f. Provide fuses for each starter switch as specified in Section 16300. Provide 3 spare fuses for each size of motor nameplate rating in each motor control center.

g. Each combination starter unit shall be stab connected to the buses, except bolt-in above 400 amp. All combination starters shall have numbered unit pre-wired terminal boards. Provide same type disconnect switch only where indicated.

3. Combination starters shall be equipped with reset buttons, selector switch or push buttons and pilots as indicated on the drawings.

a. Each starter shall have three overload protectors. These shall be individually supplied for the exact motor that each is intended to protect as verified by the nameplate at the job which may not necessarily agree with the size indicated in the motor schedule. Size all overloads for the largest maximum size permitted by the NEC.

b. Starters shall have at least two auxiliary contacts plus a holding coil contact. Provide extra contacts where indicated; where more than 4 contacts are required, provide a separate multi-pole relay in the starter or in an adjacent unit.

c. Provide a transformer for each starter pre-wired into the circuits for reduction of 480 volts to 120 volts as required for pilot and control duty. Transformers shall be fuse protected and shall be connected to the load side of the disconnect switch. Transformer shall be sized for sufficient capacity of 5 EP switches minimum.

d. Starters for cooling tower fans shall be 2 speed, variable torque, single winding type.

4. Provide permanent labels on the front of each combination starter or disconnect to identify the equipment controlled. Label shall be engraved black-white-black bakelite fastened with permanent bonding adhesive.

5. All motor control centers shall be structured with buses supported to withstand 40,000 amperes RMS symmetrical for short circuit conditions.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. Contractor shall provide all equipment, material and wiring necessary for complete installation of the systems herein specified and as shown on the plans. The complete installation and equipment shall conform to 1975 National Electrical Code and as herein specified. The Electrical Contractor shall follow all supplier recommendations.

PART 2: PRODUCTS AND INSTALLATION

2.1 SNOW MELTING SYSTEMA. INSTALLATION

1. Mats are to be sized and installed as shown on the plans. The Electrical Contractor shall verify all final dimensions. Mats must not cross expansion fittings or control joints (dummy grooves). The Electrical Contractor shall make sure that other trades do not damage the mats while in the installation or concrete pour process. The concrete pour operation is to result in a monolithic slab. Allow 2 to 4 inches on each side of mat for clearance. Allow approximately 4" between adjacent mats at expansion joints. All mats are to have a maximum concrete cover of 2" and a minimum of 1-1/2". Refer to Drawing Sheet E-10.

2. Provide all power and wiring to branch circuit panelboard and all control wiring as shown on the plans and required for automatic or manual override operation of the system. Conduit shall be sealed with non-hardening duct seal after cables are installed.

3. To assure a satisfactory installation, the following procedures shall be followed for each major area of the plaza and steps.

a) Mats shall be tested first for continuity with an ohmmeter.

b) Before concrete or bituminous is poured, units shall be laid in place and hooked up. Preliminary connections are made, tested, and the units are then put aside out of the way.

c) Concrete is a single pour. Concrete is poured and roughed off at approximately 2" below the planned finish surface. Units are then immediately repositioned while the concrete is still soft, and finish layer is poured over the units.

d) Bituminous surfaces are poured within 3/4" of top of bituminous. Mats shall be installed between base and top courses. Bituminous binder coat shall be installed on both the base coarse under the mat and over the mat before laying the final top coarse. 2-1/4" thick brick pavers will be set on topcoat.

e) A complete test for continuity is repeated and final electrical connections are made to the power source.

B. SNOW MELTING MATS

1. Snow melting mats shall be designed for 277 volts and shall dissipate 60 watts per square foot as indicated in schedule on the plans.

2. Heating mats shall consist of an insulated resistance wire, spaced on a predetermined pattern and bonded to form a mat. The heating cable shall be a resistance wire core insulated with .032" of 90° C. thermoplastic compound with a nylon jacket. A No. 18 A.W.G. copper mesh shall be braided over the nylon jacket to provide a means for grounding the heater. An additional jacket of .020" polyvinyl chloride insulation shall be extruded over the copper braid. The heating cables shall be complete with ten feet of cold lead at each end as standard. Heater wire and cold lead must be factory assembled with a waterproof molded splice connection. The cold leads shall be a stranded copper conductor insulated with .032" P.V.C. and nylon jacket. A No. 16 A.W.G. copper mesh shall be braided over the nylon jacket to provide a means for grounding the heater and an additional PVC jacket shall be extruded over the braid. The cold lead shall be #12TW as determined by maximum allowable amperage. Cold leads, mat size and mat wattage shall be as indicated in the schedule and shown on the plans.

3. Mats shall be Easy Heat Type "H" Series, Chromalox, Smith-Gates or approved equal.

4. The complete unit shall conform to standards specified by Underwriters' Laboratories. Installation is to be in accordance with manufacturer's recommendations as listed by Underwriters' Laboratories.

C. CONTROL SYSTEM

1. A temperature-moisture sensing detector device shall be located as shown on the plans. The heating mat for the concrete pad will be located beneath the detector with the detector pad sensors (one heated moisture probe, one unheated moisture probe and one temperature probe) located as shown.

2. The detector shall be connected by low voltage control wires to an automatic solid state control device and located on Floor 1 Room 101 as shown on the plans. Circuitry within the control device shall be such that snow or freezing rain will energize mat heating system, de-energize the mat heating system and automatically cycle the heating system on and off as determined by weather conditions and pre-determined settings of moisture sensitivity and temperature within the control device.

3. The detector probes shall be designed and finished to withstand exposure to outdoor conditions and pedestrian traffic.

4. The output shall be a single pole double throw relay to pick up contactors whose in rush currents do not exceed 5 amperes at 120 volts. Provide a separate pilot relay if required to meet this minimum condition. Provide a SP3T switch (on-off-auto) for control of the panelboard contactor. Provide wiring between devices per manufacturer's recommendations.

5. The Snow-Ice Detector automatic control device and detector shall be Easy Heat #SI-120U with control leads of sufficient length to run from detector to control unit in Room BI-101. The power sensing relay shall be an Easy Heat #PS-22-1C. Control cables shall be two 4 conductor cables, Easy Heat #S I-W.

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PART 1: GENERAL

1.1 SCOPE

A. Conditions of Contract, Division 1 General Requirements and Section 16010 General Provisions - Electrical apply to all work of this section. Refer to Article 12 of the Instructions to Bidders, Article 7 of the General Conditions and Section 01010 - Summary of Work and Special Requirements for requirements on pre-bid and post-bid evaluation of proposed substitute products, methods and other conditions.

B. The fire management (FM) and environmental control system (ECS) shall include the following:

1. Central Control Station
2. Fire Alarm System
3. Security System
4. Voice Alarm and Voice Communication System
5. Elevator Control System
6. Automatic Smoke Control System
7. Automatic Temperature Control System
8. Motor Control Centers

C. All electrical installation work and wiring associated with the FM and ECS shall be performed by the electrical contractor under the supervision of the FM and ECS supplier. Installation shall be in accordance with the plans and specifications and the FM and ECS installation drawings. All wiring shall be in conduit and in accordance with the appropriate sections of the National Electrical Code and applicable state and local codes.

D. It shall be the responsibility of the FM and ECS supplier to provide supervision as required for proper system installation and to totally check the system for proper operation.

E. All pneumatic control installation work associated with the FM and ECS system will be provided by the FM and ECS supplier.

F. The following work is not part of this section of the specification and will be performed by the mechanical contractor under Section 15950 with supervision by the FM and ECS supplier:

1. Confirm control damper sizes to FM and ECS supplier before fabrication.
2. Receive automatic control dampers at jobsite and perform installation of automatic control dampers.
3. Furnishing and mounting of damper blank-off plates.

4. Installation of immersion wells and pressure tapping.
5. Installation of water flow switches.
6. Receive automatic control valves at job site and perform installation of automatic control valves.
7. Installation of liquid level switches.
8. Installation of pressure tapping and associated shut-off cocks.
9. Installation of orifice plates and companion flanges.

G. The FM and ECS supplier shall submit 2 copies of reproducible engineering installation drawings of the completely integrated Fire Management and Environmental Control System prior to installation or fabrication of any equipment. All drawings shall be prepared by the supplier of the FM and ECS. Approval of the engineer shall be obtained before proceeding with fabrication or installation of any equipment.

H. Other contractors requiring sizing and location information on automatic control valves, automatic control dampers, immersion wells and other items shall request this information through the electrical contractor. The FM and ECS supplier shall transmit the requested information to the Electrical Contractor.

I. The Fire Management and Environmental Control System specified herein and shown on the drawings is based on Honeywell Inc. Conduit and wiring layouts are not shown on the plans, however, all conduit and wire required for the FM system shall be provided by the Electrical Contractor as directed by FM and ECS supplier. The FM and ECS supplier shall provide to the Electric Contractor complete conduit and wiring details and diagram for his system prior to bidding. Refer to typical wiring diagram on Sheet E61 for general wiring information. The Owner will not be responsible for any additional conduit and wiring requirements required as a result of variations in manufacturer's systems. Johnson Service Company and Powers Regulator Company shall also be approved utilizing the equipment approvals hereinafter specified.

J. It is the intent of these specifications to define a single integrated system that will have the capability of monitoring and controlling all fire alarm and fire management systems. The system must be U.L. listed for NFPA 72A and meet code requirements for the application intended.

K. The system shall have been tested, and listed by Underwriters Laboratories Inc. (UL) for use in Fire Protective Signaling Systems for the application intended. The system shall be supplied with all hardware and installed as to comply with all requirements of NFPA 72A Standards for Local Protective Signaling Systems. The system shall meet NFPA 72A signaling systems requirements.

L. The FM and ECS supplier shall provide to the Owner as a part of this contract assistance in developing the required pre-recorded tape messages for the voice alarm and voice communication systems. This assistance shall include developing the dialog, obtaining code authority approval of the dialog and prerecording tape.

1.2 GUARANTEE

A. The entire fire management and environmental control system installation shall carry a one-year guarantee after acceptance of the system by the Owner. Acceptance is defined as the date upon which the Owner and engineer have granted approval of system installation.

1. FM and ECS supplier shall guarantee all devices against defects in material or workmanship and shall guarantee all installation, material and labor provided under this section of work by the allied trades.

2. Electrical contractor shall guarantee all conduit, wire and electrical installation labor.

PART 2: PRODUCTS AND INSTALLATION

2.1 CENTRAL CONTROL STATION

A. General

1. The Central Control Station (CCS) will be located at the Third floor in Room 75 with equipment arrangement as detailed on plans. All CCS equipment will be located within the room and arranged for easy accessibility for testing and servicing. The CCS shall fit the space allotted and indicated on the plans. Emergency generator power will be provided under Section 16210.

2. The Central Control Station (CCS) specified under this section shall be totally solid state using computer oriented digital technology to insure reliability. The system must be a standard with the manufacturer to insure on-going parts availability and trained technical support. The initial installation must include all pushbuttons, indicators, switches pilot indicators, digital and analog value displays, transmission line interface equipment and software, etc., to make up a completely operable system. The initial installation shall have the capacity to handle the points specified in the input/output schedule plus 25% additional. CCS must be designed in a modular fashion to provide future expansion capability without obsoleting any equipment whether it be additional remote data panels (RDP's) or central console function and memory capability. All switching functions for both analog and digital data transmission shall be solid-state electronics. Reed relays and similar devices are not acceptable.

B. CCS Capabilities

1. Operator's Terminals:

a. The Operator's Terminals (OPT) are the main man-machine interface and shall be designed for ease of system operation and understanding. The terminals shall have point address selection buttons, a series of function buttons (labeled in English), a key-operated lock-out capability, and a digital readout display as described herein. The Operator's Terminals shall be designed for desk top operation.

b. The OPT's shall be supplied with digital indicators and light emitting diodes. Systems using incandescent lights for pilot lamp or back-lighted digital displays shall have supervised filaments with discrete alarm point assignment.

c. Two Operator's Terminals shall be provided and they shall be identical and as specified herein.

1) Operator's Terminal No. 1 (OPT 1) is located in Room 3-75 and performs all the Fire Management functions including the locking and unlocking of stairwell doors as described herein.

2) Operator's Terminal No. 2 (OPT 2) is to be located at the University Police Station and is intended for security applications. OPT 2 is connected to the Central Processing Unit located in Room 3-75 of Unit BC by redundant telephone line connections. Operation between OPT 2 and the common CPU shall be Class A operation. Both telephone lines shall be continuously supervised and upon occurrence of trouble the system shall automatically switch to the other telephone line and continue to operate without any operator intervention. A fault in the primary telephone line connection, e.g., a short open or cross, will result in the automatic switching operation described. Telephone lines are half duplex voice Grade 3002 communication lines provided by the Owner. OPT 2 shall monitor and control all security functions for individual security control of each stairwell door of Unit BC equipped with an electric lock as indicated on the floor plans through the common CPU and door control hardware. Intrusion door hinges are not provided in the Contract and will be provided in the future by the Owner. OPT 2 shall be provided with a 60-hour standby power supply. Upon loss of commercial power the system shall automatically transfer to standby operation without any operator intervention, interruption of system operation, or loss of data.

2. System Entry (Touch Dial):

a. Serial entry touch dial selection buttons shall be supplied with the system and shall be used for: access to remote control and data points, adding, deleting or resetting of alarm limits in memory; resetting program start-stop times; and adding or deleting start-stop program channels. Serial entry selection buttons shall be provided so that future expansion will not require additional buttons to be mounted on the control console.

3. Function Button Control:

a. Clearly identified labeled in English individual function buttons shall be provided to make the system easier to operate and more easily understood.

b. The system shall contain the following detailed function control buttons:

Secure/Off	Increase/Open
Access/On	Decrease/Close
Reset/Auto	Intercom Off
Alarm/Acknowledge	Alarm Summary
Intercom On	Data Display
Lamp Test	Graphics-On
Display-Time	Graphics-Off

c. Systems that require the operator to type out an instruction, for example (ALA SUM) on a typewriter type keyboard as a standard item shall include appropriate interface to perform the above specified single-entry capability.

d. The system shall display real clock time in 24-hour format when the display is not being used for other purposes. The time shall be resettable by simple keyboard entry.

4. Start-Stop Control, Two- and Three-Mode:

a. Two- and three-mode control capability shall be provided for remote control of motor loads or change-over functions. Motor starter controls will be momentary or maintained contact as indicated in the motor control schedules. Selection of a specific control point shall cause the display of the address and the current operating status.

b. The CPU shall automatically lock out alarms for a period of time after an automatic or manual start command has been issued to a remote piece of equipment. The time delay shall eliminate false alarming of equipment and allow for the transfer of differential pressure or flow switches.

5. Secure-Access Control:

a. The CCS shall be furnished with the ability to perform secure-access switching of remote security alarm systems. Intrusion while in the secure mode shall report as an alarm. Intrusion hinges are not provided in the Contract but shall be provided in the future by the Owner to provide for intrusion detection during the secure mode. Line supervision utilizing end of line resistors and current measurement shall be provided for each secure-access point as described herein. Intrusion occurring during access mode shall not be reported. A printer will record time and date of switching from secure to access and access to secure and alarm.

6. Test-Reset Control:

a. The CCS shall be capable of performing test-reset functions of remote fire and security systems. On performing the test, the system shall report the test, the type of system (fire or security) and the completion of the test.

7. Digital Setpoint Adjustment (CPA) and Damper Position Adjustment (DPA):

a. The system shall have the capability of digitally resetting the control point of remote controllers or dampers and other operators from the central console. It shall be capable of resetting and reading the control position with positive feedback of the new position. The reset position shall be displayed in a digital form in the readout window.

8. Alarm Capability:

a. The CCS shall have the capability to continuously monitor analog and digital alarm conditions. Analog capability will be utilized as a fire management function to allow for temperature detection at each fire area as future requirements dictate. Upon alarm condition the system will immediately and automatically sound the audible alarm, show the point identification number in alarm and also the engineering unit associated with that specific alarm.

The capability to print whether an analog alarm value is high or low shall also be included. Systems that require any operator intervention to obtain any or all information shall not be acceptable.

b. The digital display shall flash as long as the point is selected and still in alarm condition. The audible alarm will sound until the acknowledge button has been depressed. At the same time the point is being digitalized on the readout window, the printer shall print the alarm information in red. All alarms shall be recognized and recorded on a change-of-state basis.

c. The digital display shall again energize and show point number I.D., point type and "return to normal" condition whenever a fire or security point has gone from "Alarm to Normal" condition.

d. The CCS shall have the capability of setting individual alarm limits for each analog input point resettable from the Operators Terminal (OPT). Authorized console operators shall have the capability of assigning or changing alarm limits at any time without interrupting system operations. It shall also be possible to read back assigned high and low alarm limits at any time. The system shall also have the capability to assign analog lockout on a point by point basis. The lockout of an analog point shall be assignable to any analog point within the RDP. Analog lockout is required to prevent false alarm conditions.

9. Audible Alarm:

a. The system shall contain a solid-state audible alarm which shall be initiated with every new alarm indication. Each new contact or analog alarm shall resound the audible alarm which shall be silenced by the manual alarm acknowledge button on the central control console. The audible alarm shall not sound on the return to normal for mechanical system type alarms but must sound on return to normal of fire and security alarms.

10. Pilot Light Test:

a. The OPT shall be furnished with a single pushbutton which shall light all pilot indicators or light emitting diodes (LED's) when operated.

C. CCS Operator Access Levels

1. The CCS shall be supplied with at least three locking levels for operator access.

2. With level one locked the CCS shall receive and record alarms and automatically acute programmed equipment operation but the point selection, alarm acknowledgment, and all function buttons shall be inoperative. With level one unlocked all point selection and function buttons shall be operative to perform normal system operation.

3. Level two shall lock/unlock the programming of analog alarm limit and automatic time programs. By this level the operator can assign new analog alarm limits and reprogram start/stop times. With this level disabled the system will automatically compare limits and operate equipment at its programmed time.

4. Level three allows for the addition and deletion of system input/output points and control of display and printout assignments. Systems that require writing a new program for addition or deletion of points will not be acceptable.

D. PROGRAMS

1. The system shall have the capability of initiating commands (start/stop, secure/access, day/nite, etc.) to system points on a pre-set time schedule. Capacity for up to 30 seven-day time programs shall be provided. Separate start and stop times for each day of the week shall be provided with provision for a holiday schedule program. It shall be possible to set the holiday schedule seven days in advance of the holiday and the program shall automatically revert to the regular time schedule after the holiday program is executed. The holiday schedule shall be capable of handling any holiday period from one to four days.

2. Event Initiated Programs:

a. The system shall have the capability of automatically initiating commands upon an alarm occurrence. Any analog or digital point may be assigned as an event initiator. A change of status at the alarm initiator shall cause a pre-defined series of commands called an event program, to occur. A total of up to 200 separate event programs shall be provided with the capability of handling up to 24 points per program.

3. Analog Limits:

a. It shall be possible to assign limit values to analog inputs on a per point basis. Both high and low limit values per point shall be possible. In addition it shall be possible to automatically lock out analogs on a per point basis when the associated primary equipment is shut down.

E. Peripherals

1. Alarm, Status and Logging Printer:

a. A printer shall be supplied with the CCS to provide a hard copy printout of alarm records and logging functions. Change of state information including new alarms, restoration of alarms and alarm acknowledgments shall be printed along with demand logs such as all points, status summary, and alarm summary. All alarms and switching from secure to access shall be printed in red, all other conditions shall be printed in black.

2. Selectographic Projectors:

a. The CCS shall include two desk top 100 frame random access 35mm slide projector modules. (200 slides total)

b. Module 1 shall display multicolored schematic diagrams, floor layouts, location of FM & ECS detectors, sensors alarm points, etc.

c. Module 2 shall simultaneously display operator instructions and operating procedures and shall operate automatically in unison with module 1.

d. Quantity of graphic slides required is to be determined by the system input/output schedule. It shall be possible to manually index a

directory slide which lists all slides and their contents used in the system, as well as any slide covering any remote system.

F. Remote Data Panels

1. Remote data panels (RDP's) for collection of input data shall be furnished as required to meet system requirements and to minimize the length of wiring runs from sensors and actuators. RDP's must be able to handle start/stop commands, control point adjustments, damper positioning, digital alarm and status inputs and any intermix of analog inputs such as temperature, humidity, pressure and other industrial type millivolt inputs.

2. All analog signals entering the RDP shall be converted to error free digital signals for transmission to the central processor unit (CPU). Transmission from RDP to the CPU shall not be limited to hardwire only, but shall be capable of transmission via commercially available voice grade telephone circuits. All analog valve signals from the analog sensor to the RDP's shall not be transmitted in analog form for more than 100 feet before being converted to digital form. All digital signals entering the RDP's for fire and security shall have line monitoring for current deviation provided by end of line resistors.

3. The input/output (I/O) summary shown on the plans specifies the required data inputs and central functions for this CCS.

4. Any ventilation fans used to keep electronics within safe operating temperature shall be monitored for status and alarm.

5. RDP's shall be located where shown on the plans to minimize present and future wiring requirements.

G. Data Transmission System

1. All data transmitted between the CCS, central processing unit (CPU) and the remote data panels must be transmitted in digital form. Individual data bits are to be grouped into word format and transmitted as coded messages. A double transmission, echo transmission, or multiparity bit technique must be used to insure message integrity. Transmission system failure must be annunciated immediately as a "No Response" with display and/or printout of time and address of the data group failing to respond.

2. In addition to the one prime transmission cable, a secondary common transmission cable of the same type as the first shall be installed parallel to the first in a different riser as shown on the plans. In the event of an open circuit, ground fault or short circuit of the prime transmission cable all transmission signals between the floor panels and the central control shall be automatically switched over to the secondary transmission cable. A signal shall be annunciated at the central control station indicating that a fault has occurred on the prime transmission cable and that the transmission is being conducted over the secondary transmission cable. Both the prime and secondary transmission cable shall be continuously monitored. Trouble of either cable shall automatically be annunciated at the CCS indicating which cable has failed.

H. Digital Sensors

1. The RDP's shall be designed to accept digital inputs from devices with isolated, dry type contacts (no grounds or no voltage) of either the normally open (N.O.) or normally closed (N.C.) configuration.

I. Proof Of Equipment Operation

1. Differential pressure or air flow switches shall be provided to prove fan operation. Positive operating status and alarm condition shall be proven for all 1-hp fans and larger. Fractional hp fans may use auxiliary contacts for proof of system operation.

2. The system shall have the capability of not only alarming abnormal OFF conditions of fans, but shall also indicate abnormal ON conditions of the same equipment. If a start command has not been issued from the central console and a piece of equipment is turned on, the central processor will alarm an abnormal ON. This abnormal ON shall also sound the audible alarm and display the alarm ON condition.

2.2 FIRE ALARM SYSTEM DESCRIPTION

A. General

1. Central Control Station shall provide the functional capability for alarm monitoring, sprinkler system supervision, remote test-reset and operation, logging of the fire alarm system or systems specified and indicated in the input/output schedule on the plans.

2. The alarm monitoring function shall provide discrete identification of alarm type, condition and point location of sprinkler system alarm and supervisory devices. Sprinkler flow alarm signal and valve supervision trouble signal will be provided for each valve.

3. The remote test and reset function shall provide discrete identification of test and reset operations that are performed on equipment or systems remote from the central console.

4. The command function capabilities of the fire alarm system shall allow the central panel operator to selectively obtain a printed record in a log format of the condition of all fire alarm and sprinkler supervisory points.

5. The central console shall be capable of monitoring remote fire alarm panels and fire alarm zones for both alarm and trouble conditions. Individual points representing alarm zones shall, on an alarm condition, sound an alarm tone, flash the point address and engineering unit on the readout display and print the information in red on the alarm printer. Upon alarm acknowledgment a printout shall verify operator action. After restoration, a printout in black occurs on the alarm printer. Line supervision utilizing end of line resistors for monitoring current deviation shall be provided for both alarm and trouble conditions for each zone on remote panels since the CCS shall initiate automatic fire sequences.

6. The central console shall monitor sprinkler alarm and supervisory devices. On an alarm condition the alarm tone sounds, the point address and

engineering unit appear in the readout display and a printout in red occurs on the alarm printer. A printout shall also verify acknowledgment of alarm. Upon restoration of the alarm point, a printout in black occurs on the alarm printer.

7. Equipment shall be as manufactured by Honeywell Inc. Standard, Autocall and Pyrotronics equipment shall also be approved.

B. Code Approvals

1. It is the intent of this specification to describe a local fire alarm signaling system in full compliance with NFPA Pamphlet 72A for local protection signaling systems and U.L. listed for this application.

2. Sections of this specification will describe in detail certain operating functions of the system, however, omission of specific descriptions of portions of Pamphlet 72A shall not be construed as relieving the subcontractors under this section for work from complying with all of the requirements of Pamphlet 72A, as well as any local conditions which may be imposed upon such systems by local authority.

3. All fire and sprinkler supervisory transmitting devices, central processing unit and RDP's utilized to perform the following specific requirements shall have UL listing for the type of service performed.

C. System Requirements

1. Proof of Central Processor Operation - Central processor provided must incorporate circuitry which continuously monitors the scanning and data processing cycles. On central processor failure, an audible/visual signal shall operate if scanning fails or if incoming data is not processed. A means for testing the central processor failure circuitry shall be provided to prove operation.

2. Central Processor Power Supply and Fuse Supervision - If one or more voltages are lost due to power failure or a blown fuse, an audible signal shall sound. Standby power shall be provided for this supervisory unit to permit operation on power failure.

3. Event Commands - System shall have capability of providing an automatic output (contact closure) as THE RESULT OF AN ALARM INPUT. This capability shall provide the means to automatically initiate voice evacuation signals, trip auxiliary protective signaling devices, trip remote station protective signaling devices, control mechanical and/or electrical equipment such as elevators, HVAC systems, exhaust or supply fans, smoke control dampers, smoke and fire door holders, and provide remote pilot light annunciation.

4. Day-of-the-Year Printout - The time of day and day of the year shall be printed each hour. Any printer activity shall include the time of day.

5. Alarm Display and Annunciation - All Protection System alarm signals shall provide audible signal, nixie tube or dot matrix display of the alarm point and type of alarm, as well as a printed record for alarm acknowledge and return to normal changes of state.

6. Fault Detection and Isolation - A fault detector shall be provided to automatically condition the circuit when a fault occurs so that the data transmission continues on an uninterrupted basis. Both audible and visual annunciation of a fault condition shall be provided. A printed record shall be provided to show the remote signal encoding devices affected by the fault.

7. Standby Power - Power for the system furnished under this contract shall be supplied from two sources: a primary (main) power supply, and secondary (standby) supply. The primary and secondary power sources shall supply the central processor and all remote data panels. To provide this reliable source of standby power for the system, an uninterruptible power supply consisting of batteries and battery charger shall be furnished as part of this Contract to supply 24 hours of standby power. The CCS shall automatically switch to standby power and continue to operate in a normal manner without any operator action or start-up routine. Systems that require operator action or start up shall not be acceptable.

D. Remote Annunciation

1. Provide remote visual and audible annunciation for alarm, trouble and supervision alarm as herein specified and shown on the plans for the following locations:

- a) Mayo Information Desk (MID). Refer to Sheet E6.
- b) Unit A Data Center (ADC) Room B113. Refer to Sheet E23.

2. Provide all conduit and interconnect wiring between these locations to Unit B/C Central Control Station Room 3-75.

3. Annunciator shall be solid-state, modular design with zone indicating pilot lamps, internal audible buzzer and pushbutton silencing switch. Alarm pilots shall be red and trouble and supervisory pilot shall be amber. Unit shall be suitable for flush mounting.

4. Annunciators shall include the following:

a) MID Annunciator:

- 1 zone indication - Building B/C Fire Alarm
- 4 zone indications - Future
- 1 buzzer
- 1 pushbutton silencing switch

b) ADC Annunciator:

- 1 zone indication - Building B/C Fire Alarm
- 1 zone indication - Building B/C Fire Alarm Supervisory
- 1 zone indication - Building B/C Fire Alarm trouble

2 zone indications - Future

1 buzzer

1 pushbutton silencing switch

5. Power for annunciator shall be taken from the fire alarm control equipment.

E. Equipment

1. Manual Stations

a. The manual fire alarm stations shall be Honeywell S464 break glass type. Manual stations shall be operated by pulling down on the lever. The lever shall remain down with the alarm contacts closed until the station is reset.

b. The manual station shall be reset by opening the front, resetting the switch and replacing the glass rod. A spare glass rod shall be furnished for each station. Stations that require a special key to open and/or reset the station shall not be acceptable.

c. Stations shall be semi-flush mounted in finished areas and surface mounted in unfinished areas as shown on drawings. Provide surface mounted back box painted red for each surface mounted station.

2. Smoke Detectors

a. Ceiling mounted detectors shall be of the dual chamber low voltage ionization type. Each detector shall contain an integral visual alarm indicator with provision for connecting a remote alarm lamp if required in the installation. Both surface and recessed mounting models shall be provided and the proper quantity of each type shall be furnished as required or designated on the plans. The detectors shall mount in a plug-in base containing all terminals for field wiring connections, to allow all wiring to be completed, checked-out, and tested, prior to installation of the detectors. TC 100A

b. Duct mounted detectors shall be of the dual chamber ionization type. They shall be designed for use in air streams with an appropriate enclosure, and sampling tubes to assure cross-sectional sampling of the air stream within the duct. The duct detectors shall be completely self-contained, including power supply, isolated alarm and trouble contact outputs, power, and alarm indicating lamps, key-operated reset switch, and test connection for portable test equipment. TC 100A PM

c. Detectors shall have been tested for performance and stability in accordance with Underwriters' Laboratories Standard 167 and both ceiling and duct mounted detectors shall be U.L. listed. In addition, the detectors shall have a minimum calculated MTBF of 100,000 hours. The MTBF calculations shall be based on guidelines of MIL Standard Handbook 217A, using Military Ground Equipment Factors. The calculations shall conform to accepted methods of reliability prediction and if any assumptions have been made, such assumptions shall be clearly stated. Reference documents, if used, shall be provided for review.

d. Both ceiling and duct mounted detectors shall be of the type that portable test equipment designed for the purpose can be used to perform complete electrical measurements of the circuit voltage, sensitivity, etc., with the detectors installed in the system at the location of each detector.

e. The ceiling and duct mounted detectors and control units for the fire detection and alarm system shall be of the same manufacture.

f. The detector manufacturer shall have a nation-wide engineering-service organization with local offices capable of providing service on a 24-hour basis by trained engineers or technicians. The system installation shall be installed by, or under, the direct supervision of the manufacturers' personnel who shall perform the system check-out and testing and certify the installation. Each detector shall be field tested after installation is complete.

2.3 SECURITY ALARM SYSTEM

A. General

1. The CCS shall provide the functional capability for a security alarm monitoring, remote test and reset, access and secure switching and operation logging of a security alarm system as specified.

B. Equipment

1. Electric Door Locks:

a. Door locks will be provided and installed in doors and frames by the General Contractor and electrical wiring and final connections shall be provided under this section. Door locks will be provided for doors to stairways and as designated on the plans. Door hinges will be provided by the Owner as a future installation.

C. Operation

1. Manual selection override and automatic seven day programming for secure-access and/or test and reset of the various zones of the systems shall be provided.

2. The control console shall have the capability of testing and resetting each remote security system.

3. The command function capabilities of the security alarm system shall allow the central panel operator to selectively obtain a printed record in a log format of the condition of all security alarm points.

4. Mode 1 - Secure/Access switching of remote security systems shall be performed at the central consoles.

5. Mode 2 - Secure/Access switching shall be performed by the central processor automatically from a seven day time program with provisions for allowing the operator to manually override from the central Secure/Access Operation.

a. When a remote system is switched to "secure" there shall be an audible indication and a printout in black of the condition at the central consoles.

b. When a remote system is switched to "access" there shall be an audible alarm, a visual indication and a printout in red of that condition at the central consoles. Activation of that zones security sensor will not be indicated at the CCS.

c. When an alarm condition occurs in the protected area there shall be an audible alarm, visual indication, and a distinctive printout of the time and point address with the intrusion alarm condition printed in red.

d. The central panel operator shall silence audible alarms by depressing an acknowledge button on the operator's consoles. Subsequent alarms shall reactivate this audible alarm.

e. When the alarm condition is reset to normal, the printer shall note this action by printout of the time, point address and return to normal condition, printed out in black.

2.4 VOICE ALARM AND VOICE COMMUNICATION SYSTEM

A. General

1. It is the intent of this specification to provide for a supervised emergency evacuation system as specified herein and shown on the plans and drawings. The work includes furnishing all equipment, wiring and labor to meet the requirements of the specifications. The sound equipment racks located at the Central Control Station Room 3-75 shall contain all central sound equipment for the system hereinafter specified.

B. Function

1. Base system: The base system shall provide for speaker coverage of the zones as shown on the plans, shall interface with the alarm systems and shall provide the following functions:

a) Provide pre-recorded messages for automatic transmittal of evacuation instructions.

2. The system shall interface with the fire alarm system and upon initiation of an alarm by any of the fire alarm system devices or sprinkler system devices shall cause a pre-alert signal to be sounded over the speakers in all zones simultaneously. After six seconds the pre-alert signal shall silence automatically and the zones shall be automatically programmed to receive the pre-recorded messages in the following order:

- a. Message 1 - Zone where emergency exists
- b. Message 2 - Zone immediately above #1
- c. Message 3 - Zone immediately below #1
- d. Message 4 - Elevator cars

- e. Surgery
- f. All other floors
- g. To be selected
- h. To be selected

3. When the taped message is completed the tape shall automatically re-wind and be available for the next alarm. Should the tape be in a playback condition and channeled to a given zone, no other zone shall be connected into it until the tape is ready for the play mode. Failure of the tapedeck to start within six seconds shall cause an audible and visual trouble signal to annunciate to alert the control console operator that messages must be sent manually.

4. The selective announcing to zones shall be accomplished by selecting the zone to be paged to manually at the central control console. It shall be possible to select any one or combination of zones and give oral instructions from the control console handset.

5. The system shall consist of separate electronic equipment for the all-call and selective page channels.

6. The pre-alert tone generator shall be electrically supervised and a spare unit shall be automatically switched into the system upon main unit failure. The preamplifiers and power amplifiers shall be electrically supervised and spare power amplifiers shall be automatically switched into the system upon main unit failure.

7. The wiring to all of the zone speakers shall be electrically supervised and shall report any failure due to shorts, grounds and/or opens both visually and audible at the control console location. Each zone shall be supervised independently. Any failure of equipment, pre-alert tone generators or zone wiring shall annunciate at the control console location both visually and audibly with the visual indication showing where the problem is that initiated the failure alarm. Visual indication shall be via light emitting diodes to assure longevity of life. The visual indicator shall remain lit until the problem has been corrected. The audible alarm may be silenced, but silencing same shall cause an alarm silenced pilot light to illuminate and remain illuminated until the audible alarm has been restored to normal operation.

8. The supervision generating equipment shall be provided in redundancy with automatic switch-over to a spare unit in case of main unit failure.

9. Supervision of Loudspeakers.

a. Provide for electrical supervision of the loudspeakers in addition to the wiring in the zones.

b. Removal of a speaker, damage to a speaker or non-operation of a speaker shall cause an audible and visual annunciator to activate at the control console location.

10. A monitor speaker shall be provided to permit selective monitoring of the output channels at the control console location. The system shall also

provide for zone-to-control console and/or zone-to-zone communication via an electrically supervised common talk/listen communication system. A zone station shall be provided in each location shown on the plans and shall function as follows: The zone station shall consist of a handset jack receptacle with automatic annunciation back to the control center, and a local page switch. A telephone type network shall be wired into the box on the jack side of the common talk line for proper line matching and loading. All components shall be mounted in a custom recessed cabinet with a hinged, locking front door that is provided with a Minneapolis fireman's lock. Custom recessed box shall be designed to be installed in the elevator call button enclosure, elevator cab or stairway wall as indicated on the plans and required. Clearance for the lock must be given by the fire department.

11. Failure of any equipment or zone wiring shall annunciate visually and audibly at the CCS as outlined in the Fire Management and Environmental Control System specifications.

12. Provide five red handsets with clips for hanging to be housed in a cabinet in the Central Control Station Room 3-75. This same cabinet may be the control station of the zone common talk system.

13. Zone page from local communication system handset. This shall permit the zone handset stations to give instructions over their zone speakers. This shall be accomplished by depressing a local page switch located in the local panel. This feature shall be in addition to the functions outlined in the base system specification. Local control console zone paging shall have priority over other system functions. This feature will only function when properly set up by the control console operation.

14. All zones and subzones shall be wired back to the control center racks. It shall be possible to at any time in the future add amplifiers and separate any individual zone to be used as a local system. These subzones shall still be totally supervised and annunciate individually if and when they are separated out.

C. Equipment

1. The equipment specified is that of Dukane Corporation. Rauland, Standard, Autocall, Audio-Alert equipment shall also be approved.

2. Provide floor standing sound equipment racks with plugmold strips containing 120 volt 20A grounded receptacles 12"o.c. top to bottom of racks. Racks shall be welded construction with blank covers and access panels where required.

3. Solid State Pre-Amplifier & Mixer Panel

a. The Pre-amplifier/Mixer Panel shall be Dukane Model 2A65. It shall have facilities for four individually controlled, low impedance microphone inputs and two commonly controlled, high impedance auxiliary inputs. The microphone stages shall be differential amplifiers to accept either balanced or single ended microphone lines without the use of input matching transformers. A master volume control shall regulate all inputs simultaneously. There shall be provisions for adding remote volume controls to the microphone inputs and the master volume control. Individual bass and treble tone controls shall be provided.

b. The unit must have a voltage gain of at least 76dB and a frequency response flat within ± 1 dB from 20 to 20,000 Hz. It shall have a rated output of +6dBm at 600 ohms, single ended. Distortion shall be not more than 1% at any frequency between 20 and 20,000 Hz. The noise level shall be at least -50dB.

c. The panel shall operate over a range of 105-125 volts, 50-60 Hz and consume not more than 3 watts. The unit shall be 19" wide for rack mounting. All external connections shall be to screw terminals.

3. 200 Watt Solid State Power Amplifier

a. The Power Amplifier shall be Dukane Model IA921B. The amplifier shall employ silicon transistors exclusively and be capable of delivering 200 watts (rms) audio power at less than 1-1/2% distortion over the frequency range of 30 Hz to 20 KHz. The noise level shall be at least 80dB below rated output. The input impedance shall be 100,000 ohms. The amplifier shall require not more than 0.4 volt input signal level for rated output. A screw-driver adjust input level control shall be provided. The available outputs shall be 25 or 70 volts balanced or single ended and 12-1/2 ohms. Output regulation shall be within 1dB from no load to full load.

b. The amplifier shall be provided with a thermostat for protection against operation where excessive temperatures prevail and an electronic protective circuit that reduces power dissipated in the transistors under overload or short circuit conditions. The amplifier shall employ 21 silicon transistors and 8 silicon diodes.

c. The unit shall operate from a 105-125 volts, 50-60 Hz line and consume less than 90 watts idle and 600 watts at rated output. The amplifier shall be 19" wide for rack mounting.

d. Each loudspeaker shall be set at a minimum of one watt of power. The number of 200 watt amplifiers shall be sized according to the number of speakers plus a 40% power factor.

4. Supervisory Detection System

a. Dukane Model 14A707 Supervisory Detection System shall consist of 9A1475 Alarm and Control Panels, 9A1480 Remote Alarm and Control Panels with Fault Annunciators, 5A451 Speakers, and 110-1437 Chassis. Each 110-1437 Chassis shall house 110-1286 Signal Generator PCBs, 110-1287 Detector PCBs, 110-1288 Wide Band Detector PCBs, and 110-1289 Alarm PCBs.

b. The 110-1286 Signal Generator PCB shall operate with a supply voltage between 24 and 30 VDC and shall draw between 15 and 35 milliamperes respectively. The output shall vary no more than .2dB over this range: The output voltage shall be 5VAC(RMS) maximum. The load impedance shall be more than 600 ohms, and the output impedance shall be 70 ohms.

c. The 110-1287 Detector PCB shall operate on 24 VDC @ 75 milliamperes. The input shall be internally clamped to 0.7 volts. The output indicator shall be a light-emitting diode. The remote control relay shall be Type-A contacts (maximum voltage 250 VAC @.5 amperes into a resistive load). Reset voltage shall be +4 VDC.

d. The 110-1288 Detector PCB shall operate on 24 VDC @ 75 milliamperes. Input shall be 20 millivolts and shall be internally clamped to 0.7 volts. The remote control relay shall be Type-A contacts (maximum voltage 250 VAC @ .5 amperes into a resistive load). Reset voltage shall be +4 VDC.

e. The 110-1289 Alarm PCB shall operate on 24 VDC @ 75 milliamperes standby. The output of the system power supply shall be constantly monitored.

f. The 110-1437 Chassis shall have a capacity of 12 cards, and terminations shall be screw terminal type.

g. The 9A1475 Alarm and Control Panel shall operate on 24 VDC @ 150 milliamperes.

h. The 9A1480 Alarm and Control Panel with 50 Annunciators shall operate on 24 VDC @ 150 milliamperes standby. Lamp current shall be 40 milliamperes each. Terminations shall be screw terminals and spade terminals.

5. Tape Transports

a. The tape transports shall be Telex Model 230 or approved equal. It shall be a two speed, three motor unit with photo-cell controlled circuitry for automatic stop or automatic re-cue and continuous cycling. The tape transport shall be relay and solenoid controlled, and operated by electric, momentary contact push-buttons and suitable for remote control. A time-delay circuit shall prevent tape breakage when the transport is switched to play from fast forward or rewind modes. Supply and take-up reels are to be driven by four-pole induction motors. The tape capstan drive shall consist of multiple belts and dynamically balanced flywheel powered by a two speed hysteresis synchronous motor with front panel speed selector switch. Flutter and wow shall be less than 0.2% at 7 1/2 ips. The transport shall include a three digit index counter. A solenoid operated, differential brake system shall render the tape transport fail-safe in all operating modes including power failure.

b. The transport is to include a removable, 24 volt dc; full wave one ampere power supply. Tape heads are to be low impedance, of hyperbolic contour and operate without pressure pads. Automatic tape lifters shall remove the tape from the heads in fast forward or rewind modes. All assemblies of the tape transport are to be accessible from the back. Electrical connections to the power supply and control box assembly are to be through standard connectors and screw terminals. All relays are to be plug-in type. The transport shall be 19" wide, suitable for standard relay rack mounting with stainless steel front panel. The transport shall operate on 115 volts 60 Hz and consume less than 150 watts power.

6. Touch to Talk Microphone and Stand

a. The desk microphone assembly shall be Dukane Model 7A765A or approved equal. The microphone shall be an omnidirectional, dynamic type with a frequency range of 60 to 10,000 Hz. It shall have an impedance of 150 ohms, an output level of -52 db referred to 1 MW/10 dynes/cm² and an EIA sensitivity rating of -146 db.

b. The one piece microphone housing and desk stand shall be die cast of zinc alloy with satin chrome finish. The desk stand base shall include a

touch-to-talk bar switch wired for remote relay operation. A 7' long, four conductor cable shall be furnished.

7. Speakers

a. Speaker types shall be as follows and as shown on the plans. Provide backbox and baffle for each speakers.

(1) Type A - Model 5A451 speaker, Lowell #DP68X backbox with speaker support cover (black finish) to fit box with 7" diameter hole for speaker and mounting holes for speaker and back box. In general the type A speaker system shall be used above accessible ceilings where the perforated ceiling metal pan or panel provides the speaker baffle.

(2) Type B - Model 5A451 speaker with T95-8 backbox and T-720 baffle. Baffle shall be matte white finish. In general type B speaker system shall be recessed in plaster ceilings and walls for a flush installation.

(3) Type C - Same as type B except speaker system shall be installed as surface mounted. Unit will be relocated and installed for future suspended ceilings.

(4) Type D - Model 5A30 horn mounted on a 2 gang flush or surface outlet box with stainless steel plate. In general type D speakers shall be installed in mechanical equipment spaces and shell space. Outlet box and conduit shall be installed flush in permanent finished construction areas.

b. The loudspeakers shall be Dukane Model 5A451. The loudspeaker shall be an eight inch, seamless cone type. The ceramic magnet shall weigh at least 4.8 ounces. The frequency range shall be from 30 to 15,000 Hz. The normal wattage rating shall be 10 watts with a program rating of 16 watts. The voice coil shall be 3/4" in diameter and 8 ohms impedance. All external parts shall be cadmium plated and conform to EIA standards.

D. Remote Paging System

1. A remote 2 zone paging system shall provide access to the voice communication system from the Mayo Information Desk (MID) where shown on the plans. Provide all conduit and interconnect wiring between MID and Unit B/C Central Control Station Room 3-75 as indicated on the plan. Wiring shall consist of (2) Beldon #8450 and (2) Beldon #8470 for audio and control.

2. At MID provide a desk type microphone assembly Dukane Model #7A765A as herein specified. The microphone desk stand shall contain ZONE A and ZONE B zone control switches. Zone A shall access all speakers on floors 1 through 9 and Zone B shall access all speakers on floor B, 10 through 15 of Unit B/C. Remote zone paging shall be locked out by the voice alarm and voice communication system during an alarm condition or by use of the fire command paging microphone.

3. Provide all necessary outlet jacks, control switches and equipment for a complete installation. Pre amplifier shall be Dukane Model 2A90.

2.5 ELEVATOR CONTROL SYSTEM

- A. Fire alarm initiating devices so designated in the Input/Output Summary shall cause all elevators to return to ground floor. The elevators return to the ground floor or for the use of fire department personnel.
- B. The fire management and environmental control system supplier will provide from emergency power source a n.o contact in each elevator machine room. On fire alarm, contact closure will return elevators to ground floor. The elevator supplier will coordinate this contact into his control sequence to provide desired operation.
- C. For each elevator cab as shown on the plans at Third floor provide a voice communications speaker and fireman telephone unit. Equipment shall be installed and wired by the Elevator Contractor. Provide dimensional drawings to Elevator Contractor for rough-in requirements.

2.6 AUTOMATIC SMOKE CONTROL SYSTEM

A. General

1. Automatic smoke control system is designed to control the movement of smoke within an area where a fire has been detected. On fire alarm the Event Initiated Program (EIP) will close the smoke doors on the fire floor, close the motorized damper supplying ventilation air to the fire zone and modify the control sequence of the supply and return air fans serving the fire zone as shown in the input/output schedule, on the plans and as specified by the sequence of control for each air handling system under "Smoke Control Mode" of the Automatic temperature control system.

B. Equipment

1. Motorized Dampers

a. Dampers shall be Honeywell D640 parallel blade type. Operators shall be Honeywell electric two-position spring return damper operator sized to assure adequate torque to positively close damper when 120 volt operator power is supplied.

2. Magnetic Door Holders

a. Magnetic door holders provided and installed under the General Contract shall be wired and connected by the Electrical Contractor. Door holders will be 120 volt and will be integral with the door closers.

2.7 FIRE MANAGEMENT SEQUENCE OF OPERATION

A. On fire alarm the Event Initiated Program (EIP) shall initiate the following fire management sequence of operation.

1. Alarm is transmitted to Mayo Information Desk and to the Building Operations Department.

2. Heating, ventilating and air conditioning equipment serving fire area and fire floor automatically goes to smoke removal sequence of operation.

- a. Motorized damper in supply air at fire floor and in fire area closes.
- b. Supply air systems serving adjacent areas on fire floor go to 100 percent outdoor air.
- c. Automatic temperature controls maintain proper supply fan discharge temperature.
- d. Supply fan variable inlet vanes are placed under static pressure control to maintain desired static pressure in air supply duct.
- e. Return exhaust system serving fire area goes to 100 percent exhaust air.
- f. Motorized relief air dampers associated with Unit A building systems relieving air in a common air shaft serving both Unit A and B/C shall close for all air handling unit located at the basement equipment room only.
- g. Air supply unit for stair tower pressurization is started.
- h. Elevator shafts and equipment room are pressurized by closing return relief damper or exhaust fan shutdown.

3. Doors into stair towers are unlocked to allow access from stair towers to building.

4. Alert tone followed by pre-taped emergency message and instructions is announced over voice alarm system. Different messages are transmitted to:

Different audio zones on fire floor

Floor above fire floor

Floor below fire floor

Elevators

Override from CCS and direct microphone audio announcements to any or all audio zones may be performed at anytime.

5. All elevators are captured and brought to ground floor and placed in "key operate" mode for use by fire department personnel.

6. Smoke doors are closed isolating elevator lobby areas from general floor areas and Unit B/C from Mayo and Unit A.

7. CCS printer provides printed record of the specific alarm initiating device and verification of occurrence of individual sequence items.

8. CCS operator arrives in control room and activates graphic displays which are automatically indexed as follows:

A. Graphic Display I

Floor plan of specific fire floor area identifying all alarm initiating devices and showing heating, ventilating and air conditioning systems supplying the area.

B. Graphic Display 2

CCS operator instructions which are coordinated with information displayed on graphic display no. 1.

2.8 MOTOR CONTROL CENTERS

A. Motor control centers shall be designed for 480 volt, 3 phase, 3 wire combination motor starters detailed and scheduled on the plans. The control centers shall be totally enclosed, dead front, free standing, 90" high constructed of code gauge steel with structures bolted together to form one NEMA Class I assembly. Units shall be finished with baked gray enamel.

1. The combination fused switch and magnetic starter units shall be hinged door type.

2. The fused switches shall be quick-make, quick-break, handle operated. Switches for all starters with interlock control circuits shall be provided with integral electrical interlock disconnect.

3. Magnetic starters shall be across-the-line, full voltage type with controls as indicated on the schedule.

4. Horizontal and vertical bus shall be of copper or tin plated aluminum construction with horizontal bus rated as shown on plans.

5. Motor control centers shall be front mounted only, NEMA Class I, Type B construction.

6. Provide fuses for each starter switch as specified in Section 16300. Provide 3 spare fuses for each size of starter switch in each motor control center.

7. Each combination starter unit shall be stab connected to the buses, except bolt-in above 400 amp. All combination starters shall have numbered unit pre-wired terminal boards. Provide same type disconnect switch only where indicated.

8. Each section shall have unobstructed horizontal wireways at top and bottom which shall match with adjacent units to provide continuous horizontal wireway. Each section shall include vertical wireway. Horizontal and vertical wireways shall be isolated from busses.

9. Unused spaces shall be covered by blank plates, and all other spaces shall be fully equipped for future use.

B. Individual combination starters shall be equipped with reset buttons, selector or push buttons and pilots as indicated on the drawings.

1. Each starter shall have three overload protectors. These shall be individually supplied for the exact motor that each is intended to protect as verified by the nameplate at the job which may not necessarily agree with the size indicated in the motor schedule. Size all overloads for the largest maximum size permitted by the NEC.

2. Starters shall have auxiliary contacts plus a holding coil contact. The required number of auxiliary contacts shall be furnished to accomplish the specified sequences and interlocks.

3. Provide a transformer for each starter pre-wired into the circuits for reduction of 480 volts to 120 volts as required for pilot and control duty. Transformers shall be fuse protected and shall be connected to the load side of the disconnect switch.

C. Automatic temperature control devices requiring electrical connections and all pneumatic electric switches, electric pneumatic switches, control relays and interlocking relays shall be furnished in NEMA type I enclosure. The MCC and temperature control device enclosure shall be factory wired and tested as a single unit prior to delivery to job site. Complete terminal to terminal wiring diagrams shall be submitted prior to fabrication. All devices within enclosure will be factory wired to numbered terminal strip with 10% space terminals.

D. Provide permanent labels on the front of each combination starter or disconnect to identify the equipment controlled. Label shall be engraved black-white-black bakelite fastened with permanent bonding adhesive.

E. All motor control centers shall be structured with buses supported to withstand 40,000 amperes RMS symmetrical for short circuit conditions.

F. Motor Control Centers shall be as manufactured by Square D, General Electric, Westinghouse, Federal Pacific, Allen Bradley or approved equal.

2.9 AUTOMATIC TEMPERATURE CONTROL SYSTEM

A. GENERAL

1. The work under this subsection consists of furnishing and installing a complete system of pneumatic automatic temperature control as shown on the drawings and described herein.

2. Related work specified elsewhere:

a. Basic methods and materials: Section 15100

b. Pipe and pipe fittings: Section 15110.

c. Domestic and laboratory hot water systems: Section 15220.

d. Fire protection system: Section 15500.

e. Steam heating system: Section 15600.

f. Hot water heating system: Section 15650.

g. Ventilation and air conditioning: Section 15800.

h. Air conditioning refrigeration: Section 15900.

i. Mechanical work for fire management and environmental control systems: Section 15950

3. The following work is not part of this section of the specification and will be performed by the mechanical contractor under Section 15950 with supervision by the Fire Management and Temperature Control Sucontractor.

- a. Confirm control damper sizes to FM and ECS supplier before fabrication.
- b. Installation of automatic control dampers.
- c. Furnishing and mounting of damper blank-off plates.
- d. Installation of immersion wells and pressure tapping.
- e. Installation of water flow switches.
- f. Installation of automatic control valves.
- g. Installation of liquid level switches.
- h. Installation of pressure tapping and associated shut-off cocks.
- i. Installation of orifice plates and companion flanges.

B. AUTOMATIC TEMPERATURE CONTROL SYSTEMS

1. The automatic temperature control system shall be as manufactured and installed by Honeywell Inc., Johnson Controls, or Powers Regulator. The system shall be of the pneumatic type except that electronic equipment components shall be used where specified. The systems shall be installed under the full time supervision of an authorized installation engineer.

2. All pneumatic electric switches, electric pneumatic switches, control relays and interlocking relays shall be contained in the major control center and enclosure as specified under Article 2.8 Motor Control Centers. Low temperature protection thermostats will be wired to the MCC.

3. See Mechanical Drawing Sheets for locations of Mechanical equipment controlled, control valve and damper, thermostat and humidistat locations.

C. COMPRESSED AIR SUPPLY AND AIR PIPING SYSTEM

1. A new duplex type air compressor will be provided with sufficient capacity to supply compressed air to the entire control system of Units A, B and C.

The existing Unit 'A' temperature control system is currently being served from the 90 psi laboratory air compressed air system with a 10 HP Simplex type air compressor acting as a standby. This Contractor shall reconnect Unit 'A' temperature control system to the new duplex unit located where shown on Drawing M-65. This Contractor shall disconnect the existing 10 HP air compressor and its associated air receiver tank, dryer and oil separator and relocate it where directed by the University. This Contractor must coordinate the 10 HP compressor unit removal with the Mechanical Contractor as it is in conflict with the location of new Mechanical equipment. The lab compressed air interconnection shall remain as standby for the complete system.

2. The duplex type air compressor shall be provided with sufficient capacity to supply compressed air to the entire temperature control system of units A-B-C while operating no more than 50% of the time. Each pump operating will be operating only 25% of the time. Each pump shall have minimum of 56.6 cfm capacity. Each electric motor shall be 15 hp minimum and 460 volt, 60 Hertz, 3-phase operation. The duplex compressor shall be an Ingersoll-Rand type 30 unit with nonlubricated cylinders for oil free air. Unit shall be Model 2-10T3NLE15 air cooled.

The air compressor shall be provided with:

- a. Low resistance intake air filter (Purolator or equal).
- b. High pressure tank relief valve.
- c. Vibration isolation shall be Type "B-J" for .75" static deflection.
- d. Belt guards, totally enclosed.
- e. 120 gallon high pressure storage tank with drain test cock and automatic moisture removal trap.
- f. Automatic alternator to equalize the running time of each motor ("Autocon" H-44 or equal). Magnetic starters for each motor.
- g. Pressure reducing valves.
- h. Gauges.
- i. Check valves.

3. Refrigeration air dryers shall be installed in the air discharge line from the compressor, but ahead of the receiver. The dryers shall include a hermetically sealed non-cycling refrigeration unit, a pre-cooler heat exchanger, a hot gas bypass valve to permit load variations from 5-100% capacity without on-off compressor operation or freeze-ups and air blockage, and a moisture separator. The moisture separator shall be of the coalescing filter type capable of removing 98% of all particles of water and dirt to .04 microns from the effluent air. Dryer shall be provided with a 3 valve manifold plus automatic moisture removal trap piped to floor drain.

- a. Dryer instrumentation and equipment shall include panel-mounted refrigerant suction compound pressure-temperature gauges, outlet pressure gauge, Aquadex moisture indicator, safety pressure switch, power-on light and automatic trap.
- b. Alarms and indicators shall be furnished to indicate high pressure drop across separator and low freon charge.
- c. Dryer Operating Conditions:
 - (1) Outlet dew point at line pressure with 100°F inlet air +35°F.
 - (2) Inlet pressure 100 psig

- | | |
|--------------------------------|----------|
| (3) Inlet air temperature | 100°F |
| (4) Electrical characteristics | 460/3/60 |
| (5) Electrical class | NEMA 1 |

d. Dryers shall be Pall Trinity or approved equal. Hankinson and Ingersoll-Rand with identical characteristics are acceptable.

4. A central station SUB-MICRON air filter shall be provided. This filter shall be rated for 97% efficiency at rated air flow. Pressure reducing stations shall be provided to reduce high pressure air to that pressure required by the pneumatic control instruments. Provide combination SUB-MICRON filter - pressure reducing station similar to Honeywell PP902A or B separate SUB-MICRON filter with separate pressure reducing stations. A separate pressure reducing station will be provided in the basement mechanical room and in the 10th floor mechanical equipment room for high pressure mains for fan inlet vane operators.

Complete air piping shall be provided for the pneumatic control system, adhering to the highest standard of quality and workmanship and subject at all times to approval of the architect and engineer.

D. TEMPERATURE CONTROL PIPING

1. Piping

a. Pipe - Type "L" hard drawn copper or virgin polyethylene. Polyethylene tubing shall meet the stress and crack test performed per ASTM D 1693, and shall be classified as flame retardant and must be rated as self-extinguishing capable of passing ASTM-635 flammability test.

b. Fittings - extruded of wrought copper or sharp barb type that does not require spring clips.

c. Joints - soldered, except compression fittings shall be used at instruments or compatible with polyethylene fittings as specified above.

2. All lines in the equipment rooms and in other unfinished spaces shall be run exposed in a neat and orderly manner with pipe runs grouped as much as possible. All tubing and conduit which must run exposed shall follow vertical and horizontal contours to the satisfaction of the Architect/Engineer and be rigidly secured to the building construction at 4'-0" o.c. Tubing shall not be allowed to be fastened to ductwork or electric conduit. All lines in finished spaces shall be run concealed with the majority of each piping installed above the suspended ceilings and in furred walls.

3. Suitable drip legs and drain valves shall be installed at all low points in the piping system to eliminate accumulated condensate.

4. Air piping or controllers shall not be installed in outdoor air intakes where freezing conditions may occur.

5. All tubing or piping, except local individual room control, shall be number coded or color coded for future identification and servicing of the control system.

6. All non-metallic polyethylene tubing run in mechanical equipment rooms, utility areas, or finished spaces where other tubing is exposed shall be run within adequately supported rigid metallic raceway, EMT pipe or duct. Terminal single lines shall be hard drawn copper except if the run is less than 12", in which case flexible polyethylene tubing enclosed with flexible spring may be used.

7. Non-metallic polyethylene tubing used for thermostat fittings shall be 5/32" diameter clearly marked "branch" and "main". These two lines shall be wrapped with a polyethylene cover. A complete line of fittings shall be available for "dry wall" construction, plaster, brick, precast or tile walls. Where tubing exits the wall into the suspended ceiling area, the tubing shall be run into conduit, or protected with "spring" covering to the valve. Tubing run in flexible spring covering shall not exceed 12". Suitable plastic grommets shall be used where polyethylene tubing enters or leaves the conduit or junction boxes for the final connections.

8. Non-metallic polyethylene tubing installed in concealed locations such as suspended ceilings and pipe chases shall be run parallel to the lines of the building, be adequately supported, and protected as in subparagraph 6 above.

9. Non-metallic polyethylene tubing installed within walls and not adjacent to other services shall be installed in a neat and workmanship manner, adequately supported and run parallel to the building lines.

10. Polyethylene tubing in 4, 7 or 12 1/4" black tubes individually numbered shall be wrapped with a Mylar tape all enclosed in a .062 jacket of polyvinyl. Bundled tubing of this type may be used for switching lines and shall be self-supporting tied firmly to the structural members. Refer to paragraph 6 for support of tubing.

11. Tubing installed inside or behind control panels shall be neatly tied and supported.

12. System testing.

a. The entire pneumatic piping system shall be tested by placing it under 30 psi pressure for 24 hours with a drop not exceeding 1 psi during that time.

b. All temperature control systems shall be checked out under operating conditions with the actual operations verified and temperature readings taken around each control point to provide the correct control function or operation. All damper function shall be similarly verified. These facts shall also be included with the required certificates.

c. Temperature control air piping buried in slabs shall have a continuous air test on the piping while slabs are being poured.

E. ELECTRICAL WORK

All wiring of PE and EP switches and electrical control devices shall be by the Electrical Contractor under the supervision of the ECS supplier, except as noted otherwise.

F. CONTROL INSTRUMENTS AND EQUIPMENT

1. In general, the control instruments and equipment furnished for this installation shall be the best product of its type produced by the manufacturer. The following specifications are intended to set a minimum standard for the particular device described.

2. Dampers: Frames shall be constructed of two hot dipped sheets welded together to form a corrugated blade. Frames shall be hot dipped galvanized steel. Blade width shall be a maximum of 6". All blades shall have replaceable rubber seals along the blade edge. Frames shall have metal stops with rubber seals to seat against ends of each blade. Dampers shall have nylon bearings and oil impregnated shafts. All linkages shall have oil impregnated bearings and shall be enclosed in the dampers frame. No linkage shall be allowed in the airstream. Modulating dampers shall be opposed blade; two position dampers shall be parallel blade. All automatic dampers in acid ducts shall be treated as called for in Section 15800, paragraph 2.2.

3. Space Thermostats: They shall be of the proportional-positioning type with adjustable throttling range. Pneumatic non-bleed thermostats shall be of the key operated type, internal stops and be capable of operating on a change in temperature of plus or minus 1°F at the thermostat location. Furnish two dozen keys with the installation. Thermostat finish shall be as selected by Architect. Stat located on outside wall shall be insulated to prevent cold wall influence. Covers shall expose the set point but conceal the thermometer. Fully recessed aspirating type pneumatic thermostats shall be installed in toilet rooms, vestibules, corridors and traffic areas. Provide electric line voltage thermostats where called for on the drawings. Guards shall be provided on thermostats in equipment rooms. Submit guard for approval.

4. Electronic Space Thermostats: The sensing element of the space thermostat shall be a bobbin of wire whose electrical resistance is determined by temperature. Space thermostats shall contain no moving parts unless integral set-point adjustments are specified.

5. Pneumatic Insertion Sensors

a. Sensors shall be proportioning in action, of corrosion resistance construction, with appropriate range of Degrees Fahrenheit on a calibrated gauge located as indicated on plan. Sensors shall be factory calibrated with all adjustments at the centrally located controller. Provide a red reading angle duct, industrial type thermometer beside each insertion sensor.

b. Averaging element temperature sensors shall be supplied for mixed air, and all other sensing locations when stratification of temperature is likely. To provide adequate coverage average element shall not be less than 20 feet and be serpentine over the sensing area. If a sensor has less than a 20 foot element, two or more sensors shall be supplied.

c. Immersion sensors shall be installed in stainless steel or copper wells packed with a heat transfer compound. Honeywell No. 14500430.

d. Static pressure sensors shall be a range of 0 to 6 inches water column, operate over a 2-inch span, using a slack diaphragm sensing element, with force-balance pneumatic feedback. Sensors shall reflect a 3 to 15 psig change in pressure on a 2-inch change in static pressure.

e. Space and duct humidity sensors shall have a sensing span of 30 to 80 percent relative humidity for a 3 to 15 psig pressure change. All humidity sensors shall be temperature-compensated and provide pneumatic feedback. Adjustments shall be factory calibrated and sealed.

6. Pneumatic Sensor Controllers: These shall be force-balance, non-bleed pneumatic amplifiers designed for corrosion resistance to high humidity and with integral gauge ports. Controllers shall be field adjustable to either direct or reverse action and for width of proportional band. Set point shall be at the controllers.

a. Authority of compensating sensors shall also be adjustable at the controller.

b. Controllers shall have capability of remote control point adjustment from a proportional manual switch located as directed.

c. Pneumatic receiver controllers shall be supplied with control point adjustment input ports.

7. Pneumatic Space Humidistats: Shall be similar to the space thermostats. Units shall be actuated by a human-hair bi-wood element, with modulating key set and adjustable throttling ranges of 20 to 80 percent.

8. Pneumatic Actuators: All shall be sized to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or two-position action as specified. When so specified in the sequence of operation or where more than two actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable startpoint and operating range. Construction shall be piston-type operator, rolling neoprene diaphragm and aluminum body. Operators of plastic type construction are not acceptable.

9. Electronic Pneumatic Relays: Electronic - pneumatic relays shall be completely transistorized and contained in unitized completely enclosed cabinets. Cabinet shall contain terminal strip and all pneumatic and electronic modulating pneumatic signal to operators.

10. Relays and Switches: Relays of the positive and gradual-acting type and switches shall be furnished and installed as required for the successful operation of the system. All switches shall include suitable indicating plates. Positive positioning devices shall be utilized on all operators where sequencing is specified.

11. Control Valves:

a. Valves for reheat hot water service shall be 2-way gradual acting types. Valves shall be suitable for use with 210°F hot water and shall be

leakproof under a static head of 100 psi. Valves shall have renewable composition discs and parabolic throttling guides. Valves shall have a shut-off rating of not less than 50 psi. Valves shall be Honeywell VP 525A Johnson V-3752, V-5250, or equal.

b. Three-way control valves and diverting valves for heat recovery water system shall be Honeywell VP 516 Johnson V-4322 mixing valve, or approved equal. Where this valve does not meet flow requirements, Honeywell series 1600, Johnson V-5840, or equal shall be used. Valves shall be suitable for service with 50% glycol/water system.

c. Valves for steam service, unless otherwise specified on coils, converters, heaters, etc., shall be of the single seated, dead end service type, except those specified double seated. All valves shall have linear characterized throttling plugs. Valves for sequence control shall have positive positioning devices. All other valves shall be standard motor equipped. All steam valves shall be sized for 12 psi entering and 8 psi drop through valve. See Drawing Sheet M-106 for valve capacity for each air handling unit, and number of valves required for each.

d. Two way control valves for chilled water service shall be Honeywell VP 514C and VP 514E, Johnson V-5460, or equal normally closed. Valves shall be suitable for use with 35 degree F. to 200 degree F. water. Where this valve does not meet flow requirements Honeywell Series 9101, or equal, shall be used. See Drawing Schedule Sheet M-106 for valve capacity of each air handling unit. All valves shall have positive positioning relays.

e. All valves located where it is not obvious what equipment the valves serves shall be tagged as described in Section 15120.

f. All control valves described under this section shall have stainless steel stems and spring loaded self adjusting teflon packing.

g. Valves seats for all valves shall be screwed into body and be replaceable. Seat material shall be brass for screwed bodies and bronze for flanged bodies.

G. GAUGES

A. There shall be a minimum of one gauge on all branch lines from all controls. There shall also be sufficient gauges on main lines to indicate pressure in location of groups of controls. There will not have to be a gauge on main line to thermostats in finished rooms, but there shall be a gauge installed in the branch lines to the room unit valves. The gauges shall be a standard product of the control manufacturer for measuring air line pressure.

H. OPERATING INSTRUCTIONS

A. Upon completion of the work, the manufacturer shall have a qualified representative fully acquainted with the installation to instruct the Owner's Operator in the fundamentals and operation of the system. This instruction period shall not be less than five (5) full working days. The manufacturer shall also, upon completion and acceptance of the work, provide the Owner with three (3) typewritten and/or printed sets of operating and maintenance instructions including sheets describing fundamentals of each system in the installation. One (1) similar set shall be provided for the Architect-Engineer, all sets being neatly clipped in heavy manila folders.

B. The manufacturer shall also mount one (1) set of charts consisting of complete control diagrams, wiring diagrams, etc., adjacent to the equipment in a conspicuous location. Charts shall be mounted in a glass enclosed case.

C. When the system is completely installed and proven to be in operating condition by the control manufacturer and ready for acceptance, the manufacturer shall furnish to the Owner twelve (12) extra packaged gauges of the same type supplied on the instruments in the equipment rooms. Also he shall supply the Owner with twelve (12) complete sets of instruments adjusting keys and any special wrenches, screw-drivers, or tools necessary for normal service of the same.

1. SEQUENCES OF CONTROL

1. Supply Fan S-1C (Animal Rooms)

a. "Normal Mode"

(1) This built-up unit normal control sequence shall be identical to that described for Unit S-2C with the following exceptions.

(2) This supply unit operates with a minimum of 100% outside air and as such has no return air damper. The outdoor air dampers shall open when fan starts and close on fan shut down.

(3) The relative humidity maintained in spaces served by this unit shall be 50%.

(4) This supply unit along with Animal Supply Unit S-18C is interlocked by Electrical Contractor with Animal Exhaust E-4C.

Upon startup of either of the two supply fans, the exhaust fan shall be energized and a solenoid air valve wired to the exhaust fan motor shall fully open the exhaust damper upon fan startup.

(5) This supply unit includes a glycol/water heat recovery coil, which in conjunction with a similar coil in exhaust fan E-4C discharge plenum shall be controlled as follows.

(a) Heat Recovery coil shall be controlled by two (2) adjustable insertion controllers with twenty (20) foot capillary sensing elements. The first element shall be serpentine across the inlet air side of the heat recovery coil, and through a receiver shall start a recirculating pump, when temperature drops below 55 degrees F. The second element shall be serpentine across the air leaving side of the coil and which through a receiver shall modulate a three-way valve on the glycol pipe leaving the coil to maintain 55 degrees F. leaving air temperature.

b. "Smoke Control Mode"

(1) This built-up unit emergency control sequence shall be identical to that described for Unit S-2C with the following exceptions:

(a) The outside air damper of Unit S-1C shall remain 100% open as shall the exhaust air damper of exhaust fan E-4C.

(b) The supply unit shall have no automatic differential static pressure control of inlet vanes.

2. Supply Unit S-2C and Return-Exhaust RE-1C.

a. "Normal Mode"

(1) This system includes a built-up supply air unit with outdoor and return air dampers, steam preheat coil with integral face and bypass dampers, chilled water coil, and steam grid humidifier, and a return air fan with exhaust air dampers. The supply and return-exhaust fans shall be interlocked by the Electrical Contractor. Both supply and return-exhaust fans are equipped with variable inlet vanes.

(2) On fan shutdown, the outside and the exhaust dampers will close and the return air damper open. On failure in the pneumatic air system to the dampers, however, the exhaust and outside air dampers will open and return air damper close. Control of the supply fan S-2C shall be by means of an H-0-A switch located in the motor control center in respective equipment room with appropriate interlocks.

(3) Upon fan startup, a solenoid air valve will be energized, placing the outside, the return and the exhaust damper under control of an adjustable minimum positioning switch located at the central control panel. This switch will be located inside of the panel and will be equipped with a dial indicating 0 to 100% position of the outside air damper. An indicating gauge will offer feed-back to the switch showing the exact position of the damper motor at all times. Minimum outside air admitted to the unit under its present start up condition shall be 24%. A receiver controller with its temperature transmitter in the mixed air chamber will act as a low limit device and will prevent the mixed air temperature from dropping below a setting of 55 degrees.

An enthalpy logic center will control the positioning of the dampers in such a way as to allow the fan system to bring in air which represents the least cooling load to the system. The logic center will receive signals from the temperature and relative humidity transmitter in the outside air and a relative humidity and temperature transmitter in the return air. Should the total heat content of the outside air exceed that for the return air, and the outside air temperature exceed the temperature of the return air, the dampers will be returned to the setting of the minimum positioning switch. Should, however, the return airstream have a total heat content greater than that of the outside air, the dampers will be placed under control of the 55-degree receiver controller specified above. This controller will modulate the dampers between the minimum and the full open position to maintain set point.

(4) A sensor located in the preheat discharge acting through its controller will modulate the preheat steam coil valve and face and bypass dampers in sequence to maintain 55° air discharge temperature. A sensor located in the mixed air acting through its controller will fully open the steam coil valve when mixed air falls below 35°. Steam valve capacity shall be as shown on supply fan schedule on the drawings with a 8 psi pressure drop. See Drawing supply unit schedule for number and size of steam valves.

(5) Furnish and install a receiver controller with its temperature transmitter in the discharge of the chilled water coil. This receiver controller will maintain its set point by modulating a normally closed two-way

valve on the chilled water coil. The set point of this receiver controller will be re-set between 55 and 65 degrees by that room thermostat located in the space served by the unit which is requiring the maximum amount of cooling, providing its reheat coil is fully closed. The necessary high pressure cumulators required to accomplish this sequence will be furnished and installed by this contractor and will be located in the unit control panel. See drawings for a schedule of the key room thermostats which will, in effect, be controlling the discharge air temperature from this unit. Chilled water valve capacity shall be as scheduled on the drawings with a six (6) foot pressure drop.

(6) The unit steam humidifier shall be controlled by a space humidistat set at 30%, located as shown on the plans, which shall open a normally closed manifold jacket steam valve. A normally open temperature sensing switch furnished by the humidifier manufacturer and wired by this Contractor shall actuate an EP switch which shall open an air relay activating the air control line to the normally closed pneumatic humidifier valve. The humidistat shall then modulate the humidifier control valve. All humidifier valves shall close on fan shut down. The manifold jacket pneumatic steam valve capacity shall be as recommended by the humidifier manufacturer. The pneumatic humidifier valve will be furnished as part of the humidifier. A remote duct mounted humidistat (70% R.H.) located in supply fan discharge shall act as a high limit overriding the room humidistat by closing the humidifier control valve if the relative humidity in fan discharge rises above 70%. This humidistat shall be adjustable from a receiver controller located in the control panel. Indication shall be provided on the face of the control panel showing both the return and discharge air relative humidities.

(7) A safety low limit stat (45 degrees F.), located in the supply fan discharge shall stop the supply fan if discharge temperature drops below 45 degrees F.

(8) Control system shall include a heating-cooling switch that on cooling shall open bypass dampers on the preheat coils and close the preheat steam valve and the humidifier valve and on heating shall allow the above to modulate while the cooling coil 3-way valve is in a full bypass position.

(9) Inlet vanes provided on both supply and return-exhaust fans are not controlled under "Normal Mode" condition. These vanes will be manually set at a predetermined point by the Balancing Contractor, to be retained by the University.

b. "Smoke Control Mode"

(1) On fire emergency condition as defined in the input/output schedule, on Drawing Sheets E-59, E-60, E-61 the following shall occur:

(A) Supply and return fans will continue to run.

(B) The outside air damper shall open to the 100% position, the return air damper shall close and the exhaust air dampers shall open to the 100% position.

(C) The safety low limit discharge stat shall be locked out of operation.

(D) A differential static pressure transmitter with its sensing element located a reasonable distance downstream from the fan discharge shall, through a receiver controller located at the unit control panel, modulate the inlet vane dampers on the supply fan to maintain system static pressure in the discharge duct system as indicated in supply fan schedule on drawings. The inlet vanes shall return to their normal predetermined position when the system is returned to its "Normal Mode" of operation.

3. Supply Unit S-3C and Return-Exhaust RE-2C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and Return-Exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 52%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and Return-exhaust RE-1C.

4. Supply Unit S-4C and Return-Exhaust RE-3C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 56%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and Return-exhaust RE-1C.

5. Supply Unit S-5C and Return-exhaust RE-4C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and Return-Exhaust RE-1C except, minimum outside air admitted to the unit under its present start up conditions shall be 25%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and Return-exhaust RE-1C.

6. Supply Unit S-6C and Return-exhaust RE-5C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 10%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

7. Supply Unit S-7C and Return-Exhaust RE-6C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C

and return-exhaust RE-IC except, minimum outside air admitted to the unit under its present start up condition shall be 7%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-IC.

8. Supply Unit S-8C and Return-Exhaust RE-7C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-IC except, minimum outside air admitted to the unit under its present start up condition shall be 10%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-IC.

9. Supply Unit S-9C (Auditorium) and Return-Exhaust RE-8C

a. "Normal Mode"

(1) This system includes a packaged supply air unit with integral chilled water coil. Also included in the system are steam preheat coil with integral face and bypass dampers, steam grid humidifier, outside air and return air dampers and a return-exhaust fan with exhaust air dampers. The supply and return-exhaust fans will be interlocked by the Electrical Contractor. This supply and return-exhaust fan has no inlet vanes.

(2) "Normal Mode" control of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and Return-exhaust RE-IC except

(A) Minimum outside air admitted to the unit shall be 25%.

(B) A steam reheat on the fan discharge shall be controlled by a master space stat (75 degrees F.) resetting an adjustable remote bulb submaster stat 55 degrees F. to 90 degrees F. with bulb located at fan discharge controlling a modulating steam valve on the steam supply line to the coil.

b. "Smoke Control Mode:" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-IC, except.

(1) This supply unit has no automatic inlet vane control.

10. Supply Unit S-10C (Stairway Pressurization)

a. "Normal Mode"

(1) This system includes a packaged supply air unit with two steam preheat coils with external face and bypass dampers. Also included in the system are outside air dampers and exhaust fans with exhaust air dampers. The supply unit and associated exhaust fans will be interlocked by the

Electrical Contractor. Under normal conditions this unit and its interlocked exhaust fans shall be off and the outside air and exhaust air dampers closed.

b. "Smoke Control Mode"

(1) On fire emergency conditions as defined in the input/output schedule the following shall occur:

(A) Supply and exhaust fans shall start up, pressurizing the stairwells and exhausting smoke to maintain a .15 inches static pressure.

(B) The supply unit outside air dampers and the exhaust air dampers shall open to the 100% position.

(C) A sensor located in the second steam preheat discharge, acting through its controller will modulate the preheat steam coil valve and face and bypass dampers in sequence to maintain 55° air discharge temperature. A sensor located in the mixed air acting through its controller will fully open the first preheat steam coil valve when mixed air falls below 35°.

II. Supply Unit S-IIC (Basement Equipment Room) and Return-Exhaust RE-9C

a. "Normal Mode"

(1) This system includes a packaged supply air unit with integral chilled water coil. Two steam preheat coils with integral face and bypass dampers. Also included in the system are return air and outside air dampers, and return-exhaust fan with exhaust air dampers. The supply fan and return-exhaust fan will be interlocked by the Electrical Contractor.

(2) On fan shutdown the outside and exhaust air dampers will close and the return air damper open. On failure in the pneumatic air system to the dampers, however, the exhaust and outside dampers will open and return air damper close.

(3) Control of this supply fan shall be by means of a H-O-A switch located in the motor control center in respective equipment room with appropriate interlocks.

(4) An adjustable minimum positioning switch shall be provided for manual adjustment of outside air percentage. This switch shall be set to admit 10% outside air to the system. The mixed air temperature shall be controlled by a 20 ft. averaging bulb sensor (55°F) controlling the modulating outdoor air and return air dampers.

(5) A heat-cool master space stat shall during the heating cycle reset an adjustable remote bulb submaster stat (50°F to 75°F) with bulb located in fan discharge to modulate the second preheat coil steam valve and face and bypass dampers. A sensor located in the mixed air will fully open the first reheat steam coil valve when mixed air falls below 35°F.

(6) During the cooling cycle, the space thermostat shall control a modulating pneumatic two way valve on the water supply line to the coil. Valve capacity shall be as scheduled on the drawings with a 7 foot pressure drop.

(7) A safety low limit stat set at 40°F., located on the air entering side of the cooling coils, shall stop the supply fan if air temperature drops below 40°F.

b. "Smoke Control Mode"

(1) On fire emergency condition as defined in the input/output schedule, the following shall occur:

(A) Supply and return fans will continue to run.

(B) The outside air damper shall open to the 100% position, the return air damper shall close and the exhaust air damper shall open to the 100% position.

(C) The safety low limit discharge stat shall be locked out of operation.

12. Supply Unit S-12C (Skyway to Unit 'A')

a. "Normal Mode"

(1) This system includes a packaged supply air unit with integral cooling coil, steam heating coil and face and bypass dampers. Also included in the system are return air dampers.

(2) Control of this supply fan shall be by means of a H-O-A switch located in the motor control center in the basement equipment room.

(3) A heat-cool master space stat shall, during the heating cycle, through an adjustable low limit submaster stat (55°F) modulate the heating coil steam valve and face and bypass dampers in sequence to maintain space temperatures.

(4) On the cooling cycle the bypass dampers shall close and all air shall pass through the cooling coil. The space thermostat shall control a modulating pneumatic two way valve on the water supply line to the cooling coil. Valve capacity shall be as scheduled on the drawing and have a 7 foot pressure drop.

b. "Smoke Control Mode"

(1) On fire emergency condition as defined in the input/output schedule the following shall occur:

(A) The supply fan shall shut down.

13. Supply Unit S-13C and Return-Exhaust RE-10C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 39%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

14. Supply Unit S-14C and Return-Exhaust RE-11C

a. "Normal Mode" control of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except.

(1) Minimum outside air admitted to the unit under its present start up condition shall be 100%. Return-exhaust fan RE-11C will be provided at this time but will be manually shut down. Return and exhaust dampers and motors shall be provided at this time for future sequencing with outdoor air damper on supply unit.

(2) This supply unit includes a glycol/water heat recovery coil, which in conjunction with a similar coil in exhaust fan E-4C, discharge plenum shall be controlled as follows:

(A) Heat Recovery coil shall be controlled by two (2) adjustable insertion controllers with twenty (20) foot capillary sensing elements. The first element shall be serpentine across the inlet air side of the heat recovery coil, and through receiver shall start a recirculating pump, when temperature drops below 55 degrees F. The second element shall be serpentine across the air leaving side of the coil and which through a receiver shall modulate a three-way valve on the glycol pipe leaving the coil to maintain 55 degrees F. leaving air temperature.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

15. Supply Unit S-15C and Return-Exhaust RE-12C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 24%.

b. "Smoke Control Mode" of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

16. Supply Unit S-16C and Return-Exhaust RE-13C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except:

(1) Minimum outside air admitted to the unit under its present start up condition shall be 10%.

(2) This unit will have a future heat recovery coil. Provision shall be made for easy addition of controllers as specified under item 14.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

17. Supply Unit S-17C and Return-Exhaust RE-14C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C except, minimum outside air admitted to the unit under its present start up condition shall be 44%.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-2C and return-exhaust RE-1C.

18. Supply Fan S-18C (Animal Rooms)

a. "Normal Mode" control of this unit and its interlocked exhaust fans shall be the identical system as described for S-1C with the following exceptions:

(1) This supply unit glycol/water heat recovery coil works, in conjunction with a similar coil in Exhaust fan E-4C discharge plenum.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be identical to that described for supply unit S-1C.

19. Supply Unit S-19C (10th Floor Equipment Room) and Return-Exhaust RE-15C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C.

20. Supply Unit S-20C (Skyway to Mayo) and Return-Exhaust RE-16

a. "Normal Mode"

(1) This system includes a packaged supply air unit with integral chilled water coil, steam preheat coil and face and bypass dampers. Also included in the system are return and outdoor air dampers and return-exhaust fan with exhaust air dampers. The supply fan and return-exhaust fan will be interlocked by the Electrical Contractor.

2. On fan shutdown the outside and exhaust air dampers will close and the return air damper open. On electrical or air failure the exhaust and outdoor dampers shall close and the return air damper shall open.

3. The minimum percentage of outside air for this unit shall be 0%. The mixed air temperature shall be controlled by a 20 ft. averaging bulb sensor (55°F) controlling the modulating outdoor air and return air dampers.

4. Control of this supply fan shall be by means of an H-O-A switch located in the motor control center in the 10th floor equipment room.

5. A heat-cool master space stat shall, during the heating cycle, through an adjustable low limit submaster stat (55°F) modulate the heating coil steam valve and face and bypass dampers in sequence to maintain space temperatures.

6. On the cooling cycle the bypass dampers shall close and all air shall pass through the cooling coil. The space thermostat shall control a modulating pneumatic two way valve on the water supply line to the cooling coil. Valve capacity shall be as scheduled on the drawing fan schedule and have a 7 foot pressure drop.

7. A safety low limit stat 40°F., located on the air entering side of the cooling coils, shall stop the supply fan if air temperature drops below 40°F.

b. "Smoke Control Mode"

(1) On fire emergency condition as defined in the input/output schedule, the following shall occur:

(A) The supply fan and return-exhaust fan shall shut down.

21. Supply Unit S-21C (15th floor equipment room) and Return-Exhaust RE-17C

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C.

22. Supply Unit S-22C (Elevator Equipment Room) and Return-Exhaust RE-18C.

a. "Normal Mode" control of this unit and its interlocked return-exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C.

b. "Smoke Control Mode" of this unit and its interlocked exhaust fan shall be the identical system as described for supply unit S-11C and return-exhaust RE-9C, when smoke is sensed in the elevator equipment room itself. If any other building smoke sensor or other fire alarm device is actuated in the building, supply unit S-22C shall continue to run bringing in 100% outside air and return exhaust RE-18C shall shut down with both its return and exhaust dampers closing. This will ensure a positive pressure in the elevator shaft.

23. Supply Unit S-23C (Future Kitchen)

This packaged supply unit is being provided at this time with no interconnected ductwork and no wiring connections.

24. Unit Control Panels

a. Furnish and install unit control panels for all air supply units, converter assemblies, hot water heater units, heat recovery systems, etc. Panels shall be constructed of steel or plastic laminate and all piping, wiring, supplementary relays and switches shall be concealed behind the cover or in the back panel. All controllers, unless otherwise noted, thermometers, RH indicators, main air gauges and branch air gauges shall be mounted on the face of the unit panel.

25. Air Flow Indicators

a. Furnish and install pressure differential switches in fume hood exhaust systems FE-1C through FE-13C (one per fume hood). This Contractor shall be responsible for the devices operating satisfactorily with the pressure differentials within the duct systems. All indicator lights are furnished with the fume hoods. All wiring between PE switch and indicator lights by Electrical Contractor. This Contractor shall locate the PE switch within one (1) foot of where the fume hood exhaust duct penetrates the ceilings or as shown on plan.

26. Exhaust Fans

a. The fume hood fans will operate 24 hours on a continuous operation and therefore will have no automatic temperature control. All other exhaust fans shall have a motorized damper connected to open when the exhaust fans are running and close when the exhaust fans are closed.

27. Heating and Ventilating Unit for Elevator Shaft (S-24C)

a. Control of this unit shall be by means of an H.O.A. switch located in motor control center.

b. With fan operation a space thermostat (75°F) shall modulate a control valve on the steam heating coil. See drawings Sheet M-104 for schedule.

28. Combustion Air for Engine Driven Emergency Generators and Fire Pump

a. A combustion air damper for emergency generator and diesel fire pump shall be provided in the basement equipment room where shown on the drawings. This damper shall open when either of these two items are called on to operate. Control wiring for this sequence shall be from an emergency source.

b. A similar combustion air damper shall be provided in the 10th and 15th floor equipment room. These dampers shall open when their respective emergency generators are started up. Control wiring shall be from an emergency source.

c. Dampers shall return to closed position upon engine shut down.

29. Propeller Unit Heaters (Hot Water)

a. Space electric line voltage thermostats, shall cycle respective fans to maintain a space temperature. This contractor shall furnish and install thermostat. Wiring of unit heaters and thermostat by Electrical Contractor.

30. Cabinet Unit Heaters (Hot Water and Steam)

a. Control of the cabinet unit heaters shall be by means of a pneumatic space thermostat (75°F) and an aquastat. Aquastat shall be mounted at the coil outlet. The space thermostat shall open and close a two (2) position valve to maintain space temperature. The aquastats shall cycle the fan.

31. Convactor (Hot Water)

a. A pneumatic space thermostat shall modulate a control valve to maintain space temperature.

32. Reheat Systems Converter Control

a. Pumps shall be manually operated by H-O-A switch located in the motor control center in basement equipment room and run continuously.

b. An outside air thermostat, located to be shielded from the sun and other sources of radiation, shall reset a submaster discharge aquastat which shall, in turn, control a modulating steam valve on the steam supply line to the convertor. As the outside air temperature varies from 55 degrees F. to 95 degrees F., the water temperature shall be reset from 190 degrees F. to 138 degrees F. Range and reset ratio shall be adjustable. The aquastat shall be located a minimum distance of five (5) feet downstream from the converters. Steam valves for each converter shall be Honeywell Industrial Type Series 8105, Johnson Series V-9000, or equal, cage type, with gradutrol positioner, iron body 125 flange, single seated. Valves shall be sized for steam capacity as listed in following schedule with 12 psi entering and 8 psi drop.

(1) Valve Schedule

Convactor #1 (Reheat System 1) - 3300 lbs.

Convactor #2 (Reheat System 1) - 3300 lbs.

Convactor #3 (Reheat System 2) - 4000 lbs.

Convactor #6 (Reheat System 3) - 3300 lbs.

Convactor #7 (Reheat System 3) - 3300 lbs.

Convactor #8 (Reheat System 4) - 4000 lbs.

33. Radiation System Converters Control

a. Pumps shall be controlled by an adjustable outdoor thermostat (one for each system) to start pumps when temperature is 60 degrees F. or less and stop when temperature rises above 65 degrees F.

b. An outside air thermostat, located to be shielded from the sun and other sources of radiation, shall reset a submaster discharge aquastat which shall, in turn, control a modulating steam valve on the steam supply line to the converter. As the outside air temperature varies from -20 degrees F. to 65 degrees F., the water temperature shall be reset from 195°F to 100°F.

(1) Valve Schedule

Radiation Convactor #4 (Radiation System 1) - 900 lbs.

Radiation Convactor #9 (Radiation System 2) - 1000 lbs.

34. Hot Water Reheat Coil Control

a. Control of the individual hot water reheat coils shall be by means of a room thermostat (75°F.) controlling a modulating valve on the hot water supply line to the coil. Valve capacities shall be based upon quantities as tabulated on the drawings. Valve pressure drop shall be 7 feet, maximum.

35. Pressure Regulating and Flow Control for Reheat Systems

a. Control of water flow in the reheat systems shall be by means of a differential pressure controller, Honeywell PP903A, Johnson R-975, or equal, modulating a Honeywell Series 9101, Johnson Series 9000, or equal, normally closed, pneumatic valve at pump discharge, to throttle the water flow. Differential pressure controller shall be located on the system piping where shown on drawings. Pressure regulating valve shall be sized according to the following schedule with 8 foot pressure drop.

	<u>Flow</u>
Reheat System No. 1 -	211 GPM
No. 2 -	211 GPM
No. 3 -	255 GPM
No. 4 -	77 GPM

36. Steam Reheat Coil Control

A. Control of the individual steam reheat coils shall be by means of a room thermostat (75°F.) controlling a modulating steam valve on the steam supply line to the coil. Valve capacities shall be based on quantities as tabulated on the drawings with 8 psi pressure drop.

37. Domestic and Laboratory Water Heater Control

a. Furnish and install air lines to the valves specified in Section 15220 for each domestic and laboratory water heater. The air supply line pressure shall not be less than 18 psig.

38. Water Storage System For On-Site Fire Protection

a. This Contractor shall supply and install a motorized valve in the 8" line between the water storage vessel and the suction manifold of the two building fire pumps. See drawing schematic detail, sheet M-46. This valve shall be wired such, that with a loss of city main pressure in either of two branch mains feeding the fire pumps suction, the valve will open to the standby water source. Control wiring shall be from an emergency source.

39. Refrigeration Machine Control

a. This Contractor shall furnish and install an air supply line to each refrigeration machine as specified and furnished in Section 15900. The air supply line pressure shall not be less than 30 psig.

40. Chilled Water Secondary Loop Control (Typical 2 Secondary Systems)

a. The variable flow requirement of chilled water in the typical secondary pumped loop shall be satisfied by maintaining a constant pressure between the supply and return mains no matter how many two way valves in the system are open. Secondary loop differential chilled water pressure shall be controlled by varying the speed of the secondary chilled water pump.

(1) Honeywell Industrial 29212 Pneumatic Differential Pressure Transmitter will sense differential pressure between supply and return mains of the secondary loop. This transmitter may be overridden by a discriminatory controller, which, with logic and multiple signal selection of all two way valves on the secondary loop, detect any starved circuit whose thermostat signal may be calling for a wide-open valve, despite a lessening of differential pressure sense across the loop by the transmitter. The transmitter as previously described will convert and transmit the resultant signal to a Honeywell L91B pressure to current converter. This converter will interface directly to the SCR variable speed control input. The variable speed control unit will be supplied by the Mechanical Contractor and be an Aurora Simplex Apco-matic or equal. Accuracy of transmitter shall be $\pm 1\%$ of full scale differential pressure.

b. A constant speed pump will be provided as a standby unit for either of two variable speed pumps controlled under item a. See piping isometric drawing sheet M-104. This standby pump shall be controlled as follows: The signal from the discriminatory controller as described in a., for whichever pump is "down", shall be used to operate a "Normally Open" butterfly valve on the corresponding secondary loop return to the primary main. When the signal is switched to "Standby" position from "Normal", the variable speed pump unit shall be de-energized and the standby pump shall be energized. The amount of chilled water drawn into the secondary circuit from the primary supply main will thus be controlled from a signal which will be indicating the need of chilled water in the secondary zone. As the standby pump is a constant flow type, a bypass line with self contained pressure relief valve will be provided around the pump by the Mechanical Contractor. Butterfly valves shall be sized for gallonages as scheduled on the drawings with a 10 foot pressure drop, maximum.

41. Radiant Panel Heating (Dog Runs)

a. One hydronic converter shall serve for separate radiant floor panels in four separate dog run areas. The hydronic hot water system shall include one primary pump and four secondary circulating pumps associated with the four radiant floor panels. All control adjustments and floor slab temperature readouts will be made at the radiant heat control panel located where shown in Room 1-370.

b. The control panel shall be surface mounted and contain start-stop switches for each of the four radiant floor areas. Any of the four switches shall start the primary circulating pump and its corresponding secondary circulating pump. The primary pump shall continue to run until the last panel switch is shut off.

c. An immersion sensor located in converter leaving water acting through its controller will modulate a normally closed steam valve to maintain

desired primary loop temperature. When the primary pump is off the steam valve shall positively close. A high limit located in primary pump discharge water shall shut down system if its set point is reached.

d. An immersion sensor shall have its immersion well installed as per drawing detail 4/M-72 in each floor panel and located so as to sense average floor slab temperature. This sensor acting through its controller, shall modulate a normally closed two way valve in the typical primary loop cross over bridge allowing hotter water into the secondary circuit. Electronic or pneumatic transmission shall be used between the immersion sensor and the controller to be installed in the central control panel.

e. The face of the control panel will contain 3-1/2 inch flush mounted temperature indicators for each radiant panel slab temperature. The panel will be complete with locking hinged door. Within panel there shall be a gradual acting pneumatic switch which will allow temperature to be adjusted $\pm 20^\circ$ from the set point.

42. Cage Washer

a. In Mezzanine room 115, provide dampers in exhaust duct so that when cage washer is not running the room air shall be exhausted through room ceiling register and when the cage washer is energized the duct damper will close and the cage washer damper shall open and room air will be exhausted through cage washer.

43. R.F. Shielded Rooms

a. Rooms 1-215, 1-214, B-131, B-151, and 9-135 shall be installed complete with PVC tubing to the thermostat and reheat coil valve.

44. Humidity and Temperature Indicator (Animal Rooms)

a. In each animal room and where H_g symbol is shown on the mechanical HVAC Drawings, supply and install a humidity and temperature indicator. Indicator shall be Abbeon Certified Hygrometer Model No. HTAB-169 with accuracy within 2% plus or minus. The 5" diameter dial face shall include temperature indication and be complete with stainless steel non-corrosive metal case.

45. Booster Room Humidifier

a. Space humidistat shall modulate the humidifier steam valve to maintain the space humidity at its setting of 50% R.H. Furnish air flow detector to close valve on no air flow.

46. Electric Shaft Ventilation

a. A room thermostat located where shown on the drawings shall cycle an exhaust fan at the top of each electrical core to maintain optimum space temperature. Fan shall start on a rise above stat set point.

47. High Pressure Control Air Supply

a. A high pressure (90 psi) control air supply main shall be furnished and installed with reducing stations as required for the following:

(1) Double Acting Butterfly valves supplied and installed under Section 15900 on chilled water and condenser water inlets to each absorption machine. Pipe air to valve locations. Valve control sequence by Mechanical under Section 15900.

(2) Double Acting Butterfly valves supplied and installed under Section 15900, on cooling tower inlets on existing Unit 'A' roof. Six valves total (3 existing plus 3 new) shall be piped to high pressure control air. Valve control sequence by Mechanical under Section 15900. Existing 3 valves shall remain also connected to 90# lab. air system in Unit 'A' for standby purposes.

(3) Automatic deluge fire protection system for cooling towers on Unit 'A' roof supplied and installed under Section 15500, shall be supplied with high pressure control air. 6 systems total shall be connected up (3 existing, plus 3 new). Existing 3 systems shall remain also connected to 90# Lab. air system in Unit 'A' for standby purposes.

J. FUTURE CENTRALIZATION

1. The control systems as described in these specifications shall be fully compatible for integration into a future central data center. All controls shall be chosen so that they will not have to be changed when the future connection is accomplished.

2. Provisions shall be made in the form of resistance or thermocouple, capped tees and shut-off valves, etc. to provide the following indication as scheduled.

3. Insertion wells shall be Honeywell 14500430 for future insertion of sensors compatible with Honeywell Delta 2000 system.

4. Schedule of Remote Inputs

<u>Definitions</u>	<u>Symbol</u>
a) Start-Stop Control	SS
b) Programmed Start Stop of Day Night Control	P/SS
c) Temperature Indication	T/C
d) Pressure Indication	PI
e) Run Indication	RI
f) Flow Alarm (liquid or air)	FA
g) Filter Alarm	FLT
h) High Alarm	HI
i) Low Alarm	LO
j) Control Point Adjustment (Reset)	CPA
k) Relative Humidity Indication	RH
l) Other Alarms, as stated	X

<u>Definitions</u>		<u>Symbol</u>	
m)	Liquid Level	LL	
n)	Programmed Day-Night Control	P/DN	
4.	<u>A.H.U. #1</u> (Animal Rooms)	<u>Indication</u>	<u>Alarm</u> <u>Control</u>
	Supply Fan	RI	FA P/SS
	Freeze Alarm		X
	Filter Alarms (2 thus)		FLT
	Discharge Air	T/C	Hi/Lo CPA
	Air Leaving Preheat Coil	T/C	
	Outside Air	T/C	
	Air Leaving Heat Recovery Coil	T/C	
	Relative Humidity	RH	CPA
5.	<u>A.H.U. #2</u>	<u>Indication</u>	<u>Alarm</u> <u>Control</u>
	Supply Fan	RI	FA P/SS
	Freeze Alarm		X
	Filter Alarm (2 thus)		FLT
	Discharge Air	T/C	Hi/Lo CPA
	Air Leaving Preheat Coil	T/C	
	Outside Air	T/C	
	Mixed Air	T/C	CPA
	Relative Humidity	RH	CPA
6.	<u>A.H.U. #3</u>	<u>Indication</u>	<u>Alarm</u> <u>Control</u>
	Supply Fan	RI	FA P/SS
	Freeze Alarm		X
	Filter Alarm (2 thus)		FLT
	Discharge Air	T/C	Hi/Lo CPA

6.	<u>A.H.U. #3 (cont.)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		
7.	<u>A.H.U. #4</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
8.	<u>A.H.U. #5</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
9.	<u>A.H.U. #6</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA

9.	<u>A.H.U. #6 (cont.)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
10.	<u>A.H.U. #7</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
11.	<u>A.H.U. #8</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
12.	<u>A.H.U. #9 (Auditorium)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA

12.	<u>A.H.U. #9 (cont.)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
	Air Leaving Reheat Coil	T/C		CPA
13.	<u>A.H.U. #10</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	(Stairway Pressurization)			
	Supply Fan	RI		
14.	<u>A.H.U. #11</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	(Basement Equipment Room)			
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm		FLT	
	Discharge Air	T/C	HI/Lo	CPA
	Outside Air	T/C		
15.	<u>A.H.U. #12</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	(Skyway to Unit 'A')			
	Supply Fan	RI	FA	P/SS
	Filter Alarm		FLT	
	Discharge Air	T/C	HI/Lo	CPA
	Return Air	T/C		
16.	<u>A.H.U. #13</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	HI/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA

17.	<u>A.H.U. #14</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
	Air Leaving Heat Recovery Coil	T/C		
18.	<u>A.H.U. #15</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
19.	<u>A.H.U. #16</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA

19.	<u>A.H.U. #16 (cont.)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Air Leaving Heat Recovery Coil	T/C		
20.	<u>A.H.U. #17</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Mixed Air	T/C		CPA
	Relative Humidity	RH		CPA
21.	<u>A.H.U. #18</u> (Animal Rooms)	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm (2 thus)		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Air Leaving Preheat Coil	T/C		
	Outside Air	T/C		
	Air Leaving Heat Recovery coil	T/C		
	Relative Humidity	RH		CPA
22.	<u>A.H.U. #19</u> (10th Floor Equipment Room)	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Discharge Air	T/C	Hi/Lo	CPA
	Filter Alarm		FLT	
	Outside Air	T/C		

23.	<u>A.H.U. #20</u> (Skyway to Mayo)	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Mixed Air	T/C		
	Outside Air	T/C		

24.	<u>A.H.U. #21</u> (15th Floor Equipment Room)	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Filter Alarm		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Freeze Alarm		X	
	Outside Air	T/C		

25.	<u>A.H.U. #22</u> (Elevator Equipment Room)	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Supply Fan	RI	FA	P/SS
	Freeze Alarm		X	
	Filter Alarm		FLT	
	Discharge Air	T/C	Hi/Lo	CPA
	Outside Air	T/C		

26.	<u>Converters</u>			
	<u>Reheat System #1</u> <u>Convertor #1</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Floors 6 through 15			
	Supply Water	T/C		CPA
	Circulating Pumps		FA	
	EXPANSION TANKS		LL	

<u>Reheat System #1 Convertor #2</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
Floors 6 through 15			
Supply water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANK		LL	
<u>Reheat System #2 Convertor #3</u>			
Floors 6 through 15			
Supply Water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANK		LL	
<u>Reheat System #3 Convertor #6</u>			
Floors 1 through 5			
Supply Water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANK		LL	
<u>Reheat System #3 Convertor #7</u>			
Floors 1 through 5			
Supply Water (one)	T/C		CPA
Circulating Pumps (two)		FA	
EXPANSION TANK		LL	
<u>Reheat System #4 Convertor #8</u>			
Floors 1 through 5			
Supply water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANKS		LL	

<u>Radiation System #1 Convertor #4</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
Floors 6 through 15 (two thus)			
Supply water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANKS		LL	
<u>Radiation System #2 Convertor #9</u>			
Floors 3 through 5			
Supply water	T/C		CPA
Circulating Pumps		FA	
EXPANSION TANK		LL	
<u>Radiant Panel Generator</u>			
Supply Water	T/C		CPA
Circulating Pumps	FA		
EXPANSION TANK		LL	
27. <u>Chillers</u>			
Chiller #4 and #5 run Indication and alarm	RI	X	
Chilled Water Supply 2 each	T/C	Hi/Lo	CPA
Chilled water return 2 each	T/C		CPA
Condenser water supply 2 each	T/C	Lo	
Condenser water return 2 each	T/C	Hi	
Primary Chilled Water Pump (2 each)	RI	FA	
Secondary Chilled Water Pump (2 each)	RI	FA	SS
Condenser Water Pump (2 each)	RI	FA	

27.	<u>Chillers (cont.)</u>	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
	Secondary Chilled Water Loops (2 each)	T/C		
	Steam Inlet to Chillers (2 thus)	PI		
28.	<u>Cooling Towers #5, #6 and #7</u>			
	Cooling Tower Basin	T/C	LL	
	Cooling Tower Fan High Speed (3 thus)	RI		
	Cooling Tower Fan Low Speed (3 thus)	RI		
29.	<u>Sump Alarms</u> (Basement Equipment Room)			
	Elevator Pit (2 thus)		LL	
	Fresh Air Intake Drainage (2 thus)		LL	
30.	<u>Miscellaneous</u>			
	Hot Water Heaters (7 thus)	T/C	Hi/Lo	
	Clinical Vacuum System (2 thus)		Hi	
	On-site Water for Fire Protection		Lo	
	Overhang Floor Space			
	- 6 places 13th Floor	T/C		
	- 1 place 9th Floor	T/C		
	- 1 place 8th Floor	T/C		
	- 1 place 6th Floor	T/C		
	- 2 places 4th Floor	T/C		
	Controlled Environmental Rooms (7 thus)	T/C		
	Domestic Booster Water Pumps (3 thus)	RI	Hi/Lo	
	Heat Recovery Systems (3 thus)	RI		
	Fume Hoods (10 thus)	RI		SS

	<u>Indication</u>	<u>Alarm</u>	<u>Control</u>
31. <u>Emergency Generator Radiator Coolant System (3 thus)</u>			
Expansion Tank		LL	
32. <u>Heating Unit for Elevator Shaft (S-24C)</u>			
Supply Fan	RI	F/A	P/SS
Discharge Air	T/C	HI/Lo	CPA
Filter Alarm		FLT	

K. THERMOMETERS

1. Furnish and install Honeywell #W655, or equal, round dial remote bulb thermometer. Thermometer shall have suitable operating ranges and shall be installed so as to be conveniently read in the following locations on the supply air units.

- (a) Outside air intake of Units S-1C through S-22C with the exception of Room S-10C and S-12C.
- (b) Mixed air stream on all units except S-1C, S-10C, S-12C and S-18C.
- (c) After heat recovery coil of units S-1C, S-14C, S-18C and S-16C.
- (d) Supply air discharge of all units.
